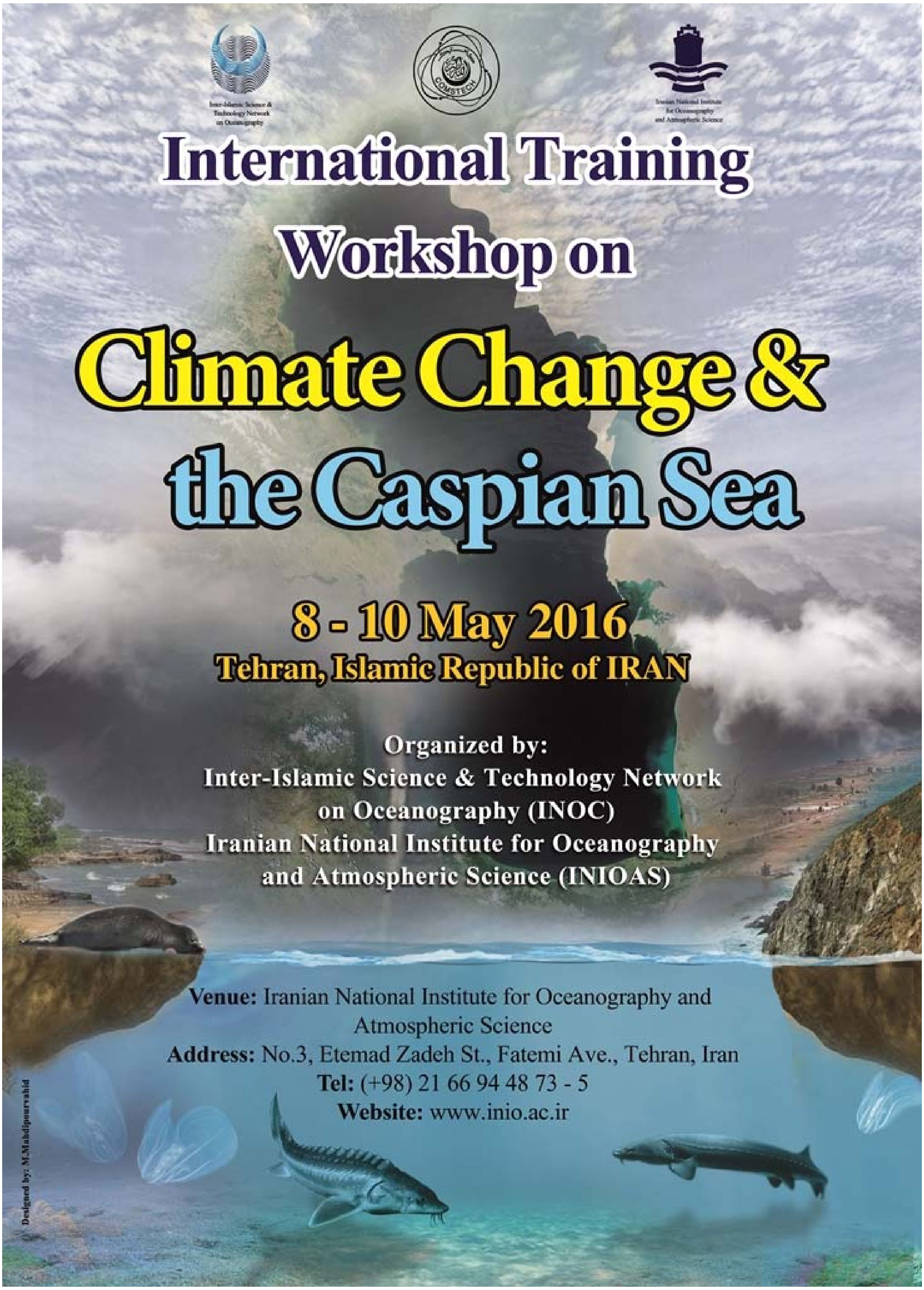
International Training
Workshop on
Climate Change &
the Caspian Sea
8 - 10 May 2016
Tehran, Islamic Republic of IRAN
Organized by:
Inter-Islamic Science & Technology Network
on Oceanography (INOC)
Iranian National Institute for Oceanography
and Atmospheric Science (INIOAS)
Venue: Iranian National Institute for Oceanography and
Atmospheric Science
Address: No.3, Etemad Zadeh St., Fatemi Ave., Tehran, Iran
Tel: (+98) 21 66 94 48 73 - 5
Website: www.inio.ac.ir

ORGANIZED BY:

	Inter-Islamic Acience and Technology Network on Oceanography (INOC), Izmir – TURKEY
	Iranian National Institute for Oceanography and Atmospheric Science (INIOAS), Tehran, Iran
	Regional Education and Research Center on Oceanography for West Asia (RCOWA), Tehran - Iran
	Ministerial Standing Committee on Scientific and Technological Cooperation (COMSTECH), Islamabad, Pakistan

8-10 May 2016; TEHRAN (ISLAMIC REPUBLIC OF IRAN)

PROGRAM OF THE CLIMATE CHANCE AND THE CASPIAN SEA WORKSHOP/TRAINING

8 May 2016

9:00-10:30	INUAGURATION
	Nasser Hadjizade Zaker; Director of INOAS
	Mustafa Ergun; Executive Director of INOC
	Qasim Jan; Adviser of COMSTECH
10-30-11:00	TEA BREAK
11:00-12:30	Nasser Hadjizade Zaker: General Aspects of the Caspian Sea
12:30-14:00	LUNCH
	14:00-15:30 Mustafa Ergun: General Tectonic/Geologic Framework of the Caspian Sea and its water connection with the Black Sea and Mediterranean
15:30-16:30	TEA BREAK
16:30-18:00	Murat Gunduz: Effects of the Atmospheric Tele-connection Patterns on the Caspian Sea Climate

9 May 2016

9:00-10:30	Elnur Safarov: Climate Change Impacts on Sea Water Level Oscillations in the Caspian
10-30-11:00	TEA BREAK
11:00-12:30	Lychagin Mikhail Yu: “Climate Change Impacts on Ecosystem and Biodiversity in the Caspian Sea
12:30-14:00	LUNCH
14:00-15:30	Harun Guclusoy: Strengthening the System of Marine and Coastal Protected Areas of Turkey"

	Chingiz Mamadov: UNDP Climate Change and Caspian Sea Related Portfolio in Azerbaijan
15:30-16:30	TEA BREAK
16:30-18:00	Ozgur Altan: Adaptation of Aquaculture Activities to Negative Effects of Climate Change

10 May 2016

9:00-10:30	New talks (open)
10-30-11:00	TEA BREAK
11:00-12:30	Climate Change Strategy and implementation plans for the Caspian Sea (GENERAL DISCUSSION)
12:30-14:00	LUNCH
AFTERNOON:	Visiting the Historical Sights in Tehran
11-12 May 2016	EXCURSION TO THE CASPIAN SEA
13 May 2016	Departure from Tehran

General Aspects of the Caspian Sea

Dr. Nasser Hadjizadeh Zaker
Director of Iranian National Institute for Oceanography and Atmospheric Science

Abstract

The Caspian Sea, as the largest inland water body on the Earth, is a very important marine environment for the world and in particular for the lateral countries around it. It is located in western Asia on the eastern edges of Europe. The measured surface area is 371,000 sq km, and the maximum depth is at 1025 m. The countries of Iran, Azerbaijan, Russia, Kazakhstan and Turkmenistan border the sea. Oil and natural gas production platforms are replete along the edges of the sea. In addition, large quantities of sturgeon live in its waters, and the caviar produced from their eggs is a valuable commodity. A vertical variation of temperature between 29°C at the sea surface and less than 8°C at 117 m depth is seen.

Previous studies on the currents of the southern shelf of the Caspian Sea adjacent to Iran show uniform alongshore currents across the shelf both horizontally and vertically. Wind stress is generally weak and mainly in west to east direction and no upwelling favorite condition or occurrence is observed. Considerable monthly currents in west to east direction are seen indicating the effect of basin scale anticlockwise currents in the Caspian Sea. In summer the temperature structure indicates the existence of a sharp thermocline however in autumn with seasonal climate changes, increase of turbulent kinetic energy and deepening of the surface mixed layer, the thickness of the thermocline decreases. Vertical salinity variations are very small. Density variations are in agreement with the temperature changes and the effect of salinity in density changes is minor.

Abstract of PP Presentation

By Chingiz Mammadov

UNDP Senior Programme Advisor

Topic:UNDP Climate Change and Caspian Sea Portfolio in Azerbaijan

Despite emitting less than half a percent of the world total GHG emissions, Azerbaijan has demonstrated a strong commitment to reducing its own negative contribution to the climate change. Under Paris Agreement on Climate Change, the Republic of Azerbaijan targets to reduce its GHG emissions by 35% by 2030 compared to 1990 base year. Azerbaijan regularly reports to the Secretariat of the United Nations Framework Convention on Climate Change (UNFCCC) on the status of its emissions under National Communications and Biennial Reporting.

Besides regular reporting, Azerbaijan implements several climate change mitigation and adaptation projects under UNFCCC. The other relevant UN Conventions under which Azerbaijan takes measures to reduce negative impact on Climate Change and the Caspian Sea is UN Convention on Biodiversity (CBD), Convention to Combat Desertification (UNCDD), Ramset Convention and Minamata Convention on Mercury. One of the most important UNDP activities in Azerbaijan is the project to transform the Gizil-Agaj Protected Area located on the Southern-Western shore of the Caspian Sea and being a Ramsar site into the National Park.

In total, there are about ten relevant active projects UNDP implements jointly with the Government of Azerbaijan. The major partner of UNDP in Azerbaijan is the Ministry of Ecology and Natural Resources. The other partners are the Ministry of Emergency Situation, the Ministry of Agriculture, and the State Oil Company of the Republic of Azerbaijan. The projects are jointly funded by the Government of Azerbaijan, UNDP and international donors. The major international donor in the sphere of ecology in Azerbaijan is the Global Environment Facility. The total funding of currently active projects is close to 10 millions USD.

STRENGTHENING THE SYSTEM OF MARINE & COASTAL PROTECTED AREAS OF TURKEY

Harun Güçlüsoy

Dokuz Eylül University - Instiute of Marine SciencesandTechnology, Izmir, Turkey
Telephone: +90 530 878 7017 Email: harun.guclusoy@undp.org&
harun.guclusoy@deu.edu.tr

ABSTRACT

The major outcome of the United Nations Conference on Sustainable Development (Rio+20) "The Future We Want" document stressed "the importance of the conservation and sustainable use of the oceans and seas and of their resources for sustainable development", and the article 177 dictated that the "importance of area-based conservation measures, including marine protected areas", and noted that "decision X/2 of the tenth Meeting of the Conference of the Parties to the Convention on Biological Diversity, that by 2020 10 per cent of coastal and marine areas, especially areas of particular importance for biodiversity and ecosystem services, [were] to be conserved through effectively and equitably managed, ecologically representative and well-connected systems of protected areas and other effective area-based conservation measures". In this context, within the marine areas bordering Turkey's lengthy coastline is found an abundant, highly diverse and globally significant biodiversity endowment. As a baseline in 2009 about 2.8% of Turkey's territorial waters were protected. Turkey's system of MPAs consists of 10 Special Environmental Protection Areas (SEPA), 3 National Parks, and 1 Nature Park, about 40 fisheries restricted areas. The proposed long-term solution for marine biodiversity conservation in Turkey's marine areas is a reconfigured Marine and Coastal Protected Areas (MCPA) network designed to protect biodiversity while optimizing its ecological service functions – under effective and sustainable adaptive management. Working together with its partners, the GEF project, started in 2009, and is supporting the development of responsible institutions able to prioritize the establishment of new MCPAs and more effectively manage existing MCPAs. The project is also facilitating adequate levels of revenue generation and cost-effective management through

the development of an MCPA management system. Finally the project promotes Inter-agency coordination mechanisms to regulate and manage economic activities within multiple use areas of the MCPAs. At the end of the project, there were major achievements under capacity building, financial sustainability and coordination outcomes. To maintain the sustainability MCPA Training and Implementation Centre was established in Akyaka, Muğla, and the curriculum for the centre is under preparation together with NOAA and WWF Mediterranean Program Office. The cabinet decree, which declares Gulf of Saros (Çanakkale) -covering approximately 75.000 ha.-as SEPA, entered into force. With the same legislation, the Gökova SEPA's (Muğla) borders were also extended (50.000 ha.) in December 2010. Gökova and Foça SEPA Management Plans were prepared. National MCPA Strategy and Action Plan document is prepared and is awaiting final inputs from relevant stakeholders. The Business Development Unit as the Permits and Management Branch Directorate of General Directorate for Protection of Natural Assets was established and income generated from respective MCPAs reached to 16% of total institutional budget from 10% baseline figure. The valuation of eco-system services for six project sites were calculated at 410 million USD, and shared with public, this was the first national level initiative for marine eco-system services. Ten No Fishing Zones were established in the Gökova and Datça-Bozburun SEPAs in 2010 and 2012 respectively. The preparation and development phase for the establishment of the 6 NFZs in Gökova SEPA were achieved under GEF-SGP funded project by the Underwater Research Society - Ecology Group.

Finally, carbon sequestration of *Posidoniaoceanica* meadows in 6 MCPAs, and mooring system established to mitigate the anchor damage on these meadows in Fethiye-Göcek Special Environment Protection Area will also be briefed.

Climate Change Impacts on Sea Water Level Oscillations in the Caspian

Elnur Safarov

Scientific researcher; Institute of Geography Azerbaijan National Academy of Science

Az1143 – Baku, Azerbaijan

e-mail: elnur.safarov@geo.ab.az

Abstract

Sea level fluctuations are among the most outstanding and debated issues of the Caspian Sea. These changes contribute to active debates among scientists. Fluctuation in the level of the Caspian Sea is quite a serious problem and there is a great need for a comprehensive study of its entire sea area.

Precipitation, underground water and river input are consistent parts of the inflow of the Caspian Sea water balance. The river input is also considered to be the main driver of the seasonal level changes of the Caspian Sea. Sufficiently large amount of this input is provided by the Volga. Although there is a good network of sea level stations covering the coastline of the sea, these facilities are not capable to reflect the sea level variations over the all surface. Meanwhile, the Caspian Sea is well observed by satellites Jason 1, Jason 2 and ENVISAT. Altimetric data taken from these satellites covers the surface of the sea much better than the data from the in-situ network stations. In this case investigation of the spatial variability of the sea level that could provide more insight into the influence of river input (especially the Volga and the Ural Rivers), precipitation and other hydro-meteorological parameters on the Caspian Sea level is very important.

Climate Change Impacts on Coastal Ecosystems of the Caspian Sea

Mikhail Yu. Lychagin

Moscow State University, Faculty of Geography

lychagin2008@gmail.com

The Caspian Sea experienced a full sea-level cycle between 1929 and 1995, with amplitude of 3 meters. Rates of the sea-level change between the 1977 low stand and the 1995 high stand average a hundred times that of the eustatic rise. An environmental problem in itself, Caspian sea-level change also offers numerous exciting opportunities to science. Caspian Sea level is controlled in the first place by its water balance, dominated by the influx of the Volga river (80%) and other rivers, and on the outflux by evaporation at the sea surface. It is obvious that changes in precipitation over the basin are closely linked to global atmospheric circulation, and therefore it may provide a yardstick for global climate change. Another opportunity is that Caspian coasts are a physical laboratory for what might happen along oceanic coasts as a result of sea-level rise triggered by global warming.

The Caspian Sea level fluctuations essentially influence a diversity of the coastal zone environment. Along accumulative shores the sea transgression gives rise to geomorphological, lithological, soil, and biotic, as well as geochemical diversity of the coastal ecosystems. This is caused by inundation and water-logging processes, with a corresponding rise of the groundwater table, and also simultaneous vigorous development of vegetation in newly-formed hydromorphic and semi-hydromorphic areas (salt marshes). On the contrary, the sea regression leads mainly to the passive drowning of the shore zone with a following decrease of the coastal environment variability.

Geochemical conditions of the coastal ecosystems are also undergone changes due to the sea-level fluctuations. Regressive stage associates with a low variability of geochemical environments in sediments and soils. The latter are characterized mainly by alkaline oxic conditions, and salinazation as a leading geochemical process. Geochemical diversity of the coastal zone during a transgressive stage is much higher. Conditions vary from neutral to highly-alkaline and from oxic to highly anoxic. Newly-formed geochemical processes are presented by sulfidization, gleyzation, ferrugination, organic matter accumulation, and salinazation. They cause a formation of various contrast geochemical barriers in soils and sediments with a consequent redistribution of chemical elements.

Formation of barrier-lagoon systems due to the sea-level rise is quite typical for accumulative shores in different areas of the world. Thus, the evolution of the Caspian coasts under the sea-level changes serves as a natural model that can be used for understanding the general features of development of the world ocean coasts. Our local study of geochemical changes of the Caspian salt marshes describes the regional environmental changes of the coastal zone.

The Volga delta serves as an example to study the impact of sea-level change on gently sloping coasts, where waves are dissipated before they can reach the coast. The Volga delta is one of the largest deltas in the world, and distinguishes itself from others by its extremely gentle gradient and by the impact of much more rapid sea-level fluctuations than at those along oceanic coasts.

Environmental geochemical study of the area revealed poor changes in aquatic systems of the Volga delta during the sea level rise. Essential changes were found within the near-shore zone, so-called avandelta. This vast shallow-water area is a specific feature of the Volga delta. Fresh river waters in the avandelta continue on their way to long distances, hence fresh/salt water mixing zone is displaced for dozens of kilometers towards the sea. Sea level rise caused a shift of this zone for 20-30 km to the north.

Water depths in the avandelta reached 2 m, which is the limit for the reed growth. Increasing influence of marine water coupled with a large amount of drowned organic material caused a sulfidization process in sediments of flooded islands. As a result, distinct accumulation of trace elements at the sulfide geochemical barrier was found there. This fact is useful for the reconstruction of paleoenvironments. Layers in deltaic Holocene sediments enriched with fine particles, organic matter and heavy metals can indicate transgressive stages of the sea-level fluctuations. Similar properties were found for lagoon sediments of barrier coasts, which are also characteristic for periods of the sea-level rise.

Reference

Kroonenberg, Salomon B., Nikolay S. Kasimov, Mikhail Yu. Lychagin, 2008 - The Caspian sea: a natural laboratory for sea-level change. Geography, Environment, Sustainability 1,1, 22-37.

Adaptation of Aquaculture Activities to Negative Effects of Climate Change

Ozgur Altan

Assoc.Prof.Dr.; Ege University Fisheries Faculty, Department of Aquaculture

35100 Bornova – Izmir, TURKEY

GSM: +90.533.3647363, e-mail: ozgur.altan.35@gmail.com

Abstract

After the long and steep decline in fisheries production in the Central Asia and the Middle East region recent investments and renewed efforts from international organizations, regional agencies, national public sector and the private industry have given a new vigour and revived interest in strengthening the sector. These are now seen as in serious jeopardy from a new threat: climate change. In this regard, the regional governments consider it as an urgent task to reduce the vulnerability of the sector from climate change impacts; they see adaptation as an important strategy. To enable a strong adaptive capacity, the governments are looking towards the development of a strategic regional action programme, supported by a regional, national and sector-level policy, and implemented in strengthened, better managed and appropriate aquaculture and culture based fishery systems.

In this study, the specific elements of the climate change adaptations will be explained according to the listed matters;

Governance guidelines that will be incorporated into policy on climate change adaptation for aquaculture and culture based fisheries;

Technological options for aquaculture and culture based fisheries that increase production and reduce vulnerability from natural and biological risks, climate change-induced or not;

Management and technical skills of the national level managers, extension workers and farmers for climate change adaptation in aquaculture and culture based fisheries; and

Capacity of the Ministries of Agriculture to formulate policy and make decisions on the management of climate change risks and its adaptation in fisheries and aquaculture.

Effects of the Atmospheric Tele-connection Patterns on the Caspian Sea climate

Murat Gündüz

Dokuz Eylül University - Instiute of Marine SciencesandTechnology, Izmir, Turkey
Email:murat.gunduz@deu.edu.tr

Some pressure anomalies are recurring and persistent covering the large areas. For example; Icelandic low pressure center or Azores high pressure centers. Such large scale oscillation of the atmosphere is known as tele-connection patterns. There are well known atmospheric tele-connection patterns such as; North Atlantic Oscillation (NAO), El-Nino Southern Oscillation (ENSO) and North Sea Caspian Pattern (NCP). Although these large scale atmospheric oscillations are local characteristics, they may influence the very remote part of the world oceans. For example, it is well known that NAO affects the temperature and precipitation regime of the Euro-Asia climate. Caspian Sea is also under the influence of such atmospheric tele-connection patterns. Among the various tele-connection patterns, North Sea Caspian Pattern (NCP) has a strong influence on the sea surface temperature and air-sea fluxes over the Caspian Sea. In this presentation, influence of the NAO, NCP and ENSO on the air-sea fluxes over the Caspian Sea will be investigated and importance of the large scale atmospheric conditions will be shown. By linking the regional climate to the upper layer atmospheric conditions it is easier to predict the effects of the future climate change on the regional seas. For example, possible influence of NCP, an upper layer oscillation seen at 500 hPa geopotential height, could be predicted by properly forecasting the geopotential height at 500 hPa. This will help to understand the flooding, increase or decrease in sea surface temperature and precipitation in the future over the Caspian Sea.

General Tectonic/Geologic Framework of the Caspian Sea and its water connection with the Black Sea and Mediterranean

Mustafa Ergun
INOC Centre
Inciralti, Izmir, Turkey
E-mail: mustafa.ergun@deu.edu.tr

The Eastern Mediterranean and the Middle East make up the southern boundary of the Tethys Ocean for the last 200 Ma by the disintegration of the Pangaea and closure of the Tethys Ocean. It covers the structures: Hellenic and Cyprus arcs; Eastern Anatolian Fault Zone; Bitlis Suture Zone and Zagros Mountains. The northern boundary of the Tethys Ocean is made up the Black Sea and the Caspian Sea, and it extends up to Po valley to the west (Pontides, Caucasus, and Alburz). Between these two zones the Alp-Himalayan orogenic belt is situated where the Balkan, Anatolia and the Iran plateaus are placed as the remnants of the lost Ocean of the Tethys. The active tectonics of the eastern Mediterranean is the consequences of the convergence between the Africa, Arabian plates in the south and the Eurasian plate in the north. These plates act as converging jaws of vise forming a crustal mosaic in between. The active crustal deformation pattern reveals two N-S trending maximum compression or crustal shortening syntaxes':

- the eastern Black Sea and the Arabian plate,
- the western Black Sea and the Isparta Angle.

The oceanic lithosphere of the Black Sea and southern Caspian Seas form a resistant “backstop”, diverting the impinging Anatolian plate to the west and “funneling” the continental lithosphere of eastern Turkey and Caucasus around the eastern side of the Black Sea. The rapid motion of the southeastern Aegean plate requires forces other than pushing from Anatolia contribute this motion; presumably forces associated with foundering Africa plate as it subducts along the Hellenic trench. The anomalous trench ward motion in the SE Aegean represents a response to particularly rapid sinking of the down going plate below this section of the arc, possibly associated with complex bending/breaking of the subducted plate.

The Anatolian/Iran Plateaus are among the most recent frontiers in the exploration of orogenic plateau formation, with relatively scant research compared to its larger counterparts in Tibet, the Altiplano, and Colorado. There are the inverse relations between the anomalies and the normal isostatic conditions. Understanding this process is a first order problem of lithospheric dynamics. Normally the Eastern Mediterranean Basin should rise under its present isostatic condition. It is known, however, that the Eastern Mediterranean Basin with its thick sediment-filled basins is actually sinking. Anatolia/Iran Plateaus, having 100 milligals gravity values higher than other isostatically compensated zones of the world, is in general undercompensated. Normal isostatic conditions require that Anatolia/Iran should sink. It is known, however, that these areas, with the exception of local grabens, are rising. While the Black Sea/South Caspian, having 100-milligal lower gravity value than other isostatically compensated oceans, it is in general overcompensated and the Black Sea and South Caspian basins with very thick sedimentary cover are actually sinking.

The Caspian Sea, like the Aral Sea, Black Sea and Lake Oroumieh, is a remnant of the ancient Paratethys Sea. It became landlocked about 5.5 million years ago due to tectonic uplift and a fall in sea level. During warm and dry climatic periods, the landlocked sea almost dried up, depositing evaporitic sediments like halite that were covered by wind-blown deposits and were sealed off as an evaporite sink when cool, wet climates refilled the basin. Due to the current inflow of fresh water, the Caspian Sea is a freshwater lake in its northern portions. It is more saline on the Iranian shore, where the catchment basin contributes little flow.

The Caspian Sea and the Black Sea were part of the Mesozoic chain of back-arc basins stretching over a distance over a distance of 3,000 km which also included the Carpathian basin in the central Europe and the Vallesian trough in Switzerland. This chain was located between the continental margins of Eurasia to the north and Mesozoic-Paleocene basin was the south of the island-arc system. These basins were formed during three separate tectonic episodes:

- Middle Jurassic
- Late Jurassic
- Late Cretaceous times.

From Middle Jurassic to Early Cretaceous time, extension occurred of the Pontic-Trans-Caucasus arc, resulting in rifting and the formation of the early Black Sea and South Caspian basins. To the east, the rate of spreading was more rapid and resulted in the development of the oceanic basin, the remnants of which now form the south Caspian Sea basin. The combined Caspian Sea-Black Sea paleobasin reached its maximum extent during the Paleocene, occupying an area 900 km wide and 3,000 km long.

Tectonic features in the South Caspian basin area are controlled by the northward migration of the Arabian plate, ward movement of the Iranian block, and west/southwestward movement of the Turkish block. This basin has been divided into fold, shale-diapir and slump fault zones. Structures are oriented northwest-southeast in the western part of the South Caspian basin and North-south to northeast-southwest in the eastern part.

The Messinian Salinity Crisis (MSC), also referred to as the Messinian Event, and in its latest stage as the Lago Mare event, was a geological event during the Mediterranean Sea and its northern domain (Black Sea and Caspian Sea) went into a cycle of partly or nearly complete desiccation throughout the latter part of the Messinian age the Miocene epoch, from 5.96 to 5.33 Ma (million years ago). It ended with the Zanclean flood, when the Atlantic reclaimed the basin.

The "Marmara Sea Gateway" connects the Black Sea and Eastern Mediterranean. The gateway consists of: (1) A linked set of narrow straits with shallow bedrock sills (the Bosphorus Strait with a sill depth of ~ –40 m; and the Dardanelles Strait with a sill depth of ~ –70 m) and; (2) The inland Marmara Sea. The Marmara Sea fills a rugged, tectonically active depression comprising three abyssal basins reaching depths of >1200 m and separated by cross-basin ridges.

The Sea of Marmara and its surrounding region has been recognized as a gateway which episodically linked Paratethys and the Mediterranean since the Middle Miocene. It is therefore an important area for constraining the timing and nature of water-mass exchanges between the two realms. The Messinian Salinity Crisis (MSC) in the Mediterranean was a major oceanographic event which resulted in the deposition of thick evaporate sequences.

The Manych-Kerch Spıllway is a large trough, deeply eroded into solid rock that connected the Caspian and Black Seas. It was inherited from an older strait between the two seas, which existed (with interruptions) since the Late Pliocene Akchagylian (white Waterfall) basin. It follows a tectonic skirts the southern periphery of Karpinsky Swell (an elevated Mezozoic structure). The total length of the spillway amounted to 950-1000 km (depending on the location of sea level), with maximum and minimum width of 50-55 and 10 km, respectively. Its depth attained 30-50 m. The spillway bottom gradient was 0.0001 (10 cm/km), and the drop in water level from the Caspian Sea (+50 m) to the Black Sea (-80 t0 -100 m) reached 150 m at the beginning of the excess water flow; by the end of this flow, the drop was 100 m. When the Khavalian transgression was its maximum (50 m asl), the spillway depth was to 30 m (its average depth was 20-25 m). Studies of spatial distribution of the flood show that "the Great Flood" was local, not global, in occurrence, but it was nevertheless widespread and impacted four types of landscapes: (1) coastal plains (as marine transgressions of the Ponto-Caspian basin), (2) river valleys (as super-floods and associated meanders), (3) interfluves (with thermokarst lakes of alas type), and (4) slopes (solifluction flows).

The Caspian Sea appears to have the epicentre of the Flood and the most sensitive indicator of the related events (sea-level rise, coastline shift, and coastal lowland flooding). This basin concentrated the bulk of the Flood water, altered water composition and marine environment, while excess water escaped into the Black Sea. In the process of flooding, the Caspian Sea expanded over an area of about one million km^2 (presently 371,000 km^2), up to 1.1 million km^2 if the Aral-Sarikamysh basin included.

In all probability, during the course of the Khavalynian transgression specific environments arouse in the Caspian basin that favored a prolonged conservation of the Mousterian technique, and, possibly, a survival of Neanderthal populations. One of the factors might be a 'cascade' of basins, including the Caspian-Black sea spillway across Manych-Kerch Valley that effectively isolated the Caucasian-Central Asia area. The spread of Upper Paleolithic technology in the area became possible only after the maximum of the Upper Khvalynian transgression, 12.5-12 ka BP.

Most people tend to consider the maps of the world map as fixed. However, in geological timescales our land-sea boundaries are in a continual state of change. The seabed stretching off many of our coasts, now covered in tens of meters of water, was once dry land. These areas supported a terrestrial biota including, at a certain point in time, early human populations. Most of the world's continental shelf was exposed by the lowering of global sea level many times during the last one million years and the vast dry area was occupied by vegetation and animals, including anatomically modern humans and their precursors, collectively known as hominis. Part of exposed shelves in the Aegean Sea, Sea of Marmara, the Black Sea and the Caspian Sea area were covered by ice caps and were, therefore, not available for occupation, but the extent to which people lived closed to the ice and exploited the peri-glacial megafauna is still uncertain. We cannot understand the whole story by studying only the present dry land record and ignoring the submerged seabed of the continental shelf. Did the fluctuating climate zones and migrating coastlines and river valleys influence where people lived? Did the falling and rising sea level create cultural experiences and responses that are still felt on and had impact in the historic world of writing and oral history.

Although the rise of the sea after the last glaciations took about 15,000 years, the change would nevertheless have been perceived as a continuous retreat of the shoreline and loss of land which was quite noticeable in one generation. These matters were more devastating for the marginal seas such as the Black Sea and the Caspian Sea as well as the Sea of Marmara because the fall of sea level was much more the open ocean waters. Given the fertility of coastal plains, both for the terrestrial fauna on grasslands and resources in marshes, deltas, and wetlands, the continuous loss of such land must have been an unfortunate aspect of life in the Late Paleolithic and Mesolithic periods. However, it should be noted that a rising sea level would occasionally inundate an area of low gradient such as the North Caspian seafloor, creating massively extensive new marshlands and new environments which could support adapting coastal and aquatic life styles. Populations certainly moved and adapted in response to such change of climate and sea level and there is a need for significant further research to track these movements. In order to understand where people could live and hunt or forage in the Caspian area at different dates and different stages of the glacial-deglacial cycles, we need to analyze the details of sea level change and ice cap limits through time.

CASPIAN SEA CLIMATE CHANGE ISSUES

OCEAN AND CLIMATE

When compared to the terrestrial habitat in which we live, the seas and oceans which dominate the surface of our planet are, as yet, relatively unexplored and poorly understood. We lack an in-depth understanding of the critical role that our oceans play within the broader Earth and climate systems, and are of the factors which threaten our marine environments with potentially serious consequences for our health and well-being. We also lack a full appreciation of the intrinsic benefits afforded to the World citizens from the seas which surround our continents and the enormous opportunities for the World societies and economies to further benefit from the marine products and services. To truly progress this knowledge, the scientists across a broad range of disciplines and domains must make a quantum leap towards holistic approaches and integrated research on a scale which will help us to much better understand, protect, manage and sustainably exploit the seas and oceans which surround us. This a Grand Challenge for human society as a whole.

The seas and oceans are a dominant feature of the Earth and climate systems. They cover 70% of our planet by volume of its biosphere, support more than 50% of global primary production and harbor an enormous diversity of life adapted to extremely broad -ranging environmental conditions. The oceans are driver of our climate but also affected by climate change and ocean acidification. They are under increasing pressure from human activities and pollution, and growing coastal populations. The combination of natural and human-induced changes taking place in our seas and oceans including, for example, rising temperatures, the melting of Arctic sea ice, ocean acidification, increasingly extreme weather events, transfer of non-indigenous marine species, changes in biodiversity and species distribution, and depletion of fisheries stocks, may have potentially profound impacts on our societies in the medium term.

The oceans are an integral part of the Earth system is intimately linked to the atmosphere and geosphere. Oceans supply almost all the water falls on land and they store and transport heat from the sun. The surface of ocean takes up about one third of all human-generated carbon from the atmosphere and ocean ecosystems, in turn, absorb and export carbon to the deep ocean. The structure and health of this biological pump is a critical component of the carbon cycle and plays an important role in the regulation of global climate and mitigating long-term climate change. Unraveling the links and feedbacks between the different components of the Earth's system, both in the past and in the present, is therefore not only scientifically challenging, it is also essential to understand the future of our planet.

It is now commonly accepted that human-induced climate change poses one of the main challenges faced by society in the coming decades. Global warming and high

CO_2 levels are driving changes in, for example, sea-level, patterns of air temperatures, ocean circulation and ocean chemistry (e.g. acidification) are expected to affect the species composition in the open ocean and, in turn, the removal of atmospheric CO_2 by the ocean, with unknown consequences. The impacts of climate change and ocean acidification may also affect commercial fishing as a result of changes in the size and distribution of fish stocks.

Although large climate change occurred during the geological past even the last century was characterized by climate fluctuations, the present rates of change, in terms of geological time-scales, unprecedented. Moreover, there is no certainty regarding the precise nature and rate of future climate change. However, even the moderate of predicted scenarios is expected to result in major changes in the marine environment, with potentially enormous environmental, economic and social consequences.

Fundamental marine scientific research has significantly contributed to an improved understanding of the underlying processes, and analyses of current and future potential impacts of climate change on the marine environment. But science is still a long way away from being able to predict future changes accurately; this is a necessary for reducing uncertainty and facilitating the planning of adaptation and mitigating responses to expected changes. Research is also critical to unlock some of the potential opportunities and benefits which may be presented by changes in the environment.

The marine change scientific research has significantly contributed to an improved understanding of the underlying processes, and analyses of current and future potential impacts of climate change on the marine environment. But science is still a long way from being able to predict future changes accurately; this is a necessity for reducing uncertainty and facilitating the planning of appropriate adaptation and mitigation responses to expected changes. Research is also to unlock some of the potential opportunities and benefits which may be presented by changes in the marine environment.

UNDERSTANDING OF INLAND WATERS AND RELATED ISSUES: CASE STUDY OF THE CASPIAN SEA

The Caspian Sea is the largest enclosed inland body of water on Earth by area, variously classed as the world's largest lake or a full-fledged sea. The sea has a surface area of 371,000 km^2 (143,200 sq mi) (not including karabogazgöl) and a volume of 78,200 km^3 (18,800 cu mi). It is in an endorheic basin (it has no outflows) and located between Europe and Asia. It is bounded to the northeast by Kazakhstan, to the northwest by Russia, to the west by Azerbaijan, to the south by Iran, and to the southeast by Turkmenistan. The Caspian Sea lies to the east of the Caucasus Mountains and to the west of the vast steppe of Central Asia. Its northern part, the Caspian Depression, is one of the lowest points on earth.

The ancient inhabitants of its coast perceived the Caspian Sea as an ocean, probably because of its saltiness and seeming boundlessness. It has a salinity of approximately 1.2% (12 g/l), about a third of the salinity of most seawater.

The Caspian Sea, like the Aral Sea, Black Sea, Lake Urmia, and Lake Oroumieh, is a remnant of the ancient Paratethys Sea. It became landlocked about 5.5 million years ago due to tectonic uplift and a fall in sea level. During warm and dry climatic periods, the landlocked sea almost dried up, depositing evaporitic sediments like halite that were covered by wind-blown deposits and were sealed off as an evaporite sink when cool, wet climates refilled the basin. Due to the current inflow of fresh water, the Caspian Sea is a freshwater lake in its northern portions. It is more saline on the Iranian shore, where the catchment basin contributes little flow. Currently, the mean salinity of the Caspian is one third that of the Earth's oceans. The Karabogazgöl embayment, which dried up when water flow from the main body of the Caspian was blocked in the 1980s but has since been restored, routinely exceeds oceanic salinity by a factor of 10.

Geography

Map of the Caspian Sea, yellow shading indicates Caspian drainage basin. (Since this map was drawn, the adjacent Aral Sea has greatly decreased in size)

The Caspian Sea is the largest inland body of water in the world and accounts for 40 to 44% of the total lacustrine waters of the world. The coastlines of the Caspian are shared by Azerbaijan, Iran, Kazakhstan, Russia, and Turkmenistan. The Caspian is divided into three distinct physical regions: the Northern, Middle, and Southern Caspian. The Northern–Middle boundary is the Mangyshlak Threshold, which runs through Chechen Island and Cape Tiub-Karagan. The Middle–Southern boundary is the Apsheron Threshold, a sill of tectonic origin between the Eurasian continent and an oceanic remnant, that runs through Zhiloi Island and Cape Kuuli. The Karabogazgöl Bay is the saline eastern inlet of the Caspian, which is part of Turkmenistan and at times has been a lake in its own right due to the isthmus that cuts it off from the Caspian.

Differences between the three regions are dramatic. The Northern Caspian only includes the Caspian shelf, and is very shallow; it accounts for less than 1% of the total water volume with an average depth of only 5–6 metres (16–20 ft). The sea noticeably drops off towards the Middle Caspian, where the average depth is 190 metres (620 ft). The Southern Caspian is the deepest, with oceanic depths of over 1,000 metres (3,300 ft). The Middle and Southern Caspian account for 33% and 66% of the total water volume, respectively.[15] The northern portion of the Caspian Sea typically freezes in the winter, and in the coldest winters ice forms in the south as well.

Over 130 rivers provide inflow to the Caspian, with the Volga River being the largest. A second affluent, the Ural River, flows in from the north, and the Kura River flows into the sea from the west. In the past, the Amu Darya (Oxus) of Central Asia in the east often changed course to empty into the Caspian through a now-desiccated riverbed called the Uzboy River, as did the Syr Darya farther north. The Caspian also has several small islands; they are primarily located in the north and have a collective land area of roughly 2,000 km^2 (770 sq mi). Adjacent to the North Caspian is the Caspian Depression, a low-lying region 27 metres (89 ft) below sea level. The Central Asian steppes stretch across the northeast coast, while the Caucasus mountains hug the western shore. The biomes to both the north and east are characterized by cold, continental deserts. Conversely, the climate to the southwest and south are generally warm with uneven elevation due to a mix of highlands and mountain ranges; the drastic changes in climate alongside the Caspian have led to a great deal of biodiversity in the region.[2]

The Caspian Sea has numerous islands throughout, all of them near the coasts. There are none in the deeper parts of the sea. Ogurja Ada is the largest island. The island is 37 km (23 mi) long, with gazelles roaming freely on it. In the North Caspian, the majority of the islands are small and uninhabited, like the Tyuleniy Archipelago, an Important Bird Area (IBA), although some of them have human settlements.

Hydrology

The Caspian has characteristics common to both seas and lakes. It is often listed as the world's largest lake, although it is not a freshwater lake. It contains about 3.5 times more water, by volume, than all five of North America's Great Lakes combined. The Caspian was once part of the Tethys Ocean, but became landlocked about 5.5 million years ago due to plate tectonics. The Volga River (about 80% of the inflow) and the Ural River discharge into the Caspian Sea, but it has no natural outflow other than by evaporation. Thus the Caspian ecosystem is a closed basin, with its own sea level history that is independent of the eustatic level of the world's oceans. The level of the Caspian has fallen and risen, often rapidly, many times over the centuries. Some Russian historians claim that a medieval rising of the Caspian, perhaps caused by the Amu Darya changing its inflow to the Caspian from the 13th century to the 16th century, caused the coastal towns of Khazaria, such as Atil, to flood. In 2004, the water level was 28 m (92 ft) below sea level.

Over the centuries, Caspian Sea levels have changed in synchrony with the estimated discharge of the Volga, which in turn depends on rainfall levels in its vast catchment basin. Precipitation is related to variations in the amount of North Atlantic depressions that reach the interior, and they in turn are affected by cycles of the North Atlantic Oscillation. Thus levels in the Caspian Sea relate to atmospheric conditions in the North Atlantic thousands of miles to the northwest.

The last short-term sea-level cycle started with a sea-level fall of 3 m (9.84 ft) from 1929 to 1977, followed by a rise of 3 m (9.84 ft) from 1977 until 1995. Since then smaller oscillations have taken place.

Environmental degradation

The Volga River, the largest in Europe, drains 20% of the European land area and is the source of 80% of the Caspian's inflow. Its lower reaches are heavily developed with numerous unregulated releases of chemical and biological pollutants. Although existing data are sparse and of questionable quality, there is ample evidence to suggest that the Volga is one of the principal sources of transboundary contaminants into the Caspian. The magnitude of fossil fuel extraction and transport activity constitute risks to water quality. Underwater oil and gas pipelines have been constructed or proposed, increasing potential environmental threats.

Most people tend to consider the maps of the world map as fixed. However, in geological timescales our land-sea boundaries are in a continual state of change. The seabed stretching off many of our coasts, now covered in tens of meters of water, was once dry land. These areas supported a terrestrial biota including, at a certain point in time,early human populations. Most of the world's continental shelf was exposed by the lowering of global sea level many times during the last one million years and the vast dry area was occuppied by vegetation and animals, including anatomically modern humans and their precursors, collectively known as hominis. Part of exposed shelf in the Caspian Sea area was covered by ice caps and was, therefore, not available for occupation, but the extent to which people lived closed to the ice and exploited the peri-glacial megafauna is still uncertain. We cannot understand the whole story by studying only the present dry land record and ignoring the submerged seabed of the continental shelf. Did the fluctuating climate zones and migrating coatlines and river valleys influence where people lived? Did the falling and rising sea level create cultural experiences and rewsponses that are still felt on and had impact in the historic world of writing and oral history.

LAST WORDS

Although the rise of the sea after the last glaciation took about 15,000 years, the change would nevertheless have been perceived as a continuous retreat of the shoreline and loss of land which was quite noticeable in one generation. These matters were more devestating for the marginal seas such as the Black Sea and the Caspian Sea because the fall of sealevel was much more the opean ocean waters. Given the fertility of coastal plains, both for the terrestrial fauna on grasslands and resources in marshes, deltas, and wetlands, the continuous loss of such land must have been an unfortunate aspect of life in the Late Palaeolithic and Mesolithic periods. However, it should be noted that a rising sea level would occasionally inundate an area of low gradient such as the North Caspian seafloor, creating massively extensive new marshlands and new environments which could support adapting coastal and aquatic life styles. Populations certainly moved and adapted in response to such change of climate and sea level and there is a need for significant further research to track these movements. In order to understand where people could live and hunt or forage in the Caspian area at different dates and different stages of the glacial-deglacial cycles, we need to analyse the details of sea level change and ice cap limits through time.

Today the demands for space in our coastal seas are growing at a rapid pace. Human activities such as fishing, aquaculture, shipping, pipe and cable-laying (energy and telecommunications), dredging, offshore wind enegy, defence and recreation are all competing for limited space. Many of these activities are also altering the marine environment. For the maritime archaeology community, these activities represent a double-edged sword. On the one hand they can damage culturally valuable sites and artefacts; on the other hand, they can alert us to the existence of sites that might otherwise have remained undiscovered. Managing the relationship between the research community and industry is an important issue to be considered. In this respect the position paper is structured as follows:

• An assessment of the current situation, including achievements, structures of the research community, key scientific issues, interaction with industrial stakeholders and the legal background of laws and treaties;

• An examination of the available resources and the range of agencies and institutions involved in different countries. A survey of the Caspian Sea area agencies would be conducted as part of the working group activities and provides quantitative data on research policy and management priorities;

• A discussion to address issues on inherent problems, such as site protection from climate change and industrial activities, lack of high resolution seabed maps, shortage of human capacity building;

• The diverse characteristics of the Caspian Sea area determine past occupation, relative change of sea level since the Last Glacial Maximum, and varied oceanographic conditions;

• There is still no acoustic technology to detect and locate prehistoric anthropogenic materials on the sea floor remotely, for example to distinguish scattered débitage of broken flints from natural gravel, or a piece of wood that has been cut and shaped from a natural log.

• A long-term integrated approach is needed. Trans-domain collaboration between disciplines and agencies is essential. Collaboration with industry is important. In addition to collaboration between oceanographers, marine geologists, interdisciplinary research will need to engage palaeoclimate researchers and modellers, geophysical engineers, and the molecular biology (genetics) research community as well as prehistoric archaeologists.