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[Report and Opinion]

Caspian Sea and its Ecological Challenges

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ABSTRACT

Caspian Sea is the largest enclosed body of water on the earth. Since the collapse of Soviet Union in 1991 and discovering large oil and gas fields, some issues such as political, economic and environmental events, made the Caspian Sea important. The ecology of the Sea are being endangered due to several issues such as petroleum extraction, river and sea pollutions, water level rise, biological damages, decline of Caspian seals and lack of legal regime among the neighbors. Tremendous infrastructures have had serious impacts on the ecosystems around the Caspian Sea and have often imposed long term damages to the sea. Activities around the Caspian Sea endangered the balance of this very sensitive and fragile ecosystem. Large oil stains on the sea level and thousands of acres of soil contaminated by oil leaking from abandoned wells are some parts of the pollutions. Some people must endure to the Caspian borders. In addition, there are various pollution-related industries, especially chemical and mineral industries, large non-irrigated agricultural and also domestic wastes. These impurities in addition to the negative impact of oil have serious effects on human welfare and wildlife of the area. Ecological balance of the Caspian Sea is nearly going to be ruined (Éfendieva & M. Dzhafarov 1993). The increase of pollutions in the area has made many problems. The negative effects of shipping activities, oil and gas extraction and oil transport through the sea, have always been problematic. Destruction of flora and fauna are of the consequences of pollution. Finally, exploitation of Caspian Sea oil and gas provide the new challenges about the ecosystem of the environment. The natural resources of environment are the source of potential wealth. So they can easily increase the conflict for example legal aspects between neighbors as well as the risk of security in the region.

Keywords: *Caspian natural geography, Caspian pollution, Sea level fluctuation, petroleum*

INTRODUCTION

Access to hydrocarbon resources have caused disputes between five Caspian littoral countries. Unequal transmittance of hydrocarbon resources increases the difference of the opinions about these oil areas. There are some conflicts on how to use the sea in a better manner. The Caspian Sea is important not only for the oil and gas but also for the materials such as coal, afferent, iron, chromium, titan, asbestos and other minerals. These in turn would cause the concentration of many of the world trades (Simonett, 2006). Natural conditions in the Caspian Sea (except the South and West Coast) seem to be undesirable. Dry climate coupled with high thermal changes in the summer and winter, very severe winter storm and lack of drinkable water make the survival of human life so problematic. Each activity has its own particular effect so that the environment is basically vulnerable against these effects. Exploitation of oil reserves or defects of the related installations have contaminated the surface and underground water. Sturgeon is regarded as a source of caviar and hence needs a healthy environment, while the Caspian environment has sever conditions with large water management projects such as irrigation, construction of dams

for power plan electricity, exploitation of oil and gas areas and sea transportation of oil by heavy tankers. The littoral states and the international community have to be deeply worried with regard to the destroy of the Caspian Sea. The internati-onal communities have to be always committed to the many issues and concerns faced in the Caspian area. Developed activities related to hydro-carbons materials in the Caspian area has stirred environmental balance throughout the region. Hydrocarbon industries produce toxic substances which have been stored as insanitary disposal in many places. One particular example can be given concerning the improper storage and disposal of the material in some places e.g. in the Abshuran peninsula located in Azerbaijan and around the city of Aqtau (Kazakhstan). There are many disputes about the sea water level changes. The water level rise would not be considered as an extraordinary phenom-enon, but it is now considered as a continuous ecology dilemma. There are different opinion among researchers regarding Caspian Sea water level (Cazenave *et al*., 1997., Efendiyeva 2000) link the water level rise in relation to tectonically movement (severe movements in the earth's crust below sea level). Some of them take the climatic conditions (rain annual increase) and surface water evaporation into account. Uncertainty of future sea level changes has stopped the development in many coastal areas (Simonett, 2006).

Ecosystem and environment of the caspian sea

The Caspian Sea is the largest enclosed water body in the world and it is located on the border of Asia and Europe. The biological resources of the Caspian Sea include 800 species of fauna and 500 species of flora (Zenkevich, 1973). Due to the presence of a very precious kind of fish called 'sturgeon', preserving the water quality in the Caspian Sea is of critical importance. Sturgeons of Caspian produce the expensive high quality caviar. There are three dominant sturgeon species in the Caspian Sea, namely; the Stellate, Beluga and the Russian sturgeon (Efendiyeva, 2000). In the mid-1990s oil and Gas brought an influx of foreign investment in energy development in the region. Oil and gas extraction, along with transportation and industrial production has been the source of soil, air and water pollution in the Caspian region. (Efendiyeva, 1994). There is no doubt that development of the oil and gas industry does have the significant impacts to the environment. The chemicals and pesticides are threats to the flora and fauna. Since 2000 due to the pollution thousands of seals died in the Caspian Sea., the pollution has weakened their immune systems (Scinexx, 2009). The Caspian is an ecosystem under stress. Existing pollution has damaged marine terrestrial communities. The over fishing of Sturgeon has caused a dramatic decline in fish stocks., the number of commercial fish has considerably been reduced. Some fish species have been included into the red book (Simonett, 2006). Weak environmental laws and regulation and the ability to enforce them is affecting efforts to protect the Caspian's environ-ment. Without increasing cooper-ation by the littoral countries, the country of the environment in the Caspian Sea and surrounding areas will remain threatened.

Caspian sea and its catchment

The coastal plain is also a transit area for freshwater organisms. It usually consists of terrestrial, partly also from Caspian-limnic sediments predominantly Quate-rnary age.

Rivers from the north reaching to the Caspian sea is provided about 85 percent of river discharge, While the rivers leading

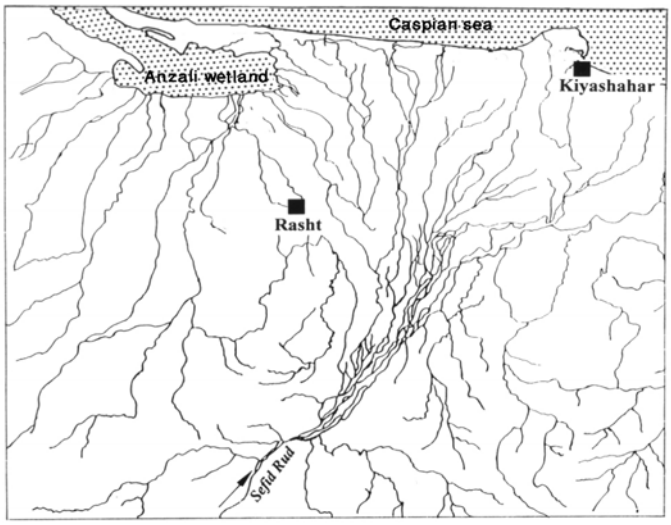

Fig. 1. The hydrographic network in the south of Guilan (Nasrollazadeh, 1999).

to the southern Caspian Sea provided 60 percent of river sediment load into the Caspian Sea. Due to the passage of the river basin, South Caspian slope of the mountains filled with low vegetation, sedimentation rate of those rivers is more dense.

Hall marks of most Caspian tributaries in Iran is a short, straightforward and deeply incised course between source and mouth (Fig. 1) (Nasrollazadeh, 1999). The flow behavior of all the southern Caspian tributaries is characterized by strong year-round water supply. The sea has 130 large and smalle tributaries mostlt flowing from the northern and western coast. More then 90% of fresh water flowing into the Sea ist provided by five large rivers in the region, that is, Volga, Kura, Terek, Ural and Sulak (Zeinolabedin 2009). Iran is on the beach Sepidrud river that with Average 4 Km^3 discharge per year is one of the biggest rivers in the North of Iran (Alizadeh 2004). General landscape ecology of the south Caspian lowlands under special consideration of ornithology (Schütz, 1962) was a newer representation of the Anzali wetland (Monawari1990),

Climate conditions

Caspian Sea has a variety of weather conditions. It is surrounded by Volga river and Ural rivers in the North, dry and semi-dry plains of Kazakhstan and Turkmenistan in the East and Alborz mountains and humid regions of the Caucasus in the South and the West. Climatic phenomena of the Caspian are linked to fluctuations of the North Atlantic (atmospheric air pressure fluctuations). Caspian Sea water's mass mainly flows through the West bank from north to south to Peninsula Abshuran and it is divided to two branches. One of them flows along the West bank and the other joins to the flow moving from south Caspian toward the north.

Chmical and biological pollutions

The sources of Caspian Sea pollution consist of water level rise, land-based sources, drilling in the sea bed, pollution in relation to ships activities, atmospheric and biological contamination (Simonett, 2006 Rodman1996). All these problems threaten Caspian ecosystem.

Ecological changes

Caspian Sea water level has been swing in the middle of geology and trough the centuries. Between 1880 and 1977, water level decreased up to 4 m and became 29 m below the free seas level (Simonett, 2006).

During 1900 to 1929, sea level was relatively stable and its maximum value was between 25.6 and 26.6 m below the ocean level in 1929. The area of Caspian Sea was 422000 km^2 in that year. In 1929 to 1977, water level of Caspian Sea has decreased 2 m. Decreasing water level in that period displaced coastal line 180 km

because of low water level in eastern and northern coasts.

Problems of Soviet Union caused some actions to prevent the reduction of water level: (Maleki, 1996)

1) Diverting water of rivers dropping to Arctic Ocean to the south-Caspian Sea.

2) Closing water input path to Kara-Bogaz-Gol-Gulf with 12000 km^2 area whose water level is 4-5 m below the surface of Caspian Sea. This gulf is next to the Kara-Bogaz-Gol-Gulf desert and is connected to Caspian Sea by a narrow strait and its evaporation rate is very high (Amirahmadi, 1996). Approximately 10-12 m^3 of water drops to this gulf from Caspian Sea each year and most of them evaporate. A dam was constructed in 1980 between Caspian Sea and entrance of the gulf. The aim of construction was to alleviate the negative effects of water flowing from Caspian Sea to this gulf because this increased 2-3 cm per year of water level of the sea.

After daming Kara-Bogaz-Gol-Gulf Straits, the activity of Gulf as a natural hydraulic system for keeping low salt amounts was stopped. This increased the salt in the southern part of the Caspian, equal to 15 g/l and resulted in a catastrophic consequence for the population of beluga. The dam was opened in 1984 for the same reason and in the spring 1992, Turkmenistan destroyed the dam due to the dimensions of disaster. On the basis of this, the relationship between the sea and the Gulf was established again (Simonett, 2006 and Amirahmadi, 1996). Until 1970, scientists were concerned about reducing the level of the Caspian Sea whereas water surface was 29 m below sea level in 1977. Caspian Sea water level started rising mysteriously and this caused many problems in 1988 (Alizade, 2004). The sea level increased about 2.5 m and this process is now continuing with a warning speed of approximately 15 cm annually. Simultaneously, the water rise of Caspian Sea has led to huge amounts of mud smeary oil and chemicals washed and are drawn toward the most sensitive parts of the sea (Schneider, 1995).

It is estimated that annual rainfall accounts for 130 km^3 of sea water. Reducing of water through penetration into the ground is less than 5 km^3 and the amount of waters that flow into the Kara-Bogaz-Gol-Gulfis are about 18 km^3 since the destruction of the dam. It is estimated that 350-375 km^3 of sea water reduce duo to evaporation each year. Total water input is estimated something like 440 km^3, and wasted water is estimated as 373 km^3. So the water level of Caspian Sea should have an increase trend now (Simonett, 2006).

POLLUTION

Extraction of oil and gas can result to increasing air, soil and sea pollutions and also the emission of greenhouse gas such as methane. Carbon dioxide can also enhance the global gases. It is estimated that fuel production of the Caspian environment will emit about 20-15 million tons of carbon dioxide per year.

Crude oil and the steam of the gas field in north Caspian have a very large content of sulfur (Simonett, 2006). Refinement process, especially for the production of liquid gas, remains a large mass of sulfur sediments in open areas which affects the environment of surrounding areas. Also a large amount of toxic gas is released in the atmosphere. Since oil leakage to the sea is inevitable, this problem can threaten fauna and flora inhabiting there. Unlike the Caspian Sea, the oceanic water can let away oil while the Caspian region cannot scatter it (Rodman, 1996). Oil wastes are broadcasted on the sea and reduce the evaporation of surface water and reduce the oxygen exchange of the sea with atmosphere.

According to green peace report, the sewage of more than 15000 oil refinery in the Caucasus region is flowing into Tarak river making sever pollution, in particular, in the area of Republic of Chechnya. (Scinexx, 2009). Analysis of oil platform in Abshuran region in recent years (2002 – 2007), has shown that the amount of, ammonium nitrate and phenol concentrations are respectively 180 and 220 times higher than the diagnosed limit (Scinexx, 2009). According to the annual World Bank report more than one million m^3 of industrial non-filtered wastewater flows only through Volga River into the Caspian Sea and brings septic water from

places with a distance of 3500 km to the lake. About 45% of industrial factories and 50% of agricultural factories of Russia are in this broad River watershed. Annually over 600000 m^3 of sewage of Georgia and Armenia falls into Kura River and this sewage falls directly into Caspian Sea via Azerbaijan. Among biotic communities, it seems that the animals were (and still are) the main victims of the Caspian Sea in the past and present. Environmental center of Astrakhan in Russia have proved the accumulation of toxic substances in the body of many aquatic Caspian Sea (Yazdani, 1996) These materials can cause death of many animals in this sea. For instance, at the coast of Kazakhstan about 4000 of the Caspian seals (*Phoca caspica*) were found dead in 2000 in a very short time interval (scinexx, 2009). A team of international researchers (Seal Conservation Society: Caspian seal (*Phoca caspica*) was formed in the request of the World Bank and their extensive researches were carried out in the given area. Based on their findings, the toxic substances would weaken the immune system of Caspian seals (*Phoca caspica*) so that they were probably infected by a virus called *Canine Distemper Virus* (CDV) enhancing the death of seals (Scinexx, 2009).

In the early twentieth century, number of seals was one million, but In recent years, due to hunting and Biological and Chemical populations their pollution has been reduce. (Alizade, 2004). Recent studies of Caspian Environment Program show that the estimated number of the Capian seals (*Phoca caspica*) reaches to less than 110000 individuals. Convention of the Caspian Sea regional environmental cooperation was signed by the countries of Iran, Russia, Kazakhstan, Turkmenistan and Azerbaijan in 2003. In 12 August 2006, it was obligatory for the all member countries to be committed in implementing the provisions of the Convention. The agreement, set up based on the agreement of the Baltic and the Mediterranean intends to reduce environmental pollutions of the Caspian Sea in order to preserve fauna and flora communities. Here, more attentions are paid on the toxic and radioactive wastes concerning oil exploration and refineries.

Biological damages

Biodiversity of flora and fauna of the Caspian sea are unique on the Earth. Approximate number of plant and animal species native to the Caspian Sea (Simonett., 2006), The fauna and flora of the Caspian have been seriously threatened by increasing the Caspian oil trade. Among fish species, 3 of them are under extremely extinction: Fringebarbel sturgeon (*Acipenser nudiventris*), Caspian salmon (*Salmo trutta caspius*), Caspian Barbel (*Barbus brachycephalus caspius*) (Alizade, 2004). Jellyfish (*Mnemiopsis leidyi*) is an eager consumer of zooplanktons. This species is an invasion in the Caspian Sea and belongs to Ctenophora phylum. The fish larva appeared in the second decade of 90th year. It adopted well with the Caspian Sea ecosystem (in terms of salinity, temperature and range of foods) and reproduces faster than native species. Because the available food is shared with native species, they have caused a severe impact on the native population and changed the entire food chains (Vladimir *et al*., 2000). Commercial fishing industry including; anchoivy / kilka (*Clupeonella grimmi)*, sturgeon for instance *Acipenser brevirostrum* , *Acipenser sturio* , *Husu husu* and Caspian seals (*Phoca caspica*) and other valuable species are seriously impacted by the jellyfish. (Vladimir *et al*., 2000). This comb jellyfish has been seen at the coast of Azerbaijan, Turkmenistan and Russia in a large individuals in 2001 (Fig. 2). In short period, *Clupeonella grimmi* supply has sharply decreased in the given areas. Studies show that between the years 1998-

Fig. 2. Geographical distribution of jellyfish in the Caspian Sea (Simonett, 2006)

In short period, *Clupeonella grimmi* supply has sharply decreased in the given areas. Studies show that between the years 1998-2000, fishing *Clupeonella grimmi* by Iranian fishermen has reduced almost 50% and this made a washout at least equal to $ 20 million per year (Simonett. 2006). Caspian Environment Program gave a high priority to combat this organism.

Caviar production was about 360 tons between 1984 and 1985 in Iran, but it reached to about 44 tons in 2004 (Naviri, 2007). 90% of sturgeons of the world live in the Caspian Sea today. The results obtained from the catch of this fish have confirmed that this trend is descending in last 20 years. (Naviri, 2007). The catch of different types of sturgeon reached to 30.000 tons in 1985, while in 1990, only 13.300 tons of caviar were caught from the Caspian Sea. In 1994 this figure was 2000 tons (Fig.3).

In addition to chemical and biological pollutions, the negative impact of water changes, lack of legal regime, excessive illegal hunting and non-principle-oriented exploitation, led to diminishing fish supplies of the Caspian Sea.

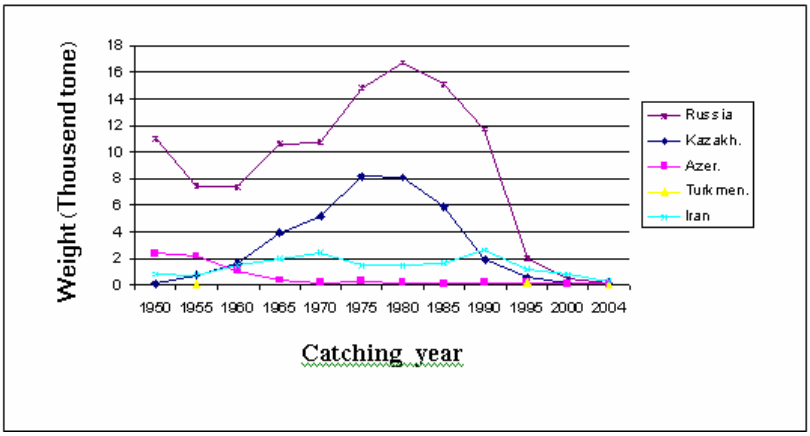

Fig. 3. Statistical comparison of the sturgeon caught in countries around the Caspian Sea (1950- 2004) (Naviri, 2007).

DISCUSSION

Caspian Sea has always played a significant role in relation to the life of human societies. Environmental pollutions of the Caspian Sea not only have negative impact on the sea, but also influence the population of all neighboring countries. Protection of this valuable Sea has a direct connection with the security and national stability of the coastal countries. Conflicts and disputes in the current management of natural resources of the coastal countries can make the deeper gap and hence leading to hostility among them in the near future. In the margin areas of Caspian that economic benefits are

provided by natural resources and mineral, the process of environmental protection has little priority (Barannik *et al* 2004). But some of the natural resources like fisheries (that constitute the survival of marginalized people in economic activities) depend on a healthy environment. Exploitation of other natural resources seems to be very beneficial because their negative side effects are not much taken into account. Valuable natural resources in the area (some non-renewable ones e.g. oil, gas and some renewable resources like fish and other fauna communities) are important factors between countries and different communities residing the area. The decrease of global oil, permanent instability in the Middle East, new markets and the increase of demand for energy, are of good reasons for people who export their goods and stuffs. Recently, ecological crisis of the Caspian are drastically enhancing because of over-exploitation of resources and the cumulative of various pollutants. Environmental co-operation can be a valuable method to prevent conflicts. This also would promote peace between the neighboring countries with a limited self-refining power. The international community have to be committed to their environmental concerns, safety, resource exploration and shaping the political geography of the Caspian Sea. Environment organizations of coastal countries held two sessions in Azarbaijan (2007) and Tehran (2008). The aim was to involve in the coastal countries to protect, restore and control the Caspian Sea. The third summit will be held in Kazakhstan. Apparently all parties reached to a consensus that an advised legal regime can be a dividing and joint regime. Economic future of the Caspian Sea coastal countries, the standard of living (especially for coastal residents), environmental health and sustainable development, all depend on the extent of exploitation of natural resources as well as the management of the Caspian environment. Therefore future meetings held in Kazakhstan in 2009 can be very important in this particular issue. Conservation and sustainable development programs will be possible only by raising the awareness of the local communities and environment exploiters. The all coastal countries with monitoring of the United Nations Environmental Program (UNEP)have to find a solution to prevent environmental pollution of the Caspian Sea in order to save its benefits for today and future generations. It is worth mentioning that this sea has to be a source of friendship, cooperation and relations of good - neigborliness

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