GRID ARENDAL

CASPIAN SEA
STATE OF THE ENVIRONMENT

2011

Caspian Sea

State of the Environment

2010

Report by the interim Secretariat of the Framework Convention for the Protection of the Marine Environment of the Caspian Sea and the Project Coordination Management Unit of the "CaspEco" project

Contents

Foreword

The Caspian Sea, abundant with natural living and fossil resources, its coastal areas home to more than 15 million people, faces a series of environmental challenges.

Well organized, updated and accessible information is essential for properly founded decision-making to tackle these challenges. Knowledge of the environmental conditions of the Caspian Sea, as well as of the causes and effects of changes in these conditions is an indispensable prerequisite for common policy development and action to keep the Sea clean and preserve its rich natural resource base for present and future generations. State of the environment reporting is a recognized way of capturing environmental information and making it accessible to policy makers and the public at large.

The Second Conference of the Parties of the Tehran Convention tasked the Interim Secretariat of the Convention to develop the State of the Caspian Sea Environment Report and present it at the Third Conference of the Parties. The Report falls under CASPECO Project Component II "Strengthened Regional Environmental Governance", Outcome 4 "Enhanced Stakeholders' Engagement in the Tehran Convention process and Improved Public Access to Information on the Status of the Caspian Sea Environment".

The basic purpose of the State of the Environment Reporting Framework is to allow for regular reporting on an agreed set of regional indicators that show changes and trends in environmental conditions. It provides necessary information for developing, monitoring programs and policies implemented at local, national and regional levels. Furthermore, it increases the number of stakeholders involved in order to benefit from their significant feedback and valuable contributions.

Governments of the Caspian riparian states have not yet fully decided on the range of information they need for collective decision-making in areas of common concern. The Tehran Convention and its ancillary protocols have in broad terms identified what issues need to be addressed, but implementation plans for the protocols have not yet been prepared and a monitoring format underpinning future reporting has not yet been developed. Sets of indicators for measuring change and progress in managing such change need to be further developed and agreed upon. An inventory of the capacity available in the countries is underway to help determining how the requirements for monitoring and reporting can be met and what type of support is needed. And a common data base and information centre must be established to receive, store and disseminate the data and information collected.

State of the Caspian Sea environment reporting, therefore, for some time to come will remain "work in progress". Governments need to invest in broadening their national base of information collection and analysis to underpin and service collective decision-making for the implementation of the Tehran Convention and its Protocols. They should stand ready and prepared to refine and where needed adapt the methodologies they use to that end. And they should start a practice of sharing the information they collect and hold on changes in the state and health of the marine environment of the Caspian Sea, eventually perhaps guided by the provisions of a commonly agreed protocol.

This State of the Caspian Sea Environment Report should be seen and considered as a first try out and starting point towards the creation of a shared environmental information system promoting and securing data collection, monitoring, analysis, harmonization and public communication in support of full implementation of the Tehran Convention and its protocols. We hope that it will improve the Caspian information base, enhance the quality, accessibility and relevance of data and ultimately, contribute to strengthening the regional environmental governance framework.

Introduction and objective

The Caspian Sea, surrounded by the five coastal countries the Republic of Azerbaijan (Azerbaijan), the Islamic Republic of Iran (Iran), Republic of Kazakhstan (Kazakhstan), the Russian Federation and Turkmenistan, is the largest land-locked water body on Earth. The isolation of the Caspian Basin together with its climatic and salinity gradients has created a unique ecological system with some 400 species endemic to the Caspian waters. Today, many Caspian species are threatened by over-exploitation, habitat destruction, pollution and climate change. It reflects negatively on human well-being, social and economic sectors, and environmental services.

By 2006, all Caspian littoral states ratified the Framework Convention for the Protection of the Marine Environment of the Caspian Sea (the Tehran Convention), which was the most significant outcome of the Caspian Environment Programme that was started in 1995. Being the first regional and legally binding instrument signed by all five Caspian littoral states, the Tehran Convention serves as an overarching framework laying down the general requirements and the institutional mechanism for the protection of the marine environment of the Caspian Sea. Concrete commitments are determined and dealt with in protocols to the Convention. Negotiations on four protocols have been concluded. They focus on biodiversity conservation; land-based sources of pollution; preparedness, response and cooperation in combating oil pollution incidents; and environmental impact assessment in a transboundary context. Two of the protocols are expected to be ready for adoption and signing at the third Meeting of the Conference of Parties (COP3) in November 2011.

At the second Meeting of the Parties to the Convention (COP2), held in Tehran, Islamic Republic of Iran, 10-12 November 2008, the Parties requested the preparation of the first State of the Environment (SoE) of the Caspian Sea Report for distribution at COP3. Pursuant to that and other related requests by COP2, the interim Secretariat of the Convention organized a meeting of the Contracting Parties on a Shared Environmental Information and Monitoring System for the Caspian Sea, in Ashgabat, Turkmenistan, 9-10 September 2009.

The meeting requested the interim Secretariat to prepare the State of the Environment Report of the Caspian Sea, based, inter alia, on reports and documentation developed under the Caspian Environment Programme and the Tehran Convention. In the preparation of the report, due account should furthermore be taken of other relevant scientific national and regional reports and publications and the development of a reporting format for the implementation of the Tehran Convention and its Protocols. In order to increase the understanding and enhance the information on the state and trends of the marine environment of the Caspian Sea, there is a clear need to get a better insight about emerging environmental concerns.

The SoE of the Caspian Sea Report is based on existing documents developed in the context of the Caspian Environment Programme, which is supported by the Global Environment Facility, and through other major projects, including the first and the second editions of the Transboundary Diagnostic Analyses (TDA), the Regional Water Quality Monitoring and Pollution Plans developed with the support of the EU, the Rapid Assessment of Pollution Sources (RAPS), and the Strategic (Tehran) Convention Action Programme. The report summarizes the findings of the different assessments and includes existing updated figures. It is based on the latest information on policy and legislative measures, institutional set-up, stakeholder engagement, future challenges and barriers to the improvement of the state of the environment in the region, provided by the governments through a questionnaire.

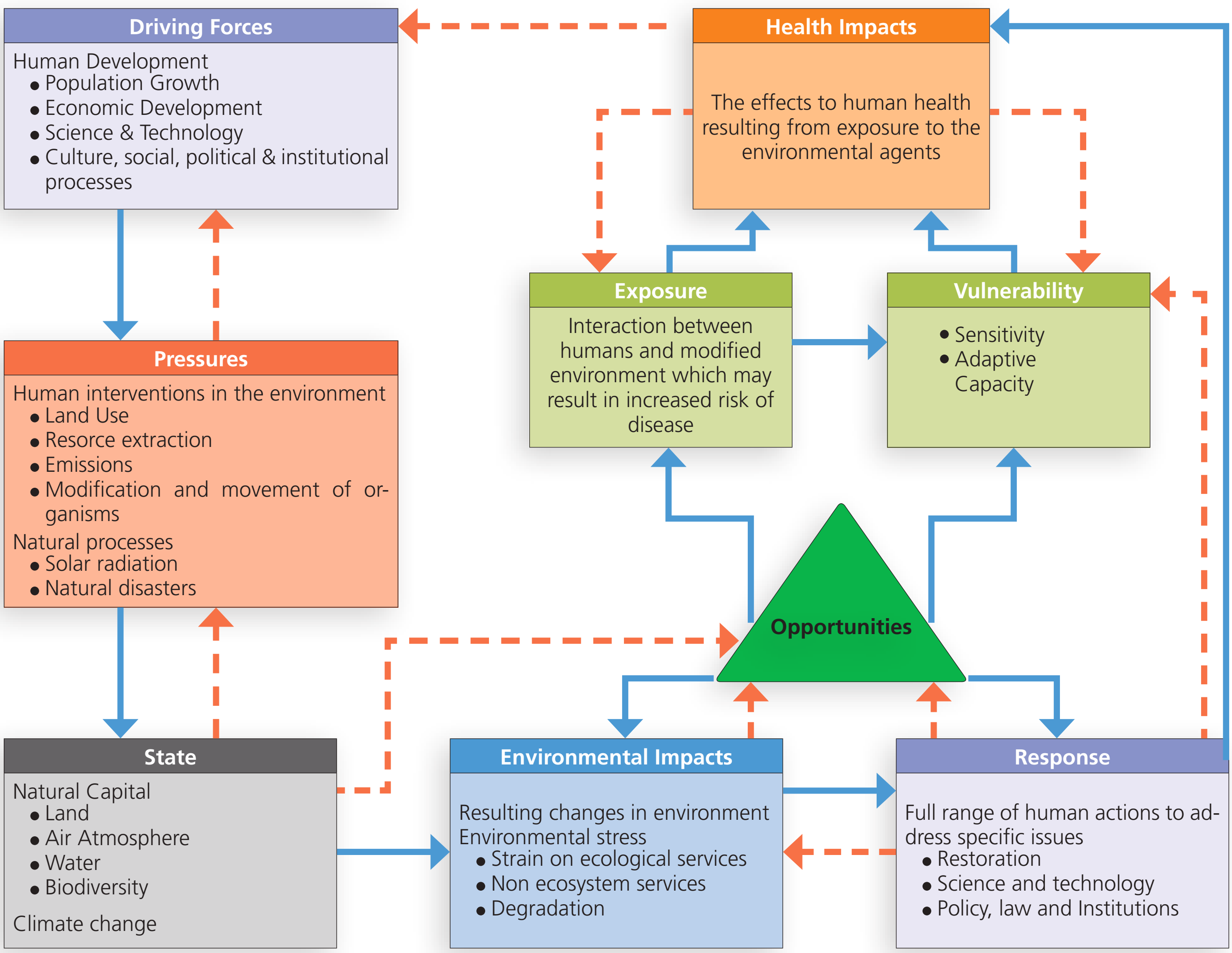
The report is an effort to highlight the main trends in the marine and coastal environment of the Caspian Sea. It provides a gap analysis, showing the needs and requirements of the countries, individually and collectively, in the areas of monitoring, information collection and management related to policy, decision-making and implementation of the Tehran Convention and its Protocols.

This report is based on materials and documents of the CEP, and does not reflect the official position of governments of the Caspian states. It should not be regarded as a comprehensive analysis taking into account the consensus of all stakeholders and developed with their participation, but rather as a blueprint fto help pave the way ahead, indicating what is needed to establish a monitoring network and programme capable of systematically measuring the state of the environment of the Caspian Sea, in light of the requirements of the Convention and its Protocols..

2. Methodology

The report is based on the Driving Forces-Pressures-State-Impacts-Responses (DPSIR) methodology, increasingly used to address integrated management issues in the marine environment (Turner et al.1998; Luiten 1999; Elliott 2002; Walmsley 2002). DPSIR is a framework, which shows the relationships between human activity and the state and trends of the environment and human well-being. UNEP's integrated environmental assessment process (in particular the Global Environment Outlook process) is based on this methodology. It has a number of advantages, including simple, intuitive analysis of human-environment interlinkages and the multi-stakeholder approach, bringing together social and natural sciences, as well as policy and law.

Driving Forces (e.g. demographic changes, economic and societal processes) lead to more specific **Pressures** on the environment (e.g. land



Source: UNEP, Global Environment Outlook: environment for development (GEO-4), 2007.

Driving forces of environmental change (e.g. demography, industrial production)
Pressures on the environment (e.g. discharges of waste water)
State of the environment (e.g. climate change, water)
Impacts on population, economy, ecosystems (e.g. water unsuitable for drinking)
Response of the society (e.g. watershed protection)

use change, resource extraction, emissions of pollutants and waste, as well as modification and movement of organisms). These pressures lead to changes in the **State** of the environment (e.g. climate change, stratospheric ozone depletion, changes in biodiversity and pollution or degradation of air water and soils), which are in addition to those resulting from natural processes.

These changes affect the ecological services that the environment provides to people, such as the provision of clean air and water, food, and protection from ultraviolet radiation, as well as impacts on other aspects of the environment itself, including land degradation, the quality and quantity of habitats, and biodiversity. As a result of changes in ecological services, driven by demographic, social and economic factors, **Impacts** on the environment and human well-being are expected. The impact is usually indicated by health, economic performance, material assets, good social relations and security.

Societal **Responses** can influence the environmental state and their associated drivers and pressures (either intentionally or unintentionally). Societal responses essentially fall under two categories: responses directed at *mitigating* exposure to environmental impacts (e.g., through environmental restoration and enhancement); and responses that help society *adapt* directly to the impacts that occur and/or build the capacity to adapt to changes in the environment. Societal responses include formulating and implementing public policy, laws and establishing/strengthening institutions, as well as promoting advances in science and technology.

The *exposure* to changes in various environmental states, combined with the *ability of society* to *adapt* to these changes, determines the degree to which people are *vulnerable* or are *resilient* to environmental change (UNEP and IISD 2008).

The SoE of the Caspian Sea Report, structured according to the DPSIR framework, includes chapters addressing driving forces referring to fundamental processes in society, pressures focusing on human interventions in the environment, the current state of the environment based on a set of indicators, impact analyses of the influence of environmental factors on human well-being, and concludes with a chapter on responses, assessing possible policy actions, in particular, adaptation and mitigation.

The SoE of the Caspian Sea Report is based on recent assessment reports published in the last 5 years, from 2005 onwards. In cases of irregular reporting, priority is given to data starting from 2000. In this light, the SoE Report analyses both editions of the Transboundary Diagnostic Analyses (TDA); a number of recent documents and reports such as the Caspian Water Quality Monitoring and Action Plan, a monitoring programme supported by the European Commission; the WB-CASPECO Study on Economics of Bioresources Utilization; the Caspian Vital Graphics: Opportunities, Aspirations, and Challenges; UNDP and HDR country reports; presentations of the first investment forum in Baku; WB case studies on environmental economic evaluation; findings of Leeds University and AGIP KCO on Caspian seals; the IOC report on the Caspian Sea, and the questionnaires collected from countries in August, 2010.

3. Driving Forces: Socio-economic challenges and opportunities

The coastal areas of the Caspian Sea have been experiencing population growth since 1999 and the trend is likely to continue. However, the population is unevenly distributed around the sea, mostly concentrated in the west and south. Urbanization in areas like Baku-Sumgayit puts additional stress on the environment. The economic growth, driven by the oil and gas sector, and manifested in the overall improvement of economic conditions, is reflected in the steady rise of GDP per capita. At the same time, it can be offset by inflation, which has an unabated tendency to grow. In general, human conditions are improving, literacy rates continue to remain high, life expectancy is increasing and infant mortality is declining regionally.

The structure of the national economies of the Caspian littoral states is determined by the industrial and services sectors, while the role of the agricultural sector is declining. The regional economy demonstrates dynamics closely tied to the energy demand both globally and regionally of major clients like the EU, China and India. The foreign trade turnover increased (with the exception of 2008-09) throughout the last decade and is likely to follow the growth pattern of the GDP. The transportation of petroleum resources, as well as associated extraction materials, will increase significantly through the use of tanker fleets and pipelines. Exploration for new oil and gas reserves, as well as the exploitation of discovered ones, together with an increase in transportation needs, will continue to propel the regional economy, but will also inevitably increase the pressures on the environment, already considerably degraded. This is, for example, significantly reflected in the depletion of fish stocks,

once a major source of export income through the fish and caviar trade.

Population

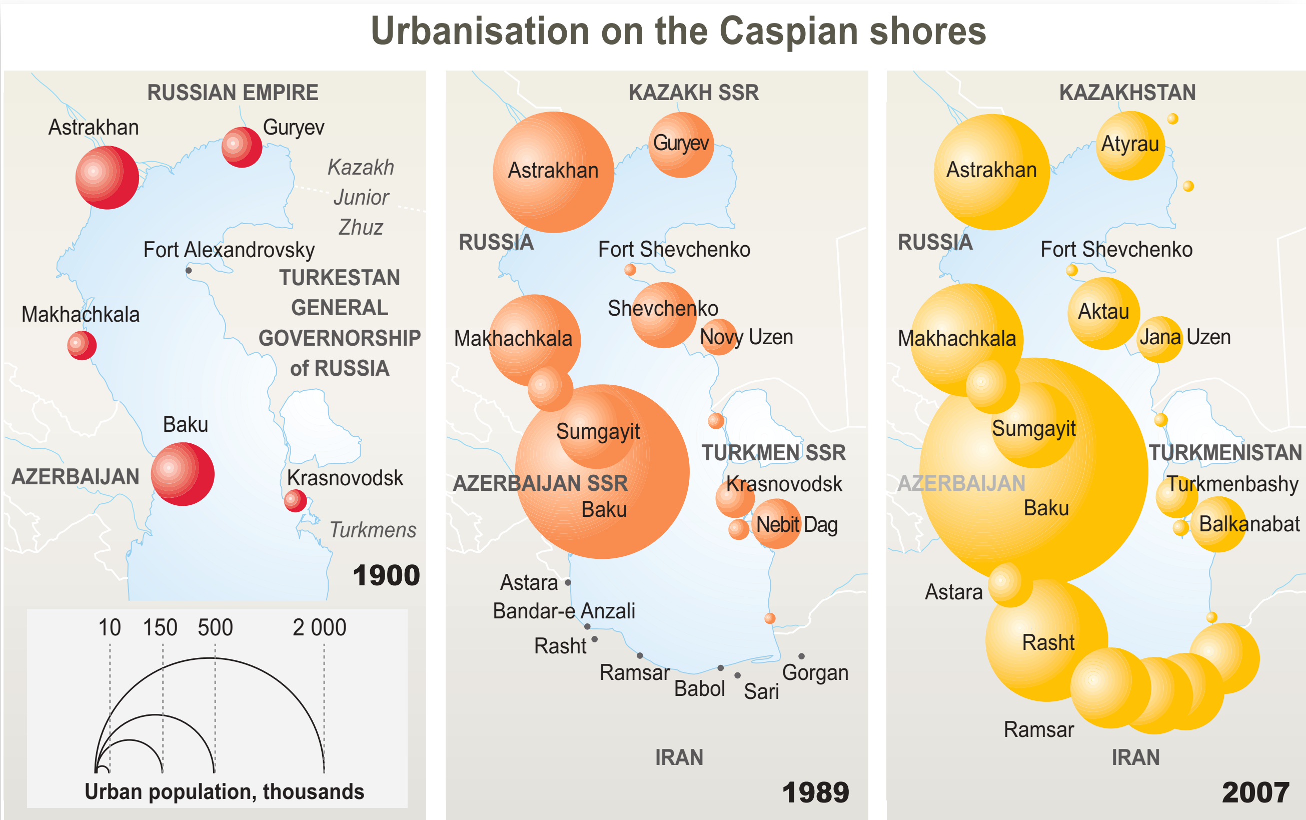
The population dynamics of the Caspian littoral states (US Census Bureau 2010) in 1992 – 2007 vary: while the overall population of Kazakhstan and Russia has declined by 7.6 and 4.8 per cent respectively, the population of Azerbaijan grew by 8.2 per cent, of Iran by 16.0 per cent and of Turkmenistan by 19.8 per cent.

However, the total Caspian coastal population (including only administrative units contiguous to the Caspian Sea) gradually increased from 1999, and has stabilized at aproximately 15.475 million by 2007 (National Statistics).

The population in Turkmenistan's coastal areas (though relatively low) grew by 42 per cent since 1999. The population in Kazakhstan grew by 13 per cent from 2000 to 2010 (probably due to the development of new oil fields and a decline in migration), followed by Iran with a 10 per cent growth between 1995 and 2006, Azerbaijan with 8 per cent growth between 1999 and 2007 and Russia with 6 per cent between 2000 and 2009 (National Statistics).

The western and southern coasts of the Caspian Sea are significantly more populated compared to the northern and eastern coastal areas, where the population is quite sparse, in part due to more inhospitable climate conditions throughout the year.

Of the littoral countries, Iran has the largest coastal population of close to 7 million (Statistical Centre of Iran 2006; UNDP 2009b). Russia and Azerbaijan together total over 7 million within the administrative districts along the Caspian (National Statistics), followed by less densely populated Kazakhstan and Turkmenistan with less than 1 million each in the Caspian coastal zone (National Statistics; CISStat; UNDP 2009).



Data for Persia (Iran) for 1900 and 1990 is missing
Map produced by UNEP/GRID-Arendal, August 2008
Sources: USSR Population Census 1989; Wikipedia; National population statistics

The Azerbaijan capital Baku is the largest and fastest growing city with a population of over 2 million (The State Statistical Committee of the Republic of Azerbaijan 2009). The population has doubled in the last decade and may reach approximately 3.3 million by the year 2030 (UNPD 2005). Sumgayit, the third largest city in Azerbaijan, has the highest population density (The State Statistical Committee of the Republic of Azerbaijan).

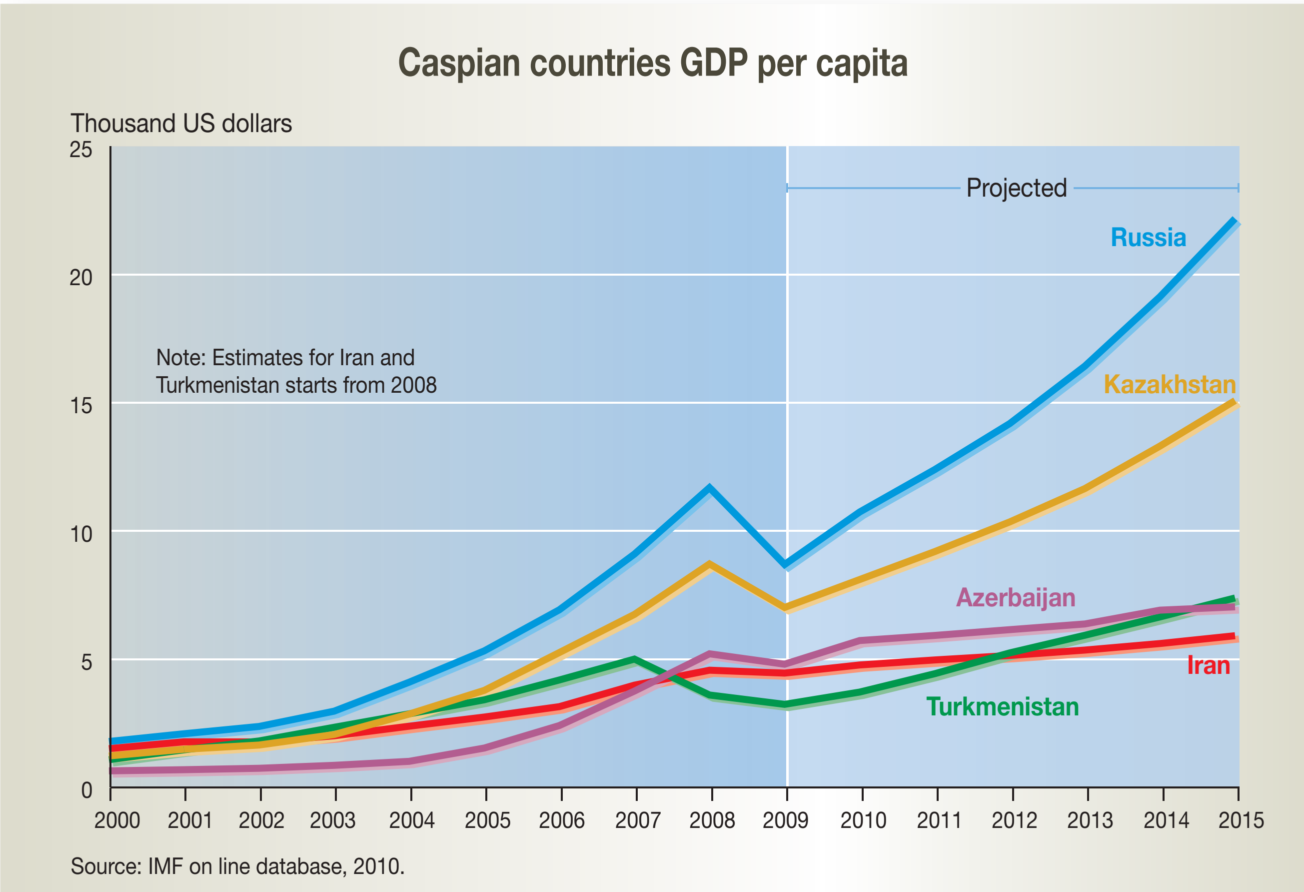
In certain areas, coastal development is accompanied by very high rates of population growth. The Iranian coastal area, located as a narrow land ribbon between the Elbourz mountain range and the Caspian Sea, has registered a population growth rate of 3,5 per cent per year during the last decade. In addition, this area doubles its 'normal' population during summer due to local tourism. This population pressure has resulted in turning the coastal lands close to the shoreline into residential areas (UNDP 2009).

In the Atyrau and Mangystau oblasts of Kazakhstan, the overall population density is low. However, in the past 30 years the region's population has increased by approximately 35 per cent (Great Soviet Encyclopedia 2010). The provincial capitals of Aktau and Atyrau accommodate nearly half of the total population in each province.

At the same time in the Russian Federation Kalmykia has lost 10 per cent of its population since 1995 (Russian Federal State Statistics Service 2009). The loss might be explained by climate change resulting in a worsening of living conditions and economic migration.

The overall population growth of the Caspian littoral states within the next 5 years is predicted to be low, with the exception of urban areas such as the city of Baku and its surrounding areas, including Sumgayit. The infant mortality rate is gradually decreasing in all Caspian countries, with an estimated trend to continue for the next 40 years (UNDP 2008).

The expenditures on health per capita (currency US$) have increased in all Caspian countries (with the exception of Iran's decrease in 2004), ranging between 2.6 per cent in Turkmenistan and 6.4 per cent in Iran, and relating to total health expenditures of GDP in 2007 (WHO 2010; WB 2010). The number of undernourished people is decreasing in all Caspian countries. The improvement is especially visible in Iran, where the malnourished population dropped from 19 per cent (in 2002) to 11 per cent (in 2006) (UNSD 2010).



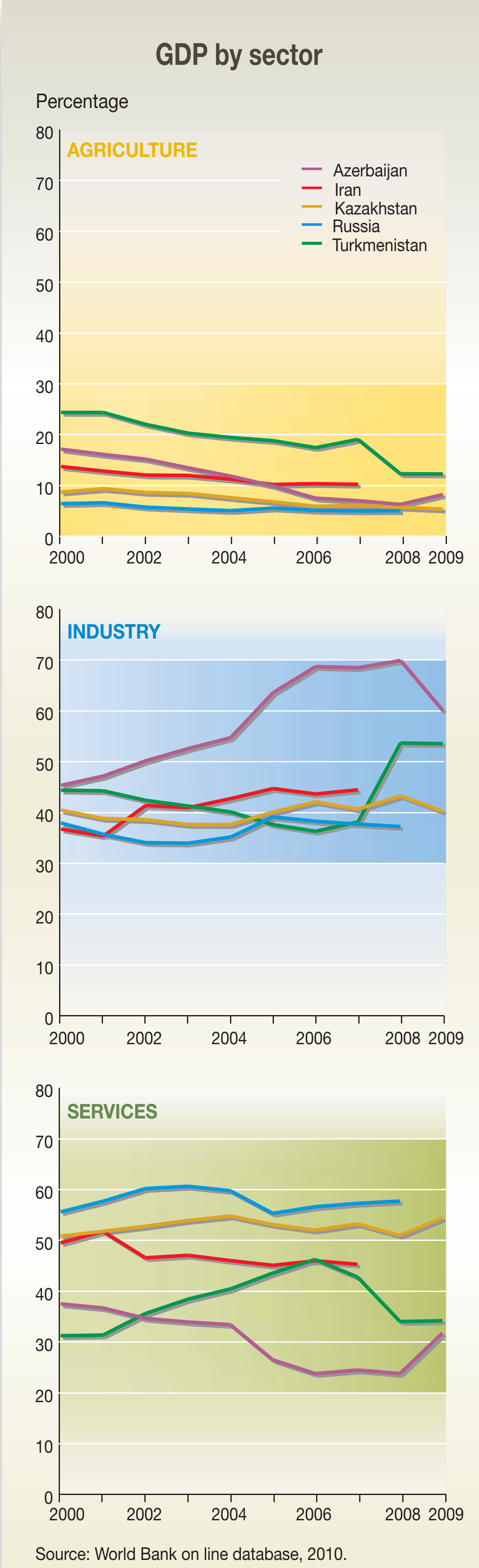
Economy

The economic prognosis for the Caspian littoral states is generally positive. After the impressive growth of the GDP (particularly for Azerbaijan) in 2002-06 and the economic slow-down in 2007-09 for all countries in the region, the prognosis until 2015 is more modest, predicting the stable annual growth of GDP in the range of 3-9 per cent (IMF 2010).

GDP based on (PPP) per capita GDP[1] is a significant indicator of economic prosperity. It reveals a quadrupling in Azerbaijan and a more than tripling in Turkmenistan, followed by factor 2.6 for Kazakhstan, 2 for Russia and 1.6 for Iran between 2000 and 2010 (IMF 2010). This is a promising outlook, since it indicates the availability of more resources for social and environmental needs. It is supported by a slow but steady growth of life expectancy and education indices as reflected by the International Human Development Index (HDI). Economic growth for the next 5 years is predicted to be slower, with a projected 1.15 – 1.55 times increase of GDP per capita (IMF 2010). GDP per capita in 2010 $ has reached respectively: $15,836 in Russia, $12,602 in Kazakhstan, $10,864 Iran, $10,033 in Azerbaijan, and $6,785 in Turkmenistan (www.economywatch.com). These increases, however, are strongly linked to oil and gas revenues and can be hampered by inflation. Since the year 2000, average consumer prices have nearly doubled in Azerbaijan, Kazakhstan and Turkmenistan and more than tripled in Russia and Iran (IMF 2010). According to the IMF prognosis, the trend will continue until 2015, looking more dramatic for Iran with a prognosis for inflation six times higher in 2015 than in 2000.

The structure of national economies of the Caspian littoral states is determined by the industrial and services sectors. The region demonstrated

[1] A nation's GDP at purchasing power parity (PPP) exchange rates is the sum value of all goods and services produced in the country valued at prices prevailing in the United States. This is the measure most economists prefer when looking at per-capita welfare and when comparing living conditions or use of resources across countries.



a growth within the industrial[2] sector between 2000 and 2009 by more than 10% from an average of 39,9% to 51,3% . The next largest sector[3], services, decreased slightly from 45% to 40% (mostly due to the crisis of 2008-09). At the same time, the agricultural[4] sector declined from 14,9% to 8,6% (WB 2010).

With the oil and gas sector continuing to grow, and driven by the energy demand of the main clients EU, China and India, transportation of petroleum resources and associated extraction materials will increase significantly through the use of tanker fleets and pipelines. The export of crude oil (including lease condensate) in 2000-09 increased 1.6 times in Russia, 2.3 times in Kazakhstan and 6.8 times in Azerbaijan (US EIA Statistics), thus boosting the turnover of oil and gas through pipelines by 53 times. The Iranian tanker fleet has increased 1.6 times since 2001, reaching 2,449 vessels in 2007 (Statistical Centre of Iran 2008).

With the increased use of the Volga-Don Canal for transportation, there will be a growing demand for significant infrastructure improvements to support the port's development. This will include the need for labor, both primary and secondary, materials, land-based transportation, and their ongoing operation. Shipping fleets are being updated, and as port capacities increase with increased traffic in the Volga-Don Canal, the overall Caspian fleet is also expected to be improved (CEP 2007a). There is an increased interested to develop a Trans-Caspian pipeline that would bring Turkmenistan's gas through pipeline system of Azerbaijan to the EU. However, there is no common consent on this issue by all littoral states.

The overall economic growth of the region, driven primarily by the energy sector, is coherent with the dynamics of foreign trade. This growth was hampered only by the financial crisis of 2008-09, and can be expected to follow the trend for the GDP and increase through the next 5 years.

While the development of the oil and gas sector serves as the driving force of the regional economy in the coming 5 years, the negative trade balance in prepared/preserved fish and caviar for all Caspian states in 2009 clearly indicates the depletion of fish stocks, primarily sturgeon (ITC 2010). Countries which were exporters in 2001 (except Russia, which was a stable importer throughout the decade), became net importers in 2009. The most radical shift occurred in Kazakhstan (+$3.1 million in 2001, -$21.1 million in 2009) and Iran (+$38.2 million in 2001 and -$1.5 million in 2009) (ITC 2010).

[2] Industry corresponds to the International Standard Industrial Classification (ISIC) divisions 10-45 and includes manufacturing (ISIC divisions 15-37). It comprises value added in mining, manufacturing (also reported as a separate subgroup), construction, electricity, water, and gas. Value added is the net output of a sector after adding up all outputs and subtracting intermediate inputs. It is calculated without making deductions for depreciation of fabricated assets or depletion and degradation of natural resources. The origin of value- added is determined by the ISIC, revision 3. Note: For VAB countries, gross value added at factor cost is used as the denominator.

[3] Services correspond to ISIC divisions 50-99 and they include value added in wholesale and retail trade (including hotels and restaurants), transport, government, and financial, professional, and personal services such as education, health care, and real estate services. Also included are imputed bank service charges, import duties, and any statistical discrepancies noted by national compilers as well as discrepancies arising from rescaling. Value added is the net output of a sector after adding up all outputs and subtracting intermediate inputs. It is calculated without making deductions for depreciation of fabricated assets or depletion and degradation of natural resources. The industrial origin of value added is determined by the ISIC, revision 3.

[4] Agriculture corresponds to ISIC divisions 1-5 and includes forestry, hunting, and fishing, as well as cultivation of crops and livestock production. Value added is the net output of a sector after adding up all outputs and subtracting intermediate inputs. It is calculated without making deductions for depreciation of fabricated assets or depletion and degradation of natural resources. The origin of value added is determined by the ISIC, revision 3. Note: For VAB countries, gross value added at factor cost is used as the denominator.

4. Pressure

4.1 Decline in bioresources

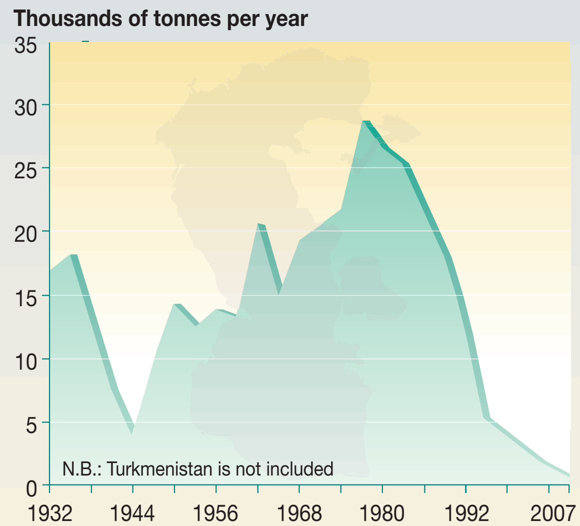
There are more than 100 species of fish in the Caspian Sea and the low deltas of adjoining rivers. About 40 species are fished commercially, of which six are species of sturgeon. In addition, the Caspian has sizeable resources of bony fish and tulka, mainly used for local consumption. Sturgeon are anadromous fish, living most of their long lives (ranging up to 100 years) in saline water, but migrating to fresh river water to spawn. Tulka species are marine fish which spawn and feed in the open sea and undertake some seasonal migrations along sea currents. Other bony fish of the Caspian Sea mainly spawn and feed in low deltas and in the north of the sea.

Sturgeon fisheries decline

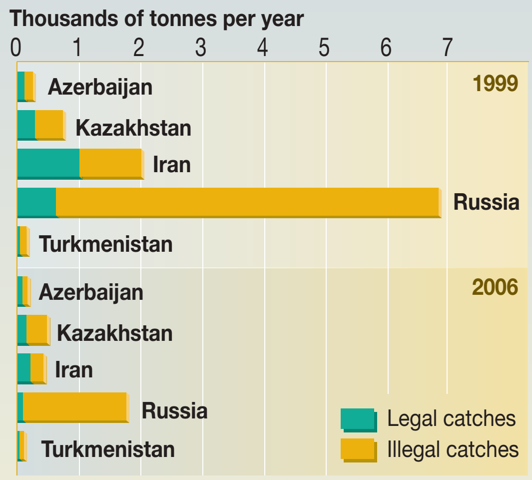
Six sturgeon species are found in the Caspian Sea and its drainage basin: Russian sturgeon (*Acipenser gueldenstaedtii*), Persian sturgeon (*A. persicus*), Stellate sturgeon (*A. stellatus*), Ship sturgeon (*A. nudiventris*), Sterlet (*Acipenser ruthenus*) and Beluga (*Huso huso*). The bulk of the world's remaining stock of wild sturgeon resources is found in the Caspian, which also accounted in the past for between 80 and 90 per cent of total world caviar production.

Since 1970, pollution from various sources, mainly from industry and agriculture in surrounding areas plus oil extraction activities, has had a major impact on the Caspian Basin and its ecosystems. Accumulations of various toxins in the main rivers surrounding the Caspian and in the sea itself have led to changes in the physiology and reproductive systems of sturgeon. In the period from 1985 to 1990, sturgeon dieoffs were recorded in the Volga and Ural rivers (Ivanov 2000). Up to 90% of sturgeon specimens examined showed muscle deterioration and shrinkage of the outer layers of eggs (Pavelieva et al., 1990).

It is clear that the decline in recorded sturgeon catches is due to a decline in available stocks. Over a 30-year period, total sturgeon catches have declined dramatically - from 27 thousands tonnes to less than one thousand tonnes. The Great Sturgeon or Beluga (*Huso huso* Linnaeus, 1758) is the biggest and most valuable sturgeon, not only in the Caspian but in the world. In the early 1990s, the total annual catch of Beluga was about one thousand tonnes: in the 2000s the catch dropped dramatically with a total in 2007 of only 33 tonnes.



Source: *Transboundary Diagnostic Analysis for the Caspian Sea,* Caspian Environment Programme, 2002. Updated in 2010 with data from the United Nations Food and Agriculture organization (FAO).



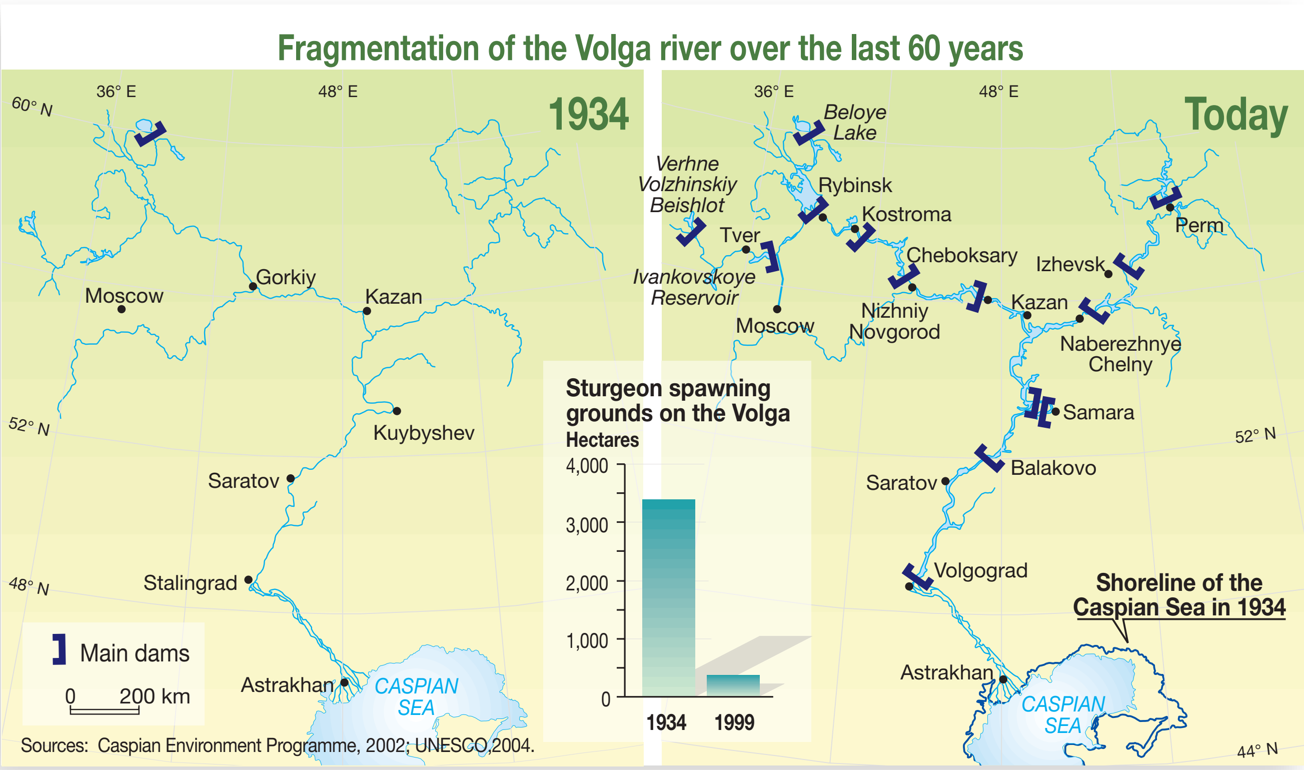
Source: Strukova, E. and Guchgeldiyev, Study of The Economics of Bio-resources Utilization in the Caspian, Estimation Of The Economic Value Lost From Degradation Of The Caspian Fishery, Including The Effects Of Sturgeon Poaching, 2010.

About 50 per cent of Beluga catches now occur in the Ural River Basin, whereas 15 years ago, 50 per cent were caught in the Volga River Basin, 25 per cent in the Ural River Basin and 23 per cent around the south Caspian shoreline in Iranian waters.

Catches of Russian sturgeon (*Acipenser gueldenstaedtii* Brandt & Ratzeburg, 1833) were exceptionally high in the 1970s – up to 12 thousand tonnes annually. By the beginning of the 1990s, the figure had dropped to between five and seven thousand tonnes per year. At that time, Russian sturgeon was the main commercial sturgeon species in the Caspian, constituting nearly 50 per cent of the total sturgeon catch. In recent years, catches have been sharply reduced - in 2008, the total official catch of Russian sturgeon was only 124 tonnes.

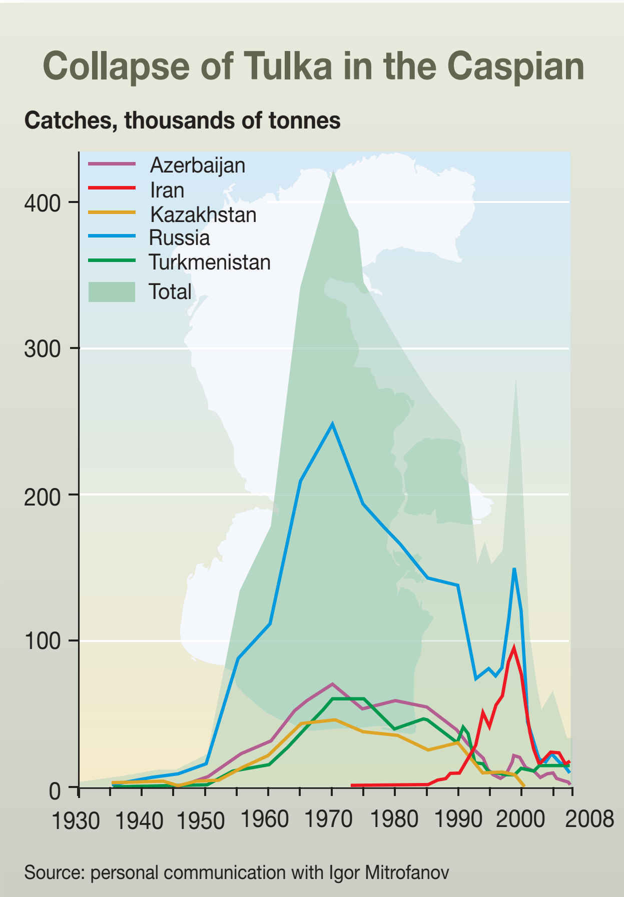
Persian sturgeon (*Acipenser persicus* Borodin, 1897) was for a long time included in statistics relating to Russian sturgeon, but from 1990, separate catch data on the species has been available. During the twentieth century, the number of Persian sturgeon caught was significantly lower than Russian sturgeon and Stellate sturgeon – these two species formed between 80 and 90 per cent of total sturgeon catches in the 1970-90 period. Total annual catches of Persian sturgeon did not exceed 1.5 thousand tonnes. Due to the large release of Persian fingerlings by Iran, catches were more or less stable in the 1990s, with about 400-500 tonnes caught annually in Iran, accounting for 70 per cent of the total annual Persian sturgeon catch. In subsequent years, catches have been reduced to 108 tonnes annually for the whole Caspian Sea (data relates to 2005).

Stellate sturgeon (*Acipenser stellatus* Pallas, 1771) is another sturgeon species of great economic importance. Its annual catch was about five thousand tonnes in the early 1990s, while at the peak of sturgeon catches in the 1970s, this figure was between 10 and 13 thousand tonnes. In 2003-04 the annual Stellate sturgeon catch was between 200 and 300 tonnes. Stellate sturgeon is small compared to other Caspian diadromous stur-



geons and thus, in a single tonne, there are far more specimens compared to other species. Stellate constituted about 30 per cent of the total sturgeon catch in the Caspian in the 1970s and 1990s, but dropped to about 20 per cent of the total in 2004. The decline in the Stellate sturgeon stock is most notable in the Ural Basin where, in 1990, it comprised 75 per cent of the commercial sturgeon catch. The total official Stellate catch in 2008 was only 90 tonnes.

Small amounts of Bastard sturgeon or Ship (*Acipenser nudiventris* Lovetsky, 1828) have traditionally been found in the Caspian. Its total annual catch never exceeds 100 tonnes and it represents only 1 per cent or less of the total sturgeon catch. It seems population levels of Ship sturgeon are more or less stable, limited to the Ural River, where commercial catch of Ship is prohibited. On top of that, Kazakhstan grows juvenile Ship and releases it into the sea. Iran has continued its commercial catching until now.



The structure of sturgeon catches has changed over the years. In recent times, Persian sturgeon has played a more important role due, in large part, to the drastic reduction in catches of other species, however there are no verifyable data on the structure of Iranian catch.

The main reasons behind the serious decline in these bioresources over the years were initially believed to be the reduction in spawning grounds (WB 2008), illegal fishing in the post-Soviet era and oil and gas development in the region (CEP 2007a). The construction of several dams along spawning rivers (mainly the Volga River) significantly altered water flows and destroyed about 90 per cent of the sturgeon's spawning grounds (UNEP/GRID-Arendal 2006). Now, only the Ural River provides spawning opportunities unaffected by dams - and is able to support long-distance spawning migration. But nevertheless, the most up-to-date analysis reveals that insufficient and ineffective control over catches of sturgeon is now the most critical factor depressing sturgeon stocks (WB 2008). Also because of the illegal sturgeon catches in number of countries have raised between 1998 and 2006 (WB 2008). According to experts, the poaching are recently shifted from the territory of Russia to Kazakhstan in the northern part of the Caspian Sea. Kazakhstan waters and its territories are under pressure from poachers from Azerbaijan, Kazakhstan and Russia.

Tulka (kilka) stock collapse

Three endemic species of tulka are recognized in the Caspian Sea: *Clupeonella caspia* – (Caspian tulka/common tulka); *Clupeonella grimmi* (Southern Caspian or Big-eye tulka), and *Clupeonella engrauliformis* (Anchovy tulka) (UNDP 2009b). Each species has its own peculiarities in terms of distribution, food preference, spawning time and other biological and ecological characteristics (UNDP 2009b). Tulka catches dramatically changed over the period 1970-2008 in all countries. Over a 20-year period, starting in 1970, catches decreased annually in Azerbaijan, Turkmenistan, Kazakhstan, and Russia. The total tulka catch declined from 410 thousand tonnes in 1970 to 132 thousand tonnes in 1996. A temporary tulka catch recovery period occurred after 1996, culminating in 270 thousand tonnes in 1999. But tulka catches dramatically decreased again in the period 1999 to 2003 in all countries apart from Turkmenistan (with the highest rate of decline recorded in Iran and Russia) (WB 2008). The cause was mass mortality of Big-eye and Anchovy tulka in 2001-2002. According to specialists, it happened because of a seaquake, accompanied with release of methane, which results in destruction of bioresources. The total catch was only 50 thousand tonnes in 2004, while in the following year the catch increased slightly to reach 65 thousand tonnes (WB 2008). The total annual Caspian tulka catch in 2007-08 dropped again and was only 32.5 thousand tonnes. However, in Turkmenistan these statistics were reversed, with the annual catch increasing from six thousand tonnes in 1998 to 14 thousand tonnes in 2003.

It is clear that the decline in the tulka fishery has been dramatic over the last ten years. This trend began in the 1980s and has persisted ever since, similar in character to the noted declines in the sturgeon fishery. The overall cause of the decline in the tulka fishery is at present unclear, although overfishing is undoubtedly one of the major factors (CEP 2007a). Overfishing had a clear impact on the anchovy tulka stock in the South Caspian (which comprised up to 90 per cent of the total catch) before the appearance of the comb jelly *Mnemiopsis leydyi* (ML) in considerable numbers. It is, however, difficult to separate the effects of overfishing and its competition with *Mnemiopsis leidyi* on anchovy tulka. ML are the main zooplankton feeders in the southern Caspian. Their interaction is complex and may be influenced by other external factors. There are reports of ML appearing as early as 1995 - it is possible that up to the year 2000, the large tulka population prevented any significant ML bloom, and that it was only after subsequent sharp declines in the tulka stock, due to overfishing, that ML became a dominant threat, inhibiting the restocking of tulkas (CEP 2007a).

Bony fish fishing

There are about 30 species of bony fish fished commercially in the Caspian Sea. The majority of these are small cyprinids, not included in statistics and with only total estimates of catch levels available. The most important bony fish species are Caspian Roach (*Rutilus rutilus caspicus*), Bream (*Abramis brama*), Carp (*Cyprinus carpio*), European Pikeperch (*Sander lucioperca*), Wels or catfish (*Silurus glanis*), Northern Pike (*Esox luceus*), and Mullet (*Liza auratus & Lisa saliens*).

Caspian Roach was a dominant fish species over a long period of time. They feed in the open sea and return, for a very short period, to low deltas for spawning early in the spring. Its maximum catch was recorded as 167 thousand tonnes in 1935. Roach catches varied over a 20-year period, but the general trend was a decline – from 167 thousand tonnes in 1935; 105 thousand tonnes in 1955; 26 thousand tonnes in 1975; 20 thousand tonnes in 1996; and only 5.7 thousand tonnes in 2008. Within a 70-year time period, catches decreased 30 times.

All bream species populate the river deltas and the marine areas around deltas. The dominant species is the European bream (*Abramis brama*). All other bream species (*Ballerus ballerus*, *Vimba persa*, *Blicca bjoerkna*, *Ballerus sapa*) are fished in small amounts and rarely exceed 1 thousand tonnes annually. The maximum catch of European bream was more than 100 thousand tonnes in the early 1930s. In subsequent years, the catch level decreased, becoming more or less stable over time at 20 thousand tonnes annually. The lowest catch was recorded in 1979-80, less than 5 thousand tonnes.

Carp, like bream, does not usually migrate far into the sea and congregate around deltas. Carp catches have always been less than bream and roach. The lowest catch levels were recorded in 1982 and 1995 – less than 4 thousand tonnes. Over the past ten years, catch levels are believed to have increased, reaching 9.4 thousand tonnes in 2008.

European Pikeperch is an active predator, preferring freshwater. Catches dropped from 55 thousand tonnes in 1948 to 0.77 thousand tonnes in 1979. In subsequent years, catches increased a little, but stayed at the low level of a few thousand tonnes. Marine pikeperch (*Sander marinus*) was fished from the 1930s to the 1950s, but is now very rare and even included in the Red Data Books.

Wels catfish (*Silurus glanis*) and northern pike (*Esox luceus*) are other predator species. Both were never considered as important commercial species, although their combined catch reached up to 24 thousand tonnes in 1956. Catches of both species have decreased, although they are more stable than those of other fish species. Present-day catch levels are about 4 to 5 thousand tonnes for pike and 6 to 8 thousand tonnes for wels catfish.

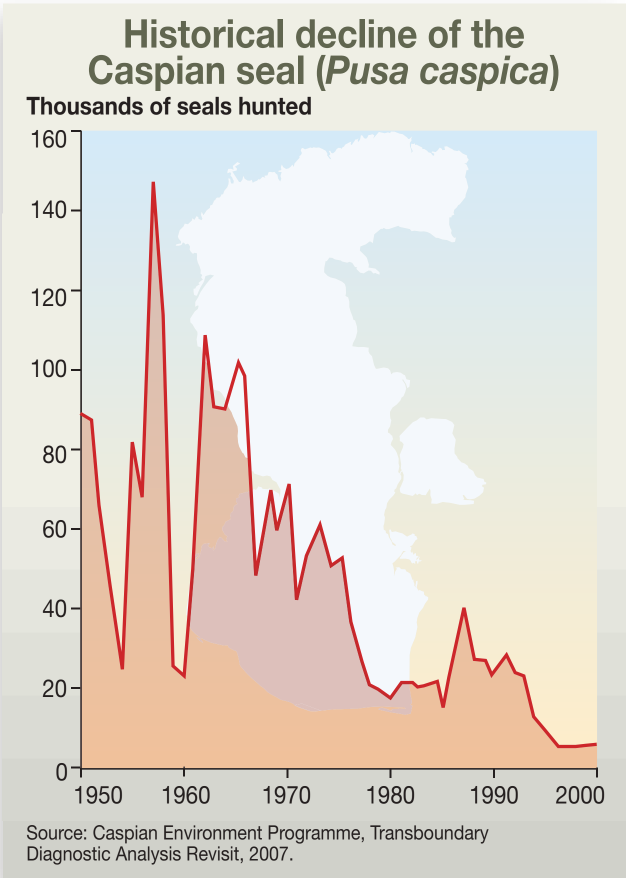
Mullets (*Liza aurata* & *Lisa saliens*) were introduced into the Caspian Sea in the early 1930s and appeared in the commercial fishing statistics from 1950 onwards. Both mullet species are fished mainly in the south Caspian. Fishing has been intensified over the last decade by Iran. The reasons for fluctuations in catches are unknown.

Seal population reduction

The seal is the only marine mammal in the Caspian Sea, feeding on tulka and other small fish. It is an endemic species in the Caspian and, because of this, is considered vulnerable. During its life span, the Caspian seal migrates from the frozen North Caspian in winter to the South Caspian in summer, and then returns to the north to give birth to pups on the ice. During these migrations, the Caspian seal can be found in all locations in the sea.

It is unclear how many seals remain in the Caspian Sea. From a population estimated at more than one million in the early years of the twentieth century, population estimates now vary between 110 000 and 350 000. For more than 100 years, hunting of seal pups was carried out in the frozen North Caspian area each winter. In the early twentieth century, nearly 100 000 seals were hunted each year; later a quota was set at 40,000 pups per year, further reduced to 20,000 pups per year. The hunting quota, set by the Caspian Bioresources Commission for 2007, was 18,000 seals. Even if during the last decade, no organized hunting has taken place in the North Caspian, the hunting quotas exceeded the estimated annual pup production (Härkönen et al 2008).

Recent mass mortalities have reduced the seal population even further. In 2000, a mass mortality due to the canine distemper virus (CDV) caused tens of thousands of deaths throughout the Caspian (Azerbaijan, Kazakhstan, Russia, and Turkmenistan). Pollution has been shown to result in a high number of barren females (up to 70% of females are thought to be barren) which also threatens the overall seal population. Besides pollution and hunting, other stress factors impact on the Caspian seal population. A major food source for the seals is the small tulka fish, once abundant in the Caspian. Another factor which has become apparent in recent years is intrusion on to the ice

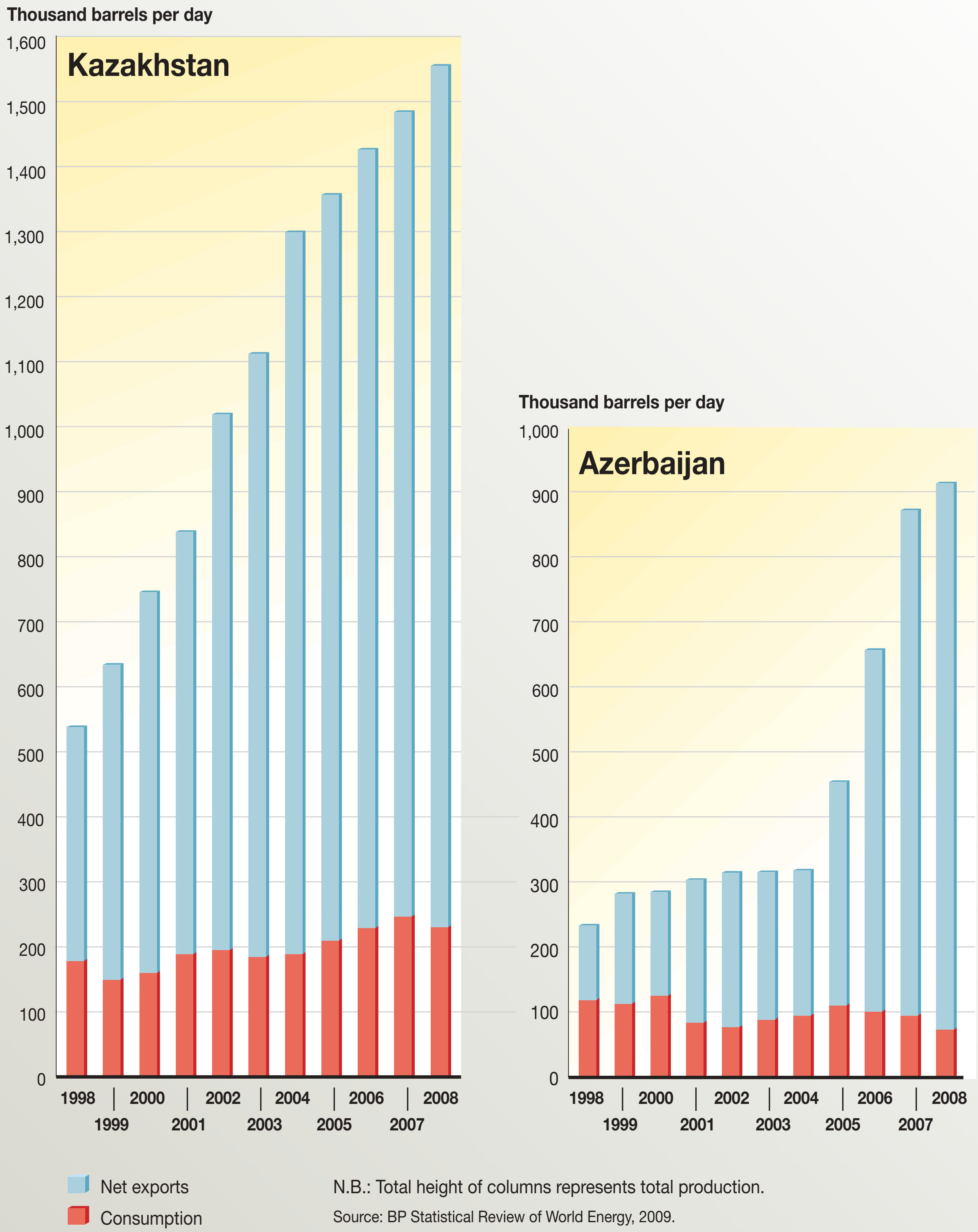


Source: Caspian Environment Programme, Transboundary Diagnostic Analysis Revisit, 2007.

during the pupping season and also the separation of mother seals from their pups (CEP 2007f).

Active conservation efforts will be required to ensure that the Caspian seal does not become extinct. As a major mammal intimately involved in the food chain, it plays an important role in the biodiversity of the Caspian Sea and is a particular indicator of ecosystem health.

Oil consumption and export



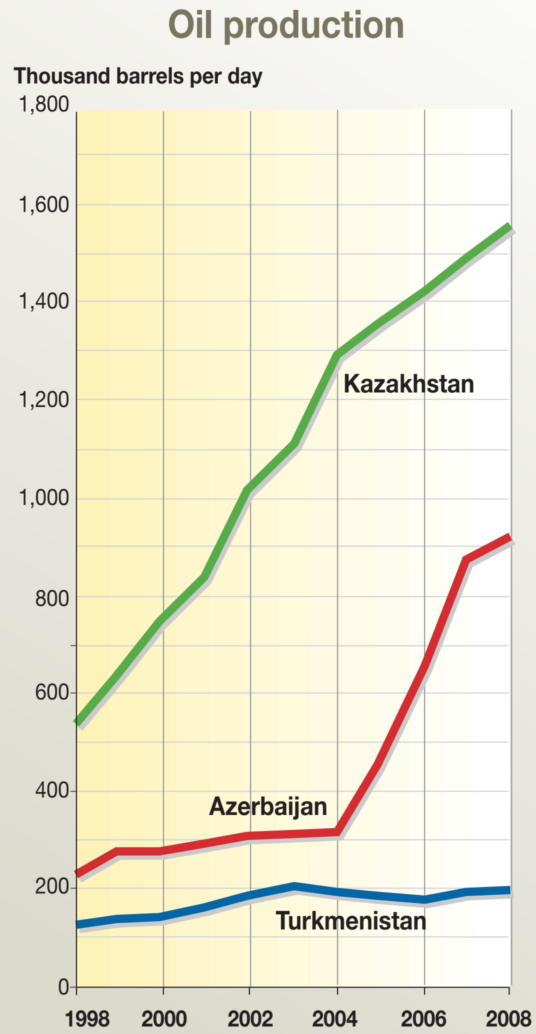
N.B.: Total height of columns represents total production.

Source: BP Statistical Review of World Energy, 2009.

4.2. Non-living resource extraction

Over the last 20 years, the Caspian Sea has become a focus of global attention. A worldwide decline in oil and gas reserves together with a rise in energy prices has heightened interest in an area where there is still growth potential in oil and gas exploration. At present, the Caspian Sea region is a significant, though not major supplier, of crude oil to the world market. For example, the Azeri-Chirag-Guneshli oilfield in Azerbaijan is listed as one of the world's 10 largest oilfields in terms of production, having reached a peak in 2007 (WEO 2008).

In 2005, oil production in the Caspian region reached approximately 1.9m b/d (EIA 2006), a figure similar to that of Brazil, South America's second largest oil producer. The 2009 BP Statistical Review of World Energy estimated the Caspian's share (in this case the Caspian share includes Azerbaijan, Kazakhstan and Turkmenistan) of the world total of proven oil and gas reserves in 2008 at 3.8% and 5.9% respectively. In terms of total world production, the Caspian accounts for 3.29% of oil production and 3.6% of gas production (BP 2009). The main focus of the oil and gas industry continues to be in the areas of Azerbaijan, Kazakhstan and Turkmenistan.



Source: BP, *Statistical Reviewof World Energy,* 2009.

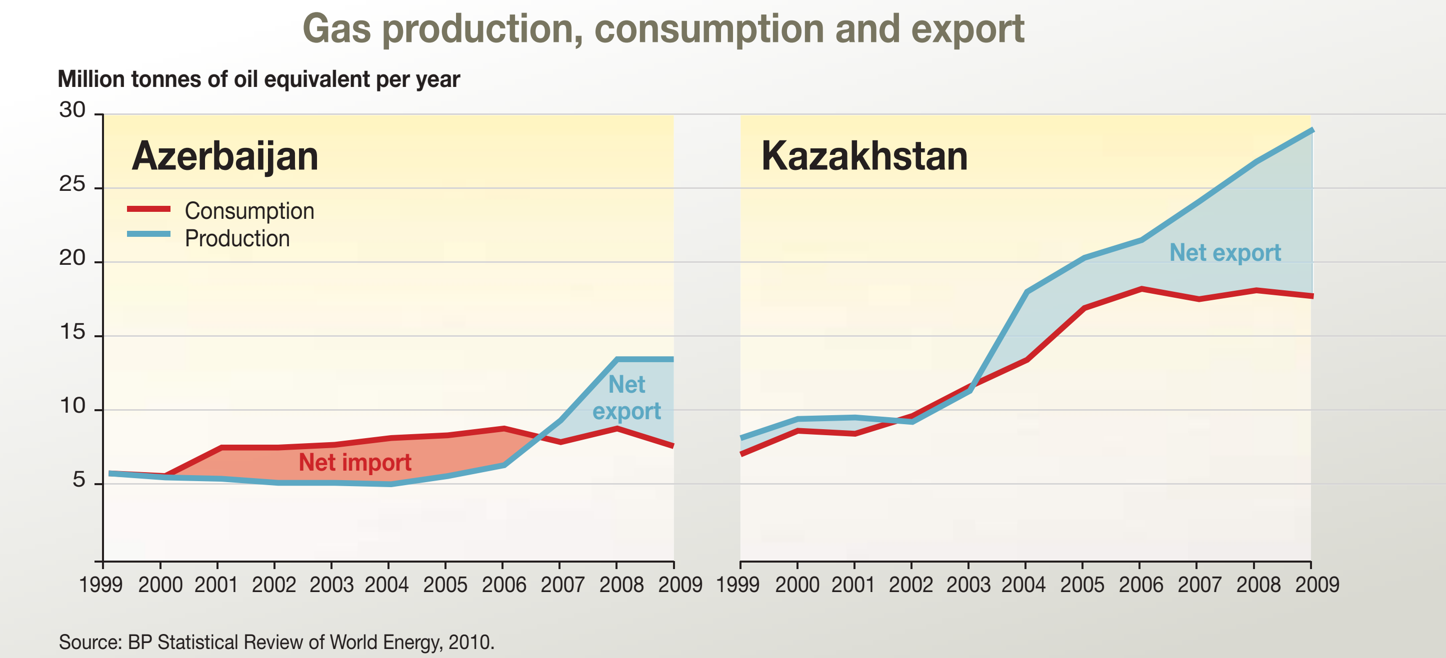
Azerbaijan has been widely recognized as an oil-producing country with the oldest field – the Balahani-Sabunchi-Ramani site – having started operations in 1871. It is only recently, with the development of the offshore Shah Deniz field from 1999 onwards, that the country became a major gas as well as oil exporter in modern times. The country's oil and gas sector continues its development; recent results from exploration for oil at the Shah Deniz field south of Baku and the Azeri-Chirag-Guneshli (ACG) field east of the capital are said to be positive. Gas production is growing, with the offshore Shah Deniz field providing up to 20 billion cubic meters (bcm) per year for export (WEO 2008).

Geological conditions in the oil and gas fields are complex, posing many challenges. These include mud volcanoes, frequent difficult weather conditions, high-pressure reservoirs, minimal pore pressure ranges, drill-hole instability problems, unstable sediments and shallow-depth drilling hazards. According to industry sources, international environmental standards are being followed where possible: as a result, the ecological degradation forecasted by some has not reached a significant level (CEP 2007a).

Since 1994, **Kazakhstan** has seen a large-scale increase in oil and gas output. The country has three main oilfields with growth potential - Tengiz, Karachaganak and Kashagan. Capacity expansion at the Tengiz and Karachaganak fields, the combined reserves being more than 3 billion barrels, has added about 500,000 b/d at peak capacity. When the Kashagan field becomes on stream, the combined production from these three fields is likely to result in Kazakhstan becoming a member of the small group of countries capable of producing more than 2m b/d (WEO 2008).

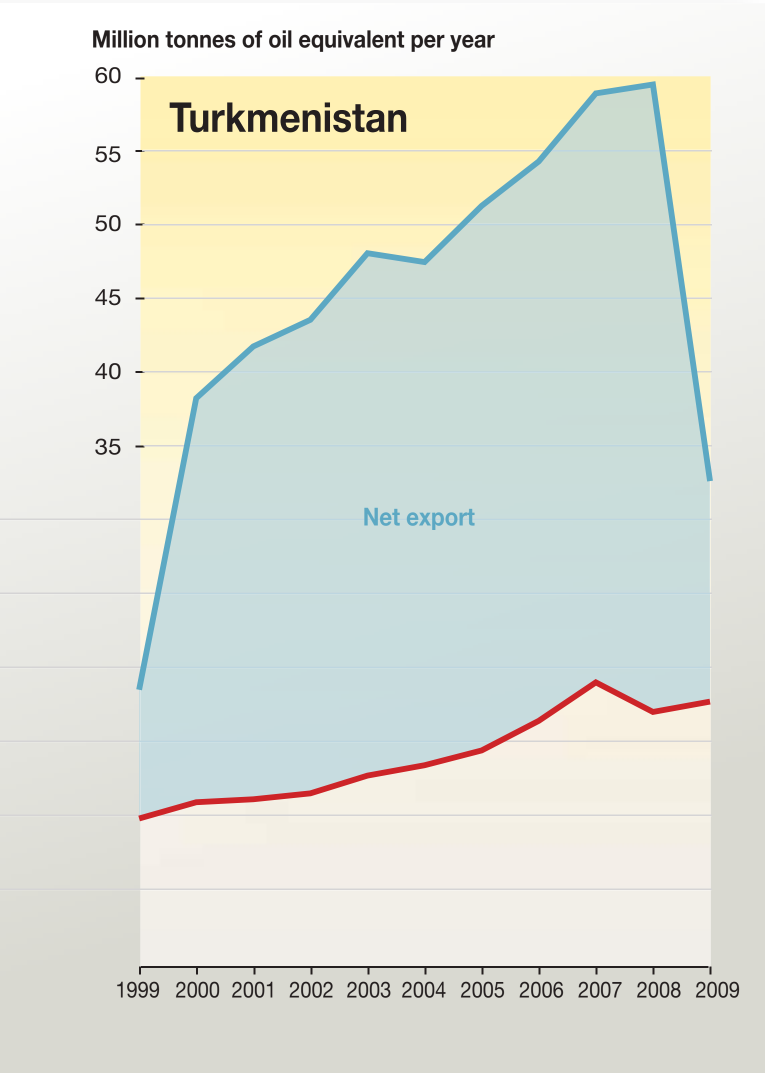
The Kashagah field was discovered in July 2000, approximately 80 km south of Atyrau. It is the largest Caspian offshore field and one of the largest fields discovered anywhere in the world in the last 30 years. It has taken several years to develop, and start-up operations have been delayed several times; latest indications forecast that the first production will be on stream in 2014 (WEO 2008). The geological formation in the Kashagah field is characterized by very high pressure (800 bars), high temperatures (125°C), hydrogen sulphide content (15–20%) and the presence of naturally occurring toxic substances (mercaptanes) (ENVSEC 2008). These factors create major logistical difficulties. Ecological conditions are also difficult, with exploration taking place in extremely cold, very shallow and environmentally sensitive waters. Production facilities will be based on several artificial islands, surrounded by ice-protection barriers (Agip KCO). The high volumes of hydrogen sulphide in the reserve characterize some of the challenges involved in bringing production on stream. Making the production facilities safe for workers has been an expensive business. Plans to re-inject gas into Kashagan's reservoirs have caused considerable concern among environmental NGOs (CEP 2007a).

Turkmenistan implements projects aiming at the increase of the production and export of energy. Turkmenistan is the biggest producer of gas



in the Central Asia: in 2010 production reached 75 bcm, most of it for export. The main importes of the Turkmenistan's gas are Russia, China and Iran.

Turkmenistan has huge reserves of hydrocarbon resources. It is generally believed that Turkmenistan has some of the world's largest natural gas reserves. According to the information specified in the National Program for oil and gas industry for the period until 2030, total natural gas reserves are estimated at 22.4 trillion m^3, including 6.2 trillion m^3 in the Turkmen sector of the Caspian Sea. According to the international audit, the total proven natural gas reserves of the South Yoloten-Osmman field alone amount to 14-16 trillion m^3. Subsequent research on land and offshore in the Caspian Sea will allow Turkmenistan to continue to build up its reserves and production of natural gas and oil. Turkmen government has ambitious plans to increase the annual natural gas production to 250 billion m^3 by 2030, of which more than 200 billion m^3 will be exported. Also, according to the national development plan until 2030, oil production will increase to 110 million tons by introducing large-scale programs of development and exploration.



There have been significant advances in the transportation of Caspian hydrocarbon resources, through large investments in pipelines, marine and railroad traffic from the Caspian to major international markets. The main developments over the last five years have been the completion of the Baku-Tbilisi-Ceyhan (BTC) pipeline and the increase in capacity of the Caspian Pipeline Consortium (CPC), carrying oil from the northern Caspian to the Black Sea coast at Novorossiisk. Both of these pipeline projects have faced significant challenges due to concerns relating to their environmental impacts, although a significant amount of these concerns are related to areas outside the Caspian Basin.

The European Union's TRACECA programme (Transport Corridor Europe-Caucasus-Asia) helped modernize the Baku-Turkmenbashi ferry line - for many years the only one in existence - and added a Baku-Aktau service to Kazakhstan. To counter competition from what was seen by some as a new Silk Road, Russia has launched a project to build a north-south link, connecting the Baltic and Russia to Iran and the Persian Gulf. Russia has opened a new port at Olya, on the Volga delta, connected to the river and canal system and to the rail network that runs parallel to the river, providing fast container transport. Russia also plans to supplement the maritime route by developing a coastal rail link, modernizing the existing track between Azerbaijan and Iran.

At the same time, Iran is building larger tankers in the hope of attracting more Kazakhstani crude oil to its Caspian port of Neka, which is already linked by pipeline to refineries in Tehran and Tabriz. Until recently, there was a rapid growth in oil swaps between the two countries – with Iran purchasing oil from Kazakhstan for domestic refining and consumption, and then selling, in exchange, compensatory quantities of Iranian oil to the world market from its Persian Gulf ports. In 2005, Iranian oil swaps with Kazakhstan reached 1.4 million tonnes, rising in 2006 to 4.2 million tonnes (CEP 2007a). However, due to U.N. sanctions against Iran in June 2010, such oil swaps have momentarily come to a halt. Plans for additional pipelines between the Caspian and Asia are emerging with negotiations underway to pump Kazakh Caspian oil to energy-hungry markets in Asia.

4.3. External inputs: run offs

The Caspian Sea is one of the most important endorheic basins or closed drainage systems in the world and, given its landlocked nature, no flow-through exists to aid self-purification. Pollutants entering the water body are retained, having no means by which they can be removed. Therefore, it is vital to fully understand levels of contaminant inputs, and thus choose the best-informed and most cost-effective means to mitigate or alleviate pollution. River inflows are a key factor in the Caspian Basin; this reinforces the importance of quantifying riverine fluxes of pollutants. The main sectors contributing to these pollution fluxes are agriculture, industry - including the oil and gas sector - and urbanization.

This section is based on the first and second Transboundary Diagnostic Analyses, Rapid Assessment of Pollution Sources studies performed by all littoral states (2007), the Baseline Inventory Report: Land-based point and non-point pollution sources in the Caspian Coastal Zone (2008) and the Regional Pollution Action Plan (2009). These documents analyse the quantities and types of contaminants in each littoral state arising from various land-based sources, including wastewater treatment plants, food production, oil, metal and other manufacturing industries plus municipal sewage. Data referring to the Biological Oxygen Demand load (BOD), total suspended solids (TSS), total nitrogen and total phosphorus levels were available for all five of the Caspian countries through the Baseline Inventory Report. However, much of this data was of uncertain quality and could not be verified independently from national records: it was therefore impossible to compare various sets of data. Also, it was not possible to assess in detail river pollution loads.

Table 1: Pollution loads from rivers, municipalities and industry in the littoral countries.

Countries	Sources	BOD t/y	Nitrogen t/y	Phosphorus t/y	Oil t/y
Azerbaijan	Rivers	36,000	19,000	1,000	600
	Municipalities	38,000	13,000	3,300	9,400
	Industry	7,100	1,100	300	14,000
Iran	Rivers	49,500	12,000	1,200	400
	Municipalities	68,000	16,000	4,400	7,800
	Industry	28,200	600	210	12,500
Kazakhstan	Rivers	13,200	6,000	600	400
	Municipalities	800	500	100	200
	Industry	2,900	7,100	100	1,800
Russia	Rivers	807,900	805,000	87,500	73,100
	Municipalities	16,000	5,000	1,400	3,800
	Industry	4,900	300	100	8,900
Turkmenistan	Rivers	0	0	0	0
	Municipalities	1,600	400	100	100
	Industry	1,500	100	3,970	5,400
Total		**1,075,600**	**886,100**	**104,280**	**138,400**

Note: BOD = Biological Oxygen Demand   Source: Transboundary Diagnostic Analyses for the Caspian Sea, 2002

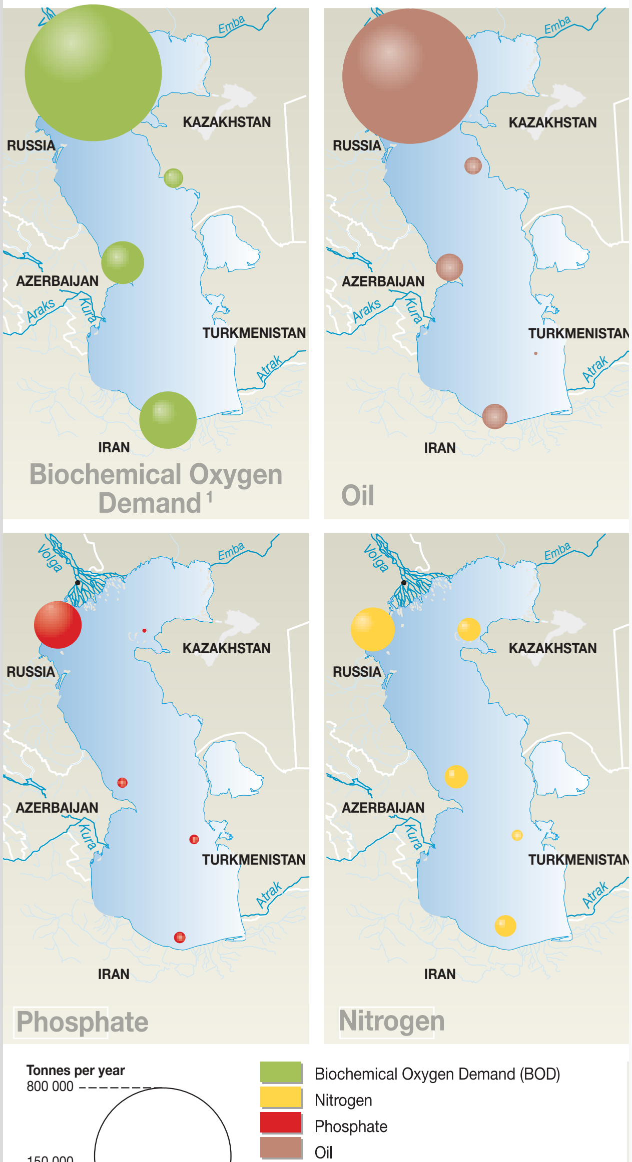
In relation to agriculture, chemicals used in fertilizers and pesticides include chlorinated pesticides, notably DDT and HCHs. These are mainly used in small-scale farming enterprises along the coastline of the Caspian Sea and in its freshwater deltas in Azerbaijan, Iran and Turkmenistan. As a result, there has been an increase in run offs of these pollutants into the Caspian Sea. The use of banned pesticides such as DDT is commonly reported in the region and such products seem to be widely available. Recent infestations of locusts in the Russian Federation and in Kazakhstan resulted in aerial spraying of DDT-based pesticides in these countries. Newly established farms are also dependent on a large-scale use of pesticides, and also irrigation, in order to ensure adequate production. At present, environmentally harmful pesticides are both cheap and readily available on the local market throughout the Caspian Economic Hinterland (CEH), whereas modern and less damaging alternatives are relatively expensive, and therefore seldom used by poor farmers.

Industrial discharges are a substantial contributor to pollution in the Caspian Sea. The problem is linked to wastewater treatment plants which, due to economic difficulties, have not been updated and, if they function at all, are very inefficient. While substantial areas of the Caspian Sea such as its northern, mid and southeastern parts have not been affected by oil pollution, this is an acute problem around the Absheron Peninsula in Azerbaijan, in the waters outside Hazar in Turkmenistan, and in Atyrau in Kazakhstan. Though it is difficult to quality-control, accidental spills, improved technologies and trained staff could reduce the risks of future large-scale disasters as well as sporadic smaller spills. Modernization of technology and infrastructure is also urgently needed to offset leakages in older or abandoned oil wells.

It is generally agreed that the main part of the total pollution load in the Caspian comes from the Volga, Ural and Kura rivers. The contribution, in terms of pollution, of the Terek, Samur and other rivers in Iran is relatively low, although their regional impact is considerable, due to the specific water circulation mode. A peculiarity of the area is that the bulk of toxic substances originating in the Volga River are deposited in its delta and in the adjacent sea area, while toxic substances of the Ural River are deposited in the eutrophic environment system of the shallow northern part of the Caspian Sea.

Azerbaijan: Baku, the capital, and surrounding communities including part of the Absheron peninsula, is home to more than a third of the country's population and two thirds of its industrial production (ENVSEC 2004). Official statistics

Discharge of selected pollutants



1. Measure determining the extent to which oxygen within a sample can support microbial life.

Source: CEP, Caspian Water Quality Monitoring and Action Plan for Areas of Pollution Concern, 2009.

indicate that the population of Baku city has grown from about one million in 2000 to about two million in 2009 (The State Statistical Committee of the Republic of Azerbaijan 2009). Clearly, such population growth and industrial concentration have an impact on infrastructure which was not designed to cope with what are now far greater discharge loads. In Azerbaijan, Baku accounts for approximately 75% of the pollution load from domestic wastewater in the Caspian Sea (UNECE 2004). The wastewater network in Baku serves about 72% of the city, but only about 50% of the wastewater is treated – 90% biologically and 10% mechanically (UNECE 2004). The conclusion of the Baseline Inventory Report of 2008 is that there are three main sources of municipal wastewater discharges, with more than 100 tonnes per year of BOD, plus six main sources of industrial wastewater discharges with more than 10 tonnes per year of BOD - or more than one tonne per year of oil. The main municipal wastewater discharges are from Govsan Aeration Station (Baku- Surakhani), Zykh Treatment Stations (Baku-Hatai), and Kishly Manifold (Baku-Hatai). The main industrial wastewater discharges are from Rubber Synthesis and the Organic Synthesis Plant (Sumgayit). Water from both plants passes the water treatment system of the Organic Synthesis Plant and then is discharged.

According to the questionnaires, there has been an improvement in wastewater management over the last three years. A programme on the installation of wastewater treatment facilities and portable water purification units, in all district centers of the country, is being implemented. In 2007, a biological wastewater treatment facility with a daily capacity of 10,000 m^3 was built in Buzovna village. In 2008, the Mardakan-Shuvalya biological wastewater treatment facility with a daily capacity of 20,000 m^3 was commissioned after reconstruction. In 2009, the country's largest biological wastewater treatment plant – Govsaninskaya station in Baku – was put into operation after reconstruction; its daily aeration capacity is 640,000 m^3. In the same year, the first operation line of the newly-built biological wastewater treatment plant, 200,000m^3 daily capacity, was commissioned in Sumgayit (Questionnaire AZ 2010).

Iran: Pollution loads were calculated for all sectors regarding both point and diffuse sources, with the exception of those relating to transportation and the agricultural application of pesticides. Sewage and agricultural activities, particularly animal husbandry, are the major sources of pollution (i.e., BOD, TSS, and nutrients) in Iran. Urban run off also contributes to the total suspended solids (TSS) pollution load. The nutrients (total nitrogen and total phosphorus) are derived from both point (sewage) and diffuse (crops and pastures) sources. Of the pollution loads in the three Caspian provinces, 26.5% stem from point and 73.5% from diffuse sources. Compared to calculations completed during Phase I of the CEP, the total pollution load has increased considerably. However, several mitigating circumstances can explain this change. Firstly, the sources inventory is now a more complete study, providing additional and improved data. Point sources in this area were also more clearly identified. Pollution loads from diffuse sources that were not considered during Phase I have been incorporated into the new calculations. Secondly, an increase in population has led to an increase in the urban wastewater pollution load

Kazakhstan: According to the Baseline Inventory, the total volume of discharged wastewater into the Caspian Sea, treated by standard methods, amounts to 820,138,000 m^3. There are no direct discharges of untreated municipal and industrial wastewaters into the Caspian Sea. Wastewater treated to normative levels are discharged into evaporation ponds and filtration fields. Some of these are located close to the Caspian Sea and could thus be a source of diffuse emission by groundwater exchange or flooding. Such situation has to be surveyed in the field and prevented by monitoring local coastal waters. Information concerning some industrial enterprises, such as the Atyrau Oil Refinery Plant and the MAEC-KazAtomProm, is difficult to interpret.

An emerging environmental priority is the sedimentation tank of "Tukhlaya Balka" in Kazakhstan. Wastewater from this tank in Atyrau represents one of the potential sources of Caspian Sea pollution. To date, about 50 to 70 million m^3 of highly contaminated liquid waste has accumulated in the filtration sections of the tank. The wastewater contains high concentrations of chlorides, ammonium salts, sulfates, and heavy metals (copper, zinc, chromium). Oil-content levels amount to 200 per cent of maximum permissible concentration (MPC) and phenol between 20 and 80 per cent MPC. As a result of the sea-level rise of the Caspian, the coastline is closely approaching (up to 10 km) the sedimentation tank. During sea-level surges, this distance can be reduced to 3 to 4 km. If these waters flow into the Caspian Sea, this could result in serious environmental consequences (Questionnaire KZ 2010).

Russian Federation: Pollution of water bodies and land in the Astrakhan oblast is mainly caused by overloading the design capacities of wastewater treatment plants in towns and urban settlements. In some areas, there are no such plants. The total amount of all pollutants entering the pre-estuary part of the Volga River from Astrakhan oblast does not exceed 10% of the basic mass of pollutants carried by Volga waters through the oblast territory.

A major problem in the city of Astrakhan is expansion of network for collecting and transporting of storm and dranage water runoffs, as well as the lack of appropriate facilities and equipment for their treatment. The average annual volume of runoffs is about 540 thousand m^3, and most of it is discharged into the Volga delta.

The main sources of surface water pollution in the oblast are communal town services which not only generate their own wastes but also receive the waste of other enterprises located in these towns. It is clear that if industrial wastewaters of some enterprises are polluted with organic and other toxic substances, these should be properly treated at local treatment facilities prior to their discharge into the town sewage system. (It should be noted that if any of the polluting substances in the discharge exceeds the maximum permissibnle level, then all sewage waters are considered to be polluted).

In 2007, a reconstruction of the aeration system at the Southern and Northern sewage treatment facilities (STF in Astrakhan oblasts) was carried out: this included reconstruction of sludge beds, primary and secondary dirt collectors on the northern STFs as well as reconstruction of biological ponds on the right bank STFs. These measures resulted in a significant improvement in BOD indicators, in ammonium nitrogen levels and weighted substances and in reducing discharges of a number of other pollution sources.

In connection with sewerage wastewaters, there are seven municipal sewage systems with more than 100 tonnes per year of BOD that discharge into the Volga delta. These are located in Astrakhan, Buinaks, Derbent, Izerbash, Hasavyurt, and Makhachkala.

The total volume of sewage water discharge in 2005 was some 410 million m^3, including polluted waters that accounted for about 68 million m^3 or 16.6% of total volume of sewage water discharge. The main source of contaminated discharge in the Volga delta is run offs from the city of Astrakhan - in 2005, 63.6 million m^3 of polluted sewage was discharged into the delta. In 2005 – 07, pollution of waters from oil products and phenols was minimal.

In the Republic of Dagestan, the total volume of polluted wastewater discharge in 2007 was more than 74 million m^3. This was a reduction of 0.04 million m^3 compared to the 2006 figure. Some parts of the wastewasters are untreated, for example from such towns as Izerbash, Derbent, and Dagestanskiye Ogny. The bulk of polluted wastewater discharged into the Caspian Sea is absorbed by a treatment plant (Municipal sewage treatment facility "Mahachkala-Kaspiisk"), responsible for 52.5 million m^3, constituting 70% of the total discharge of polluted run offs in the Republic.

There are seven cities on the territory of Caspian regions of Russia (Astrakhan, Buynaksk, Derbent, Izberbash, Hasavyurt and Makhachkala), where the biochemical oxygen demand (BOD) of sewage exceeds 100 tons per year.

The Volga River remains a pollution hot spot of the northern Caspian Basin. Therefore, further investigations, monitoring and an appropriate River Basin Management Programme are needed. Due to its regional impact, the latter is recommended to be included within a regional framework (TACIS 2009a).

Turkmenistan: The main sources of pollution in the Caspian coastal zone of Turkmenistan are exploration and production of oil and natural gas, chemical industry, energy and transport.

The largest industrial area in the Caspian Sea coastal zone are the Turkmenbashi complex of oil refineries (Turkmenbashi Refinery), oil deposit Kenar, power plants, the sea port in the city of Turkmenbashi, Khazar chemical plant in Khazar, Production Association "Garabogazsulfat" in Bekdash.

The problem of clearing the Soymonov Bay area of 8 km^2, which is separated from the sea by the dike, is persistent in the city of Turkmenbashi. A series of planned important environmental measures outlined in the National Environmental Action Plan aimed at prevention of further pollution of the Soymonov Bay. At the same time a complex series of scientific, research and monitoring measures aimed at the restoration of the natural resources of the Soymonov Bay have been carried out.

Following an assessment of these various documents, it can be concluded that there are important knowledge gaps, making it difficult to calculate any trends on discharges into water bodies. The information available is still of a low calibre with sources of pollution inadequately described, river fluxes poorly quantified, and inputs from diffuse sources not properly analyzed, making it impossible to make comparable estimates of pollution loads and fluxes.

4.4 Air emissions

All countries have joined an international treaty that sets general rules and goals for confronting climate change - the United Nations Framework Convention on Climate Change (UNFCCC). Under the Convention, countries are required to fulfil various reporting requirements. The Russian Federation is an Annex I party to the UNFCCC, while Azerbaijan, Iran, Kazakhstan and Turkmenistan are non-Annex I parties.

National data can be obtained from greenhouse gas (GHG) inventories, though data collection is not always reliable and up to date. Initial National Communication Papers are available for Iran in 2003 and for Turkmenistan in 2000 - amended in 2006. are available for Kazakhstan and the Russian Federation submitted National Communications in 2009. Second National Communication of Azerbaijan was submitted in 2010. There is a lack of specific knowledge about air pollutants and greenhouse gases emissions at the regional level. Regional data is difficult to obtain and assess due to a sparsity of knowledge on air pollutants and greenhouse gases. This chapter includes material from the Environmental Performance Reviews for Azerbaijan and Kazakhstan.

Azerbaijan: Total emissions of air pollutants from both static and mobile sources have fallen since 1990 due to reduced industrial activity and the recession. In 1990, total discharges into the air from static sources amounted to 2.1 million tonnes, while in 2002 the figure was only 217,000 tonnes. During the same period, emissions from transport have increased due to a rapid growth in car ownership and use. Traffic is burgeoning in urban areas, but vehicle registration, inspection and maintenance fall short of what is needed to support efforts to improve air quality. Poor fuel quality and ageing vehicles worsen emission problems. (UNECE 2004). Level of emissions in 2005 was 1,054,300 tons and automobile transport accounted for 47% of total emissions (SNC).

The emission inventory system in Azerbaijan is based on annual emission reports which operators of air polluting companies are required to provide. The GHG inventory covering years 1990 to 2003 was conducted with the support of UNDP and GEF. .Azerbaijan submitted its Second National Communication (SNC) in 2010. It states, that Azerbaijan's GHG emissions have been declining from 1990 till 2000, mainly due to prevailing economic conditions up until the beginning of the millennium. However, already in 2005 the level of GHG net emissions constituted 70.6% of the 1990 base year level. According to Azerbaijani experts, emissions will reach the level of the baseline year in 2007-2008 (SNC).

Iran: The Initial National Communication to the Conference of the Parties of the UNFCCC was made available in 2003. At a national level, the total CO_2 emission from different sectors in 1994 was about 342,062 Gg, where the energy sector contributed about 84% of total emissions, while the industrial sector and forestry contributed about 7% and 9% respectively. The total nationwide CO_2 GHG equivalent was estimated to be approximately 417,012 Gg in 1994. Within this calculation, the energy sector contributed the greatest volume at 77% and the waste sector the lowest at 2%.

Kazakhstan: The Second National Communication to the UNFCCC was made available in 2009. Kazakhstan's total GHG emissions amounted to 243 million tonnes of CO_2 equivalent in 2005. The energy sector contributed the biggest share of anthropogenic greenhouse gases - around 81% of the total (UNFCCC 2009). Among GHGs, CO_2 accounts for, by far, the largest emissions share, followed by methane and nitrous oxide. Between 2000 and 2005, when Kazakhstan's economy began to recover from the downturn of previous years, CO_2 emissions from the energy sector increased by 36%: however, this was still 30% below 1992 levels. Given the high rate of economic growth and accelerated development in fuel and energy, as well as mining sectors, it is projected that average annual GHG emissions will grow, possibly reaching the 1990 level (around 300 million tonnes of CO_2 equivalent) by the end of the first Kyoto period in 2012, increasing further to between 340 to 390 million tonnes by 2015 (UNDP 2007/2008).

Most of Kazakhstan's atmospheric emissions come from oil- and gas- related industries in Atyrau and Mangystau - the Caspian oblasts of Kazakhstan. Over 800 million m^3 of associated gas is flared annually (UNECE 2008). Some measures to improve the situation have been implemented (UNECE 2008) with major oil companies undertaking environmental protection activities relating to both present and past pollution. Most of the major companies, including KazMunaiGaz, Tengizchevroil (TCO) and Agip KCO, have received ISO 14001 certification. Gas flaring during oil production has been banned. However, according to the latest survey, gas flaring is still happening and tackling it is an environmental priority (Questionnaire KZ 2010). In Atyrau oblast, the main air polluter through routine gas flaring is the Tengizchevroil Company (TCO) (Questionnaire KZ 2010).

Russian Federation: Although the Fourth National Communication to the UNFCCC is a centrally-based in-depth review, information is provided only at the national level without including regional levels. It is therefore difficult to apply the information given specifically to the Caspian Sea region. According to the latest Transboundary Diagnostic Analyses, the main atmospheric emissions are the result of natural gas extraction and transportation, together with the production and distribution of power and water. Astrakhangasprom accounted for 84.6% of the total volume of atmospheric pollutant emissions in the Astrakhan oblast in 2005 (CEP 2007a).

Turkmenistan: The Second National Communication to the Conference of the Parties of the UNFCCC is still not available. The First National Communication reported that emissions from the oil and gas sector accounted for 95% of the total volume of harmful substances emitted in the country. (These include hydrocarbons, sulfur dioxide, carbon dioxide, oxides of nitrogen and solid substances). In 2001, GHG emissions fell by 46% compared to 1999, due to the utilization of casinghead gas in the fields in western Turkmenistan rather than, as previously practiced, flared or emitted into the atmosphere. At present, this gas is either fed into the trunk gas pipeline or injected into oil beds to encourage extraction. In future, the plan is to reduce the emission of harmful substances into the atmosphere through the implementation of various environmental protection measures. These include the construction of new treatment facilities, modernization of production methods, replacement of old equipment and improved use of various new technological processes.

4.5 Waste

Azerbaijan: Agricultural and industrial activities plus the presence of open dumping sites have been identified as the main land-based factors in Azerbaijan leading to pollution of the Caspian Sea.

Solid municipal waste: According to the Environment Performance Review of Azerbaijan, there is at present a lack of information within the country concerning the disposal of municipal waste. However, more information is available about the situation in Baku, the capital. Waste collection is judged to be reasonably good in Baku - for example, no municipal waste is disposed of at illegal dump sites. The reporting system in other cities and rural areas is not reliable: The available data indicates that many illegal dumps exist throughout the country.

However, the current state of affairs in municipal and industrial waste management in large industrial cities of Azerbaijan, including the Absheron peninsula, particularly Baku, has improved with adoption of "The Complex Plan of Measures for Improvement of Ecological Situation in the Republic of Azerbaijan for 2006-2010". Special waste bins have been placed in public waste disposal areas and the infrastructure required for the transportation of wastes has been established (CEP 2007b). According to the presidential Decree the newly established JSC "Tamiz Shahar" is put in charge of placement and disposal of the solid household wastes in the city of Baku, contributing to improvement of ecological situation .

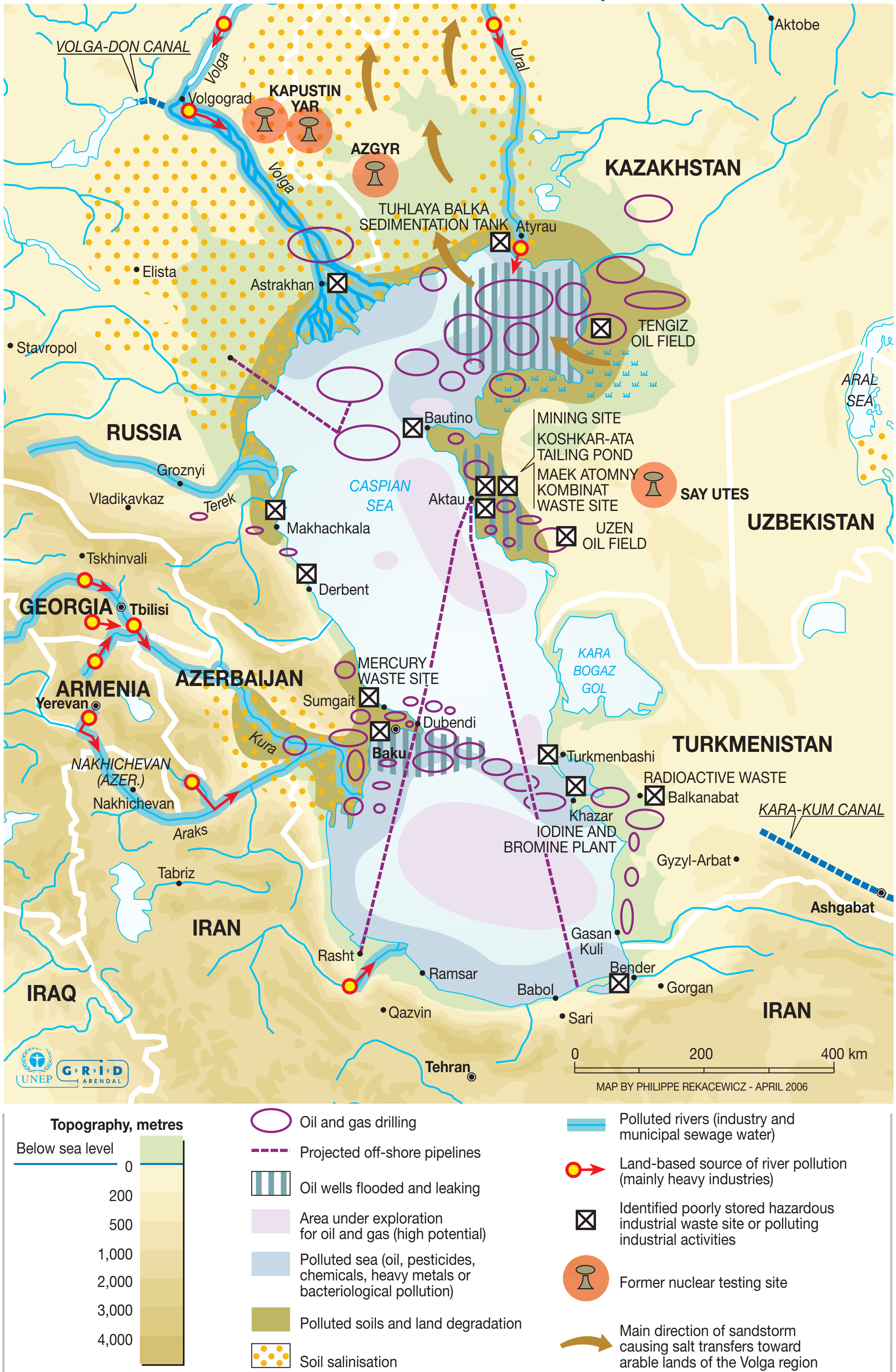
Industrial waste: Since 2003-2004, focus has been given to hazardous wastes management in compliance with environmental standards. As a result, statistical data shows a decline in the the volume of stockpiled hazardous industrial wastes from 26.9 thousand tonnes to 11.2 thousand tonnes. Activities are being carried out on the clean-up of metal wastes (solid industrial waste) in Baku Bay. One of the significant actions is the removal of 16 sunken vessels with a total weight of 900 tons from Baku Bay (CEP 2007b).

According to the results of the Baseline Inventory report of 2008, there were three industrial waste hot spots in Azerbaijan. Since then the first hot spot in Bibiheybatneft area has been removed: the lakes that were the source of danger were dried and about 100 ha of land was cleaned. The remaining two hot spots are: the oil-contaminated rocky area on Pirallahi, Jilov and Gum Adasi islands and Sumgayit, a major Soviet era industrial center containing more than 40 industrial and agricultural chemical manufacturing factories.

In the Absheron peninsula area of Azerbaijan, there is widespread pollution from oil and oil products. In total, 21.3 thousand ha of land in the area is polluted with oil to varying extents: 10.1 thousand ha is polluted in lower layers or at aquifer level, and eight thousand ha is covered with oil, while oil is present elsewhere in water pools. These land areas are located out on the western part of the peninsula - from the east side of the cement mill in Garadag along a narrow strip of land to Pirallahi Island. The presence of oil pools in this area over many years has caused serious anthropogenic change in the environment and natural landscape (TACIS 2009).

The most toxic elements on the Absheron peninsula are B, Al, Pb, U, Se, Fe, C, Na and Mg. The main region in Azerbaijan, where land is either unused or is in need of recultivation, is on the Absheron peninsula: some of this land area is on the Siyazan-Sumgayit massif, while other land is in the Salyan and Neftechala regions. In these regions, areas of soils polluted with oil range from

Hazards in and around the Caspian



Sources: National Caspian Action Plan of Azerbaijan, 2002; National Action Programme on Enhancement of the Environment of the Caspian Sea, Kazakhstan 2003-2012; *Environmental Performance Review of Kazakhstan*, UNECE, 2000; *Environmental Performance Review of Azerbaijan*, UNECE, 2003; *Study for Safe Management of Radioactive Sites in Turkmenistan*, NATO, 2005; *Environment and Security: Transforming Risks into Cooperation, Case of Central Asia*, UNEP/UNDP/OSCE, 2003 ; *Global Alarm: Dust and Sandstorms from the WorldЂs Drylands*, UNCCD, 2001

0.3 – 0.5 ha in size to 50 – 100 ha. Because these lands have laid fallow for a considerable time, both the upper, fertile strata and deep rocks in the land are polluted with crude oil. In many of these areas, small pits and lakes polluted with oil have been transformed into dumping grounds for manufacturing and construction waste and household rubbish (TACIS 2009).

On the Absheron peninsula, land areas polluted with oil and those requiring recultivation are state-owned lands located mainly in the Karadag, Sabunchi, Binagadi, Surakhani and Azizbekov regions. The areas where pollution is considered to be most severe are Pirallahi, Gala, Mashtagi, Romanah, Sabunchi, Surakhani, Binagadi and Garadag (TACIS 2009).

Oil pollution on the peninsula is recorded at various depths:
1,029.2 ha is polluted to a depth of 10 cm
857.3 ha to 25 cm
1,285.7 ha to 50 cm
remaining lands to more than 50 cm

Recent large-scale studies looked at soil properties in the upper layers of lands in the eastern part of the Absheron Peninsula. Results revealed that upper soil layers have been subject to considerable change, due both to a rise in the sea level linked with a rise in groundwater and also to contaminants associated with oil wells and irrigation. The studies showed that underground water levels are approaching the soil surface (depth 0,5 – 1,5 m) in Pirshagi – Kurdakhani, Bina – Airport, Sarai – Khirdilan, Binagadi – Novkhani, while in other areas, the formation of man-made lakes has led to waterlogging and secondary salinization. The estimate is that up to 5.0 thousand ha of arable soil is damaged and is not suitable for agricultural production (TACIS 2009).

In total 14 thousand ha are contaminated by oil and 10 thousand ha of contaminated lands are in Absheron peninsula.

There are also oil-polluted lands in the Siyazanneft area. These lands spread in a narrow strip from the borders of Zarat village to the town of Siyazan between the Caspian Sea and the Baku-Siyazan highway. Oil well pollution also encompasses the resort of Galaalty (TACIS 2009).

On the Siyazan massif, amounts of oil are soaking into the upper soil layer (0-14 cm) forming a 21% column mass, while the content sharply decreases to 2.1% at lower layers (14-26 cm).

Land in the Salyan region is oil-polluted; 4,177.2 ha of land is polluted as a result of anthropogenic products.

In the Neftechala region, more than 3,425 ha of land has been polluted due to anthropogenic activities such as oil dumps and secondary salinization. Included in that figure, 1,768 ha is polluted with oil. Oil-contaminated soil contents are: 100 ha polluted to a depth of 0-10 cm, 70 ha to a depth of 0-25 cm and 6.8 ha to a depth of 0-50 cm (TACIS 2009).

By 2010 45 ha of contaminated lands have been cleaned in Pirallahi, 9 ha in Tagiyev, 15 ha in Siyazan, and 40 ha in Salyan. State Oil Company of Azerbaijan Republic (SOCAR) has prepared a two-phase recovery programme for lands previously affected by oil exploration. In the first phase 2800 ha of land will be mechanically and biologically remediated. The second phase encompasses technical reclamation of the land.

As regards agricultural waste, it has been noted that there has been a dramatic decrease in the use of pesticides in Azerbaijan. According to available statistics, only about 500 tonnes of pesticides were used in 2000 compared with more than 38,000 tonnes in 1988 (UNECE 2004). In 2006, a national inventory was carried out, mainly to identify sites with stockpiles of DDT and other POPs listed in 2006 (WB 2009). Since then the distribution of pesticides in the country has changed by the removal of many pesticides – mainly the solid ones – from former distribution centers to a site at Jangi or to other locations. The inventory indicated that there were about 3,084 tonnes of pesticide stocks at central stores in Azerbaijan by 2010. Liquid pesticides, mainly polydophen, until recently mostly remained at the old sites. However by 2010 1,184 barrels of liquid pesticides and 200 contaminated trays were removed to the central stores.

As far as hazardous wastes are concerned, there are five landfills in Azerbaijan for disposal purposes. The newest landfill for hazardous waste, with a total capacity of 250,000 m^3, was constructed with financial support from the World Bank, and has been in operation since 2004. Mercury wastes in the amount of 40,000 m^3, removed from the Synthetic Detergents Plant, have been buried in the landfill. According to the questionnaire, removal and management of toxic mercury waste of Sumgait is completed. The landfill is managed under the umbrella of the Ministry of Ecology and Natural Resources and meets international standards (CEP 2007b). In 2010 another new landfill for hazardous waste with total capacity of 250,000 m^3 was constructed with financial support of government. In total 95,000 m^3 of mercury wastes have been removed by 2011.

Iran: Very little is known about the situation in Iran. The only information available is that pesticides are considered to be the most serious pollutants, with “hot spots” found in the dense agricultural areas of river deltas and along the Caspian coast of Iran. In addition, an emerging environmental problem is poor urban and rural solid waste management, with no effective means of urban solid waste disposal (Questionnaire Iran 2010).

Kazakhstan: According to the Baseline Inventory, there are eight hot spots in Kazakhstan relating to industrial waste dumps, of which six represent oily waste and two are toxic industrial sites.

“Koshkar-Ata”, near the city of Aktau in Manghistau oblast and 7-8 km from the Caspian shoreline, is a tailing dump established in the 1960s. According to the questionnaire, it is still seen as an emerging environmental problem. The Koshkar-Ata depression was chosen as a dumping site for radioactive and toxic waste from uranium deposits developed by the Caspian mining and metallurgical industry. The threat posed by the tailing dump on the Caspian Sea environment escalated following the collapse of the Soviet Union: output of the industry fell, leading to reduced water discharges into the tailing dump and the consequent draining of its bottom layers which are contaminated with radioactive elements. At present, the water level in the tailing dump is maintained by wastewater disposal from the urban sewage system as well as by untreated household sewage from the city of Aktau. It is calculated that the amount of discharge needed for maintaining the water level is six million m3 while the area of coastal beach subjected to dusting amounts to 24 km^2. It should be noted that each year there are measures taken to stabilize the level of liquid of the tailings. The basic problem is that dust containing radionuclides, heavy metals

and other harmful chemical elements is transferred by wind to surrounding areas. There have been consistent readings of concentrations of chemical elements and their compounds exceeding the maximum permissible levels - for fluoride by 130% and for phosphate by 180%. According to the evaluation criteria, this signifies that the environmental status of the area is hazardous. Underground dispersal and the release of polluted tailing water clearly pose a risk of contamination of ground and marine waters (Questionnaire KZ 2010).

Over the years of uranium production, 356 million tonnes of mining waste with a total radiation level of 11 242 Curie was channelled into the Koshkar-Ata tailing pond. Uranium mill tailings with low- to medium-level radioactivity account for almost 105 million tonnes of the total. Significantly increased exposure rates of 80 to 150 micro roentgen per hour (μR/h) were measured in the southern part (UNEP/GRID-Arendal 2006).

In Mangistau oblast, there are 19 enterprises which use radioactive substances during their production cycles. To date 17,694 tonnes of radioactive waste have accumulated in the oblast, not including the radioactive waste of the Koshkar-Ata tailing pit. For example, there are 5,000 tonnes of radioactive scrap metal stored in land areas controlled by the KASKOR Joint Stock Company, a chemical-hydrometallurgical plant (TACIS 2009).

Alpha-active long-life radionuclides measurements were taken in the ambient air of the beach zone of Koshkar-Ata and Aktau city. These indicated that maximum measurements of active aerosoles, equal to 0,041 Bq/m3 at the Koshkar-Ata tailing pit and 0,034 Bq/m3 within the precincts of Aktau city, were not harmful to humans.

There are 19 oilfields with 1485 oil wells in the coastal zone of the Caspian Sea, including 148 in the flooded zone. These oil wells belong to the State (Baseline Inventory 2008). Only 24 flooded oil wells were sealed during the 2004-2006 period (CEP 2007a). Flooded oil wells are still an emerging environmental problem in Kazakhstan (Questionnaire KZ 2010). Due to the rise in the level of the Caspian Sea, many coastal areas have become flooded, including the locations of oil wells. Drilling technology from the 1960s to the 1980s did not account for the corrosive nature of seawater and its effects on metal casings. Over time, these wells have become a considerable source of marine pollution.

Oil storage pits have also been listed among the emerging environmental problems in Kazakhstan. A number of major oil and gas deposits are located in Mangistau oblast. Their operation was followed by the construction of numerous earthen pits (barns) containing oil on these sites. There are 52 such pits with a total volume of 64,282.01 tonnes. In 2008, two storage pits were put out of use, with a total of 872.9 tonnes of oil pumped out and disposed of (Questionnaire KZ 2010).

According to the Baseline Inventory, the total volume of oil wastes in Mangistau oblast is 1,844,651 m^3: in the Uzen oil field there is 1,419,234 m^3 of oil waste, in Zhetybai and Kalamkas oil fields 343,125 m^3 and in Karazham-bas oil field 82,292 m^3. Some of these oil wastes are used as construction material, paving roads and sites in the oil fields. In 2004, 468 m^3 of oil-soaked ('masutted') grounds were used in the Northern Buzachi oil field while 10,780 m^3 were used in the Karazhanbas oil field in 2005. In 2006, 8,478 m^3 of oil and drilling wastes were used as construction material to pave roads inside the sites of the Northern Buzachi, Borankol and Tolkyn oil fields.

A major by-product of oil production in Kazakhstan is sulphur, which is used by many industries for manufacturing a wide range of products. Sulphur is found, in varying amounts, in crude oil and natural gas. For example, the crude oil produced by Tengizchevroil (TCO) contains "sour gas", which has a hydrogen sulfide content of about 14 per cent. The company regularly separates sulphur from oil, with its current production amounting to about 1.6 million tonnes of sulphur per year. Sulphur production is expected to increase. Tengizchevroil has already built up a stock of 5,4 million tonnes of sulphur (as of March 2011), stored in solid blocks on specially designed pads. Depending on the end-use for these materials, the sulphur blocks are melted and turned into granules or flakes and transported by rail. As the sulphur market is highly cyclical with a long-term demand, production has fallen behind in recent years. This has led to an increase of sulphur stocks. It is projected that the sulphur stocks of two major oil companies - AGIP and Tengizchevroil - will reach 35 million tonnes by 2020 (UNECE 2008).

Russian Federation: In the Caspian region of Russia the cause of negative impact on the marine environment and the Caspian coast is rooted in activities of industrial enterprises (production, transportation, processing and utilization of oil hydrocarbons, mining and processing of mineral resources, fishing), agricultural activities and municipal enterprises.

The Astrakhan oblast is an important transport center, where the Caspian marine environment, the Volga River and railways and highways intersect. The main mineral resources in the oblast are hydrocarbons (oil, gas and gas condensate) and sodium chloride. The Baskunchak sodium chloride deposit is one of the largest in the world, 98% high quality, supplying 80% of Russia's total demand. The oblast also has construction materials - gypsum, limestone and others (CEP 2007a).

According to the Baseline Inventory, there are four significant industrial waste pollution hotspots. These include three of oily waste and one of phosphorous sludge, as well as two large municipal solid waste landfills in Mahachkala and Astrakhan and many scattered small industrial and municipal solid waste dump sites.

There is an acute problem of municipal solid waste management in the Astrakhan oblast. In early 2007, the amount of waste collected was more than three million tonnes. In 2009 around 400 thousand tonnes of waste were accumulated, most of which were municipal solid waste (MSW) and industrial waste of the same category (polymer-waste, plastics, cardboard, paper and packaging materials). Solid waste of the city of Astrakhan and the surrounding territories is disposed in the city landfill, covering an area of 37 ha. Landfill capacity was estimated as 12.3 million m^3. At the beginning of 2011 the volume of landfill was utilized by75%. The landfill operates since 1984 and is currently the object of high environmental risk due to processes of technogenesis and raise of water table, high emissions of pollutants into the atmosphere due to lack of protective layers of soil insulation. Frequent fires occur at the landfill.

Enterprise "The Environmental Complex ECO+" is engaged in processing of liquid and solid wastes contaminated with oil products and has an organized storage area for recyclable waste. Similar activities are performed by Astrakhan branch of "Lower Volga Product" JSC "Lukoil", which has a capacity of processing and disposal of 40 tonnes of waste oil per annum.

In 1970, special oil pits were constructed for storing fuel oil residues, but they have not been in use since the 1980s. They have accumulated a large amount of waste from drilling oil, oil containing waste waters, oil sludge, drilling bit cuttings, stratum contaminated with oil products and other waste products. Concentrations of oil products in oil pits are currently between 30 – 400 g/kg. The subsoil in oil pits is described as being heavily polluted,(concentration of phenols is exceeding maximum persistent concentration). The oil products concentration in the ground water is also high.

More than 4.2 million tonnes of waste of various hazard categories have accumulated in storehouses, dump sites, waste disposal ponds and on open ground in the Republic of Dagestan. Most of the solid waste polygons or landfills do not meet sanitary and ecological requirements (TACIS 2009). For example, the authorized landfill at Makhachkala, located 6 kms away from the city, is often set on fire.

The wastes include about four million tonnes of solid domestic waste, 135.7 thousand tonnes of drilling waste, about eight thousand tonnes of oily waste, over 400 kg of galvanic production wastes and about 32,000 mercury-containing lamps. There are approximately 27 waste disposal sites in the Republic of Dagestan. These include the drilled pits of "Dmitrovskaya" and "Izberbash"; the oil sludge storage and mechanical treatment of wastewaters (RGUP "Dagnefteproduct"); project sites located on the territory of OSA "Sudoremont", the storehouse of industrial waste and other project sites at the "Dazdiezel" plant; project sites located on the construction sites "Dagestanskaya generatsiya", OSA "YUGK –TGK – 8" (Mahachkala & Kaspiisk thermo – electrical heating station), all located in an area between 300 and 700 m from the coast.

One of the most important problems in Dagestan is the lack of procedures for handling pesticides in an ecologically safe manner. There are about 400 registered dump sites, covering more than 100 hectares. Most of these waste dump sites are located within 100 km of the Caspian Sea. At present, 248 tonnes of worthless or banned pesticides, including 120 tonnes of unidentified pesticide mixtures and 100 kg of granosan, are stockpiled in the main storehouses of SUE "Dagagropormchemistry" and of the Ministry of Agriculture.

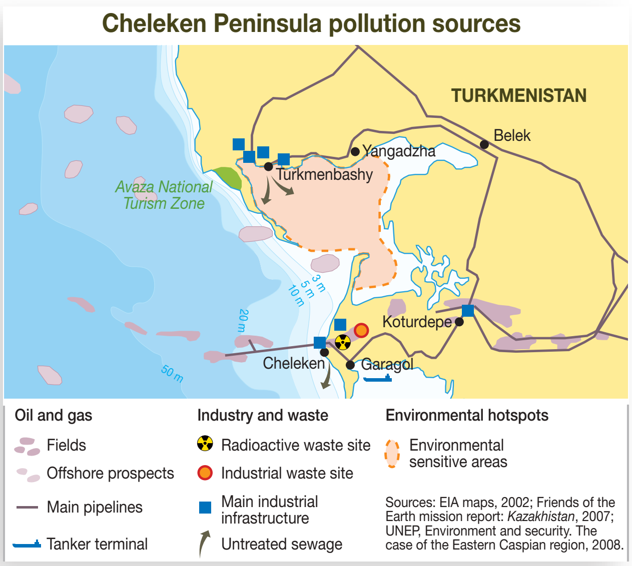
Pollution from the Republic of Kalmykia can be described as insignificant compared with that in Astrakhan oblast and that of the Republic of Dagestan. Agricultural activities are the major source of pollution. The population is about 289,000, of which over half live in rural areas. There are significant oil and gas reserves, both on land and in coastal waters. At present, nine operating oil and gas fields are located within 15-30 km of the Caspian Sea.

Turkmenistan: The major activities in the coastal province of Balkan velayat in Turkmenistan are oil and gas production, oil refining, power generation, food and light industry, fishing and cattle breeding. Oil and oil product storage spots are potential sources of pollution; some of these are located near oil terminals such as Ufra and Ekerem while others are located some distance away.Special attention and compliance with all environmental protection measures is necessary for the functioning of the oil terminals and oil storage facilities of "Dragon Oil" company and state enterprise "Turkmeneft" in the city of Khazar (TACIS 2009).

There are three main waste disposal areas associated with oil and gas companies OGPA "Nebitdagnebit", OGPA "Goturdepe" and OGPA "Gumdagnebit." The main waste products are formation water, which after the separation of oil and water are discharged into so-called "evaporation ponds", which are used as natural topographic lows (takyrs and salt marshes, rarely lows between crescentic dunes).

On the territory of the Khazar chemical plant (Khazar) the radioactive waste has been accumulated (TACIS, 2009; "Environment and Security" Initiative, 2008). Waste storage facility was located 200 meters from the coastline.

Khazar chemical plant (Khazar) and Iodine Balkanabad plant (Balkanabad) produce iodine and bromine. Activated carbon is used as a sorbent, collecting natural radionuclides (primarily radium), which leads to the accumulation of radioactive waste. Production of iron bromide ($FeBr_2$)



was launched at the Khazar chemical plant in 1940, and the production of iodine - in 1976. The annual output of the plant is 250 tons of iodine. During the decades of production the two plants have accumulated about 21 000 tons of radioactive waste. It was stockpiled near these plants and posed a risk to the environment, which has been increasing with the Caspian Sea level rise, which has moved the coastline at least 200 m towards the disposal site of the Khazar chemical plant. During 2009-2010 the State company "Turkmenchimiya" has completed work on the transportation and safe storage of this waste in the new burial ground near the small town of Aigul, 15 km in the direction of the desert.

5. State: Changes in environmental quality (natural capital)

5.1. State of marine water quality and incoming fresh water

The Caspian Sea is landlocked with limited flow through. Potential contaminants enter the water body via rivers and are generally retained in the system. There are almost 130 rivers discharging into the Caspian Sea, but the majority has low discharge rates (only eight have a developed delta, the Volga, Terek, Sulak, Samur, Kura, Ural, Atrek, and Sefidrud rivers). The largest inflow of freshwater comes from the Volga, which accounts for nearly 80% of the mean river discharge per year (Kosarev & Yablonskaya, 1994). The river catchment is extremely large, with an area of approximately 3.5 million km2, of which the Volga catchment accounts for 1.4 million km2 (Kosarev, 2005).

The northern part of the sea is relatively flat, with a maximum depth of about 10 m. In contrast the southern region, which is part of an active tectonic zone, reaches a maximum depth of 1 025 m. The sea straddles several climatic zones – the north, including the Volga catchment is in the continental climate zone, the west and south are in the warm continental belt, while the east is a desert climate. Generally the shallow northern third of the sea freezes in winter. Sea level is cyclical, generally reaching its lowest value in winter and rising during May–July, following the spring floods (e.g., Domroes et al., 1998). The inflow of freshwater (compensated by evaporation over the sea), results in the formation of a north - south salinity gradient. Surface water's salinity in the shallow norther region's ranges from 1-2 ppt in the Volga river mouth to 9-12 ppt in the zone of mixing between the riverine and marine waters. In the south, salinity ranges from 11.5-13.5 ppt (Kosarev, 2005; Tuzhilkin & Kosarev, 2005). Average ocean salinity is 35 ppt). Because of the limited inflow of freshwater in the southern part of the sea, the seasonal salinity variation is minimal.

Previous studies have shown that industrial discharges into the rivers entering the Caspian Sea contain a wide range of pollutants including petroleum, sulfate, phenol, synthetic surfactants and heavy metals. Agriculture waste is also known to contribute to a reduction in water quality, with large volumes of organic material discharged into the rivers entering the Caspian Sea. The environmental impacts of the petroleum industry on the Caspian environment include on-going leakages from inundated historic wells as well as accidental spillages (CEP 2007a). In addition, since the 1990's, increases in high-tonnage shipping and the creation of port facilities may have added to the pollution load of rivers (Shaw et al., 1998).

Because of the closed nature of the Caspian Sea, quantifying river influxes of key variables is important in understanding and managing the environment. The pollutants that enter the sea principally through the Volga, Kura, Terek, and Ural rivers, from industrial sources and municipal wastewaters, are transported throughout the sea. A large percentage of the toxic substances, including persistent organic pollutants, have been shown to accumulate in bottom sediments (TACIS 2009b). Revised Transboundary Diagnostic Analyses reported that the flux of some pollutants entering the Caspian Sea may have diminished since the 1990s. However, there is little empirical evidence for this, but possible reasons for decline may be a reduction in agricultural and/or industrial activities, improved trapping of contaminants in the reservoirs, especially in the Volga and Kura River basins.

Even if there are numbers of national and regional efforts to monitor marine and incoming fresh water quality, there are very limited information available and considerable gaps to build a reasonable assessment over the time. The main reasons of the gaps are insufficient monitoring system, luck of monitoring programs, and insufficient funds to maintain the operations. Considering these obstacles, analyses of marine and fresh water quality is based on conclusions of the existing and available documents such

Table 2. Average concentration of pollutants in the waters of the North Caspian from 1993-2002 (Korshenko and Gul, 2005).

	Year, month, region									
Pollutant	1993 June (1)	1994 June (1)	1995 July-August (1)	1996 July-August (1)	2000 July (1)	2000 Novem-ber (2)	2001 June (1)	2001 Decem-ber (2)	2002 August (1)	2002 October (2)
TPHs (mg/l)	0.049	0.050	0.021	0.020	0.121	0.027	0.151	0.109	0.010	0.008
Phenols (mg/l)	-	-	-	-	-	0.003	-	0.003	-	0.008
Detergents (mg/L)	-	-	-	-	-	0.032	-	0.033	-	Less than DL*
NH_4 (µg /l	490.3	203.7	204.8	-	192.6	-	701.2	74.7	30.8	14.0
DDT (ng/l	0.300	0.353	0.175	0.110	-	-	-	-	-	0.244
DDE (ng/l)	0.050	0.073	0.043	0.025	-	-	-	-	-	0.010
DDD (ng/l)	0.069	0.090	0.020	0.007	-	-	-	-	-	Less than DL**
α-HCH (ng/l)	0.070	0.108	0.080	0.029	-	-	-	-	-	3.460
γ-HCH (ng/l)	0.030	0.034	0.025	0.006	-	-	-	-	-	1.394
Fe (µg/l)	-	-	-	-	-	35.6	-	32.2	-	24.0
Mn (µg/l)	-	-	-	-	-	3.6	-	3.0	-	1.3
Zn (µg/l)	-	-	-	1.1	-	5.6	-	4.5	-	7.1
Ni (µg/l)	1.3	-	0	0	-	2.1	-	2.1	-	2.4
Cu (µg/l)	1.2	1.2	0.1	0.1	-	3.1	-	2.8	-	4.3
Pb (µg/l)	0.15	0.1	0.1	0.1	-	4.9	-	4.1	-	0.5
Cd (µg/l)	0.1	0.1	0.1	0.1	-	0.7	-	0.5	-	0.2

*Detection limit 0.025 mg/l; ** Detection limit 0.05 ng/l

Table 3. Mean values of pollutants in Dagestan coastal waters and a cross section of the middle Caspian Sea, 1978-2003 (from Korshenko and Gul, 2005).

Region	TPHs (mg/L)	NH4 (μg/L)	Phenols (mg/L)	Detergents (mg/L)
Lopatin town	0.076	110	0.006	0.056
Terek River	0.084	101	0.007	0.064
Sulak River	0.074	100	0.006	0.065
Makhachkala town	0.070	90	0.006	0.062
Kaspyisk town	0.068	86	0.005	0.060
Izberbash town	0.094	89	0.007	0.061
Derbent town	0.086	90	0.006	0.066
Samur River	0.069	90	0.006	0.058
Cross-section, Chechen-Magy-shlak	0.063	66	0.004	0.053
Cross-section, Makhachkala-Sagunduk	0.080	62	0.005	0.043
Average for all regions	0.076	91	0.006	0.060

as Transboundary Diagnostic Analyses, relevant studies on Volga, Kura-Araks and Terek rivers, recent Regional Water Quality Monitoring Plan, and recent research papers.

Water chemistry

The monitoring of the central and southern Caspian Sea between 1995 and 2007 by Sapozhnikov et al. (2005, 2006, 2007, 2008) revealed changes in the water chemistry occurring over this period. They observed similarities with changes apparent in the Black Sea between 1986-1993, that were attributed to the regulation of rivers entering the sea. In the Caspian Sea, the construction of water reservoirs on inflowing rivers changed the water chemistry and consequently the biological productivity. The construction of the resevoirs resulted in a drastic reduction in the supply of phosphates, dissolved silicic acid, and particulate phosphorus and silicon. This was accompanied by an increase in dissolved organic matter, ammonium and urea (an organic nitrogen-containing compound). Sea level rise has further increased the amount of organic matter entering the sea from the Volga River delta and this has resulted in the formation of large areas of oxygen depletion that can extend to depths of 10m. This can cause algal blooms, benthic dieoffs, fish kills and changes in fish distribution (Butts and Bradshaw, 1999). In his research Sapozhnikov revealed that a considerable amount of organic matters is also accumulated in the bottom sediments where for example, nitrates are partially reduced to nitrites (Sapozhnikov at al. 2008).

Seasonal variations in dissolved oxygen in the Caspian Sea adjacent to Iran, were investigated by Zaker (2007). Measurements were made along a transect perpendicular to the eastern part of the Southern Caspian coast. The results indicate that

Table 4. The average annual load of pollutants in the apex and on the Volga delta seashore line (adapted from CEP, 2006 b).

Pollutant	Units	Delta Apex (1977-1993)	Delta Apex (1995-2004)	Delta sea-shore line total (1995-2004)	including western part	including eastern part
Petroleum hydrocarbons	thousand tonnes	71.65	54.80	57.10	37.2	19.9
Detergents	thousand tonnes	5.29	6.96	7.95	4.35	3.60
Phenols	thousand tonnes	0.70	0.98	1.07	0.68	0.39
Iron	thousand tonnes			51.05	31.55	19.50
Zinc	thousand tonnes	4.97	9.42	9.45	6.01	3.44
Copper	thousand tonnes	2.19	1.89	1.66		
Nickel	thousand tonnes			1.49		
Lead	tonne			439		
Cobalt	tonne			311		
Manganese	tonne			273		
Chrome	tonne			186		
Cadmium	tonne			122		
Mercury	tonne			15,4		
DDT	kg	3 710	1861	94		
DDE	kg	1 320	271	29,5		

Note: For calculation of pollutant flows for delta seashore line, their concentrations in the central part of delta were used.

the large quantity of degradable waste, including sewage and agricultural waste, has caused a decline in dissolved oxygen, especially in the deeper layers. During the period of the study from 2004 - 2005, the lowest levels were observed in the autumn when dissolved oxygen varied from 7.1-10.9 mg/L in the surface water, reducing to less than 5 mg/L at 160 m depth. Zaker concluded that these conditions were unfavorable for biological activity and fish below 150-200 m and that measures needed to be taken to reduce the amount of oxygen demanding waste and plant nutrients entering the Caspian Sea in this region.

The pH levels of the Caspian are generally high, due to alkaline river inflows. They have been observed to average 8.3 to 8.6 in the surface layer and decrease to 7.8 to 8.0 at depth (Butts and Bradshaw, 1999).

Water pollution

Korshenko and Gul (2005) reported the results of pollution monitoring - Table "Average concentration of pollutants in the waters of the North Caspian Sea from 1993-2002" gives values for the average concentration of pollutants in the northern part of the Caspian Sea for the period 1993-2002. The monitoring revealed that the levels of petroleum hydrocarbons were high in the 1980's especially in the estuary of the Ural River and on the boarder of the Dagestan shelf. In the later part of the monitoring period, the levels were found to decrease and only occasional patches of high concentration. These high values were found in offshore areas of the Northern Caspian Sea, indicating that river, especially Volga, input may not have been responsible. Phenol concentration was detected rather high and showed significant variations both in space and time. The long-term monitoring revealed clear decline in phenol concentrations. Ammonium concentrations were measured high in estuarine waters of the Volga River and in the western part of the North Caspian Sea.

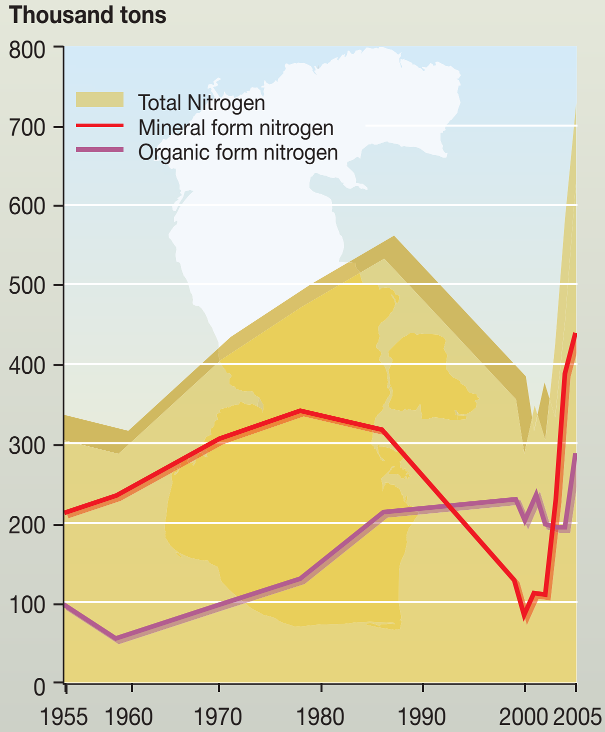
(1) Seaside the Volga delta (2) North Caspian

In the same study, monitoring was carried out in 1978-2004 at 36 stations in the shallow waters of the Dagestan shelf and a cross section of the middle Caspian Sea. (Table x). It revealed that the TPH concentration was lower than in the Northern Caspian Sea and had a clear tendency to decline. The most polluted area was near the town of Izberbash. Some high concentrations were also detected close to the Terek River and the village of Lopatin. Phenol concentration was rather high around Dagestan and showed significant variability both in space and time. In general, long-term research revealed decrease in phenol concentrations in waters. However, there are still single high concentration values that occur, but it can be associated to selected patches. High average value of ammonium concentrations were measured in estuarine waters of Terek and Sulak Rivers.

Korshenko and Gul, 2005 also reported on water quality in the Southern Caspian Sea. They found high concentrations of petroleum hydrocarbons, phenols and detergents in the western region, which decreased eastward. The results indicated that in general, the waters of the Southern Caspian Sea could be considered to be heavily polluted.

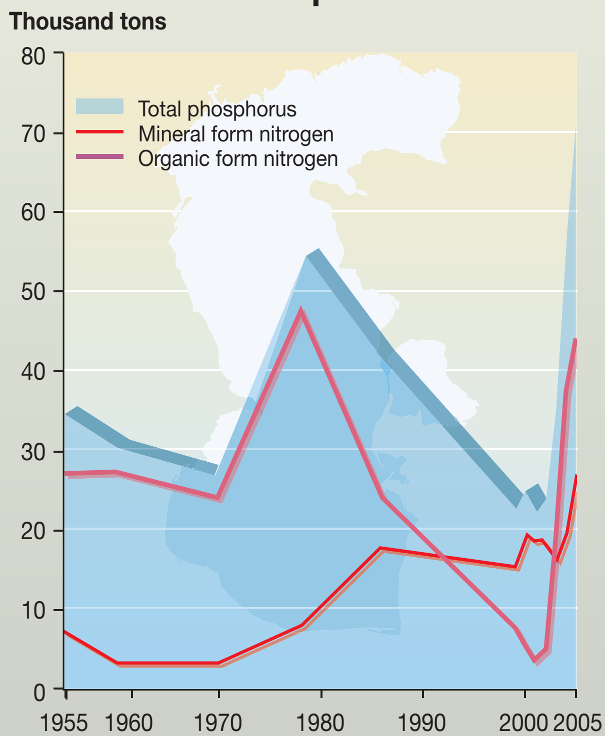
More recently (2008 and 2009), four marine expeditions were carried out, covering all national sectors apart from Iran (CEP 2009). The water and bottom sediment samples taken during these cruises were analyzed in the national laboratories (selected on the results of an inter-calibration test). Not all sample analysis has been completed and as yet no results are available.

Nitrogen discharge from Volga to the Caspian Sea



Source: Mitrofanov, I., *Outlook Report on the State of the Marine Biodiversity in the Caspian region*, Montreal, 2010.

Phosphorus discharge from Volga to the Caspian Sea



Source: Mitrofanov, I., *Outlook Report on the State of the Marine Biodiversity in the Caspian region*, Montreal, 2010.

River input

Volga River

Rivers are reported to be the main source of water pollution entering the Caspian Sea, however reliable data characterizing the concentration and sources of this pollution remains limited. Much of the available data was collected in the 1990's and concentrations reported for a number of parameters are highly variable, indicating perhaps different methodologies and analysis techniques.

In 1994, Bukharitsin and Luneva reported that more than 23 km^3 of wastewater and industrial wastes containing approximately 387 thousand tonnes of suspended sediments entered the Caspian Sea from Volga River each year. As mentioned the bulk of the flow in the Volga River has been highly regulated by a series of hydro-engineering constructions since 1955. This flow regulation has changed the spring- summer flood regime, which is the main influence on transport of sediment into the Volga Delta. Studies indicate that the over a period of 1978-1991, 8.9 million tones of suspended solids per year on average entered the delta, at average water turbidity 33 g/m^3. In 1992-2004 the average flow of sediments constituted 5.9 million tones per year, while average turbidity reduced down to 22 g/m^3. Research carried out in 1997 by the Russian Academy of Sciences showed that a significant amount of the heavy metals in the waters of the Lower Volga were transported on suspended solids (CEP, 2006 b).

In 2006, «The Study and Review for Determination of Major Pollutants Flow from the Volga Cascade» estimated and summarized annual fluxes at different parts of the delta for some key pollutants. These averages are calculated for three zones of the Volga River delta, namely at the apex and the shoreline (DSL) at the western and eastern delta fronts. The fluxes of pollutants vary. The western part usually receives 60-70% of flow, except for lindane (γ-HCH), which is more prevalent in the eastern discharge.

Comparison of data from the period 1995-2004 to those from 1977-1993 illustrates significant declines in the fluxes of petroleum hydrocarbons and chlorinated pesticides (DDT, and DDE). Whereas the annual discharge of some components (detergents, phenols and copper) has remained relatively unchanged, the flux of zinc has apparently doubled in recent years. In1977-1993 average annual loads of DDT and DDE were 3,710 kg and 1,320 kg respectively.

Katunin et al. (2003, 2005, 2006) has estimated phosphorus and nitrogen loading from the Volga River. As Volga River represents the major water influx, it also indicates the main tendency of the whole region. Remarkable increase in the phosphorus and nitrogen loads was detected after 2000.

Kura River

In 2005, a pilot study was conducted in the Kura River, with a survey undertaken at seven sites from the Mingechaur Reservoir to the Kura River Delta. Although profond conclutions were difficult to determined, the study revealed that a wide range of elements such as As, Cd, Cr, Cu, Hg, Mo, Ni, Pb, and Zn had concentrations always below the respective Maximum Contaminant Level (MCL). Measurable levels of PAHs, PCBs, and several chlorinated pesticides were often, but not always, detected (CEP 2005).

A radiological survey of the Kura and Araks River system in Azerbaijan conducted in 2005 by the International Atomic Energy Agency reported about activity of several radioisotopes (^{137}Cs, ^{238}U, ^{234}U, ^{240}Pu, ^{238}Pu, ^{90}Sr and ^{241}Am). They were measured in sediment samples and some aquatic plants. The values obtained for the radionuclide levels in the freshwater sediments were relatively low, and in most cases below the detection limit. Available information reflects that radionuclides are natural and/or related to known atmospheric inputs (Shaw, at al., 1998).

Terek River

The data on Terek River refers to "A Desk Study Project to Determine the Fluxes of Major Contaminants from the Terek River into the Caspian Sea" accomplished in 2007. Historical data sets about water quality are sparse and official data for water discharge statistics in the Terek River remain limited. The study revealed that the river is highly polluted by the petroleum hydrocarbons. It was also very clear that the Upper part of the Terek stream could be considered as more polluted then Lower part of the river. The monitoring results registered the petroleum hydrocarbons as high as 29 times exceeding the maximum allowed concentrations. The study concluded that trace metals such as copper, lead and nickel concentrations were elevated, but some can be explained by high background concentrations (CEP 2007 h).

Other rivers

Information from other rivers discharging into the Caspian Sea is very limited. The CEP reported in 2007 that concentrations of heavy metals were generally low. There appears to be no recent published data for the Ural or Sefidroud Rivers, which may be expected to discharge pollutants in to the Caspian Sea.

It is difficult to properly assess the water quality of the Caspian Sea due to significant gaps in data availability. Monitoring of the contaminant load and flow volumes of rivers entering the Caspian Sea is incomplete. For example, there is a lack of systematic data collection from the rivers Volga and Ural and other significant rivers entering the system. Data collection is expensive and to be effective, a system designed to reflect river dynamics and human activities needs to be implemented.

5.2. State of air quality

Air quality depends on the magnitude of both natural emissions and those caused by humans and, in terms of mitigation, the capability of ecosystems to absorb such emissions and abate pollutants. The 2002 Transboundary Diagnostic Analyses reported on a decline in air quality, but the studies contained little supporting information. In the Global International Water Assessment Report on the Caspian Sea, industry-related air pollution was cited as a cause of community movement and habitat loss. In the 2006 Transboundary Diagnostic Analyses, air quality issues were not reported.

It is clear from sources such as Environmental Performance Reviews by UNECE, National State of the Environment Reports, Rapid Assessment of Pollution and the National Caspian Action Plans, that air quality remains an environmental concern, particularly in large cities and industrial centres in specific countries.

In **Azerbaijan,** air pollution is most severe in the capital city of Baku and at Sumgayit. These cities host heavy industries such as petrochemical plants, crude oil refineries, and aluminium and cement production (Mansurov 2009). Urban air pollution is an issue of increasing concern in Azerbaijan, caused by rapid urbanization, a growth in transport and rapid economic growth (UNECE 2004, ENVSEC 2004). Another source of air pollution is a landfill situated between Baku and Sumgayit: due to faulty construction and poor management plus illegal dumping and the frequent uncontrolled burning of waste, the site is a major source of toxic emissions in the region's atmosphere (Mansurov 2009).

In 2000, hazardous emissions from road transport amounted to 392,700 tonnes from a total of 423,000 tonnes for all types of motor vehicles. By 2008, such emissions had climbed to 642,000 tonnes. With the total number of vehicles nearly doubled to 823,000, 70% of overall volume of noxious emissions generated from automobile transport. (4th National Report to CBD, p.98)

The main sources of air pollution — traffic and industry — tend to be concentrated in and around the large cities (UNECE 2004). At present, the air quality in Baku and Sumgayit is considered to be improving as a consequence of an overall decline in industry, particularly in the petrochemical and oil refinery production sectors. The main problem is now considered to be the rapid increase in emissions from the transport sector with the use of low-quality fuels in high-emission vehicles (Mansurov 2009).

In the Caspian Sea shore area of **Kazakhstan,** the highest level of air pollution was registered in Aktau. The oil and gas industry in the west of Kazakhstan, in Atyrau and Mangystau oblasts, is described as playing a negative role in air pollution (MNRE Kazakhstan 1999). A further cause of declining air quality is the presence of open industrial sites exposed to various climatic conditions. An example is the uranium waste tailing site of Koshkar-Ata, which represents a source of serious concern regarding air quality. As the results of various scientific investigations show, strong winds cause concentrations of the lead-radioactive isotope ^{210}Pb in the atmosphere to exceed background values by 15 times. Elements such as nickel, zinc, copper, chromium and tungsten have also been observed in the ambient air near the tailing site. Increased concentrations of heavy elements have also been recorded in soils at settlements including Akshukur, Bayandy, Kzyl-Tube and the Mangystau railway station, located to the east and west of the tailing site (TACIS 2009a).

A further cause of air pollution in the area is the oil and gas extraction process. Hundreds of billions in cubic meters of various gases are burned by oil and gas activities in the region. For example, in Mangystau oblast, the volume of torched gas over a nine-month period in 2005 amounted to 11,116 billion m^3. In Atyrau oblast, the main source of such gases is Tengizshevroil (TCO) (CEP 2007f).

In reference to the development of oil production in Kazakhstan's Caspian Sea region, there is an additional air quality problem arising from the open-air storage of lumpy sulphur. 5,4 million tonnes of lumpy sulphur have accumulated by March 2011. According to information available, "TCO" plans to reduce the accumulated amount of sulfur to the industrial needs (circa 1 million tons) by 2017. It is expected that within a few years, much of the lump sulfur will be stored next to the plant "Bolashak" in Atyrau oblast (CEP 2007f).

The Caspian's largest oil fields are characterized by very complex geological conditions - in particular by extreme strata pressure up to 1,100 atmospheres. They also have aggressive properties with the content of hydrogen sulphide registering up to 20 per cent. Therefore, accidents connected with oil deposits can lead to major disasters. This happened in 1985-86 when such an accident led to oil flames burning continuously for more than 398 days (CEP 2007f).

Pollution from mobile sources such as transport is also a particular source of declining air quality in Kazakhstan. In 2006, the total volume of pollution from such sources was nearly 27,000 tonnes in the Kazakhstan sector of the Caspian Sea region, consisting of nitrogen oxide (13,600 tonnes), carbon oxide (7,400 tonnes), hydrocarbons (4,300 tonnes) and other sources (1,700 tonnes) (TACIS 2009a).

5.3. State of sediment quality

Seas, oceans and lakes accumulate sediment over time. The material can originate in various water systems or be terrigenous — sediments resulting from the erosion of land-based rocks. Many years of oil exploitation and pollution from oil by-products have left a sizeable footprint on sediments in the Caspian Sea. There are also considerable amounts of other anthropogenic organic and inorganic pollutants in bottom sedimentation — caused by industrial and agricultural activities and atmospheric deposits from burnt waste gas at refineries and oil extraction installations. Polluted sediments can be buried under clean sediments, but when such sediments are disturbed, they can affect fauna growing at the bottom of the sea and also cause secondary water pollution.

This section of the report is based on information collected from various monitoring activities including the At Sea Training Programme (ASTP): the Contaminant Screening Programme, the Caspian Environment Programme's (CEP) contaminant surveys of 2005, the Regional Water Quality Monitoring Plan, in addition to selected research reports.

The "At Sea Training Programme"(ASTP) was the first sediment quality programme in the coastal zone of the Caspian Sea. The programme's research covered the period from October 2000 to September 2001. In total, 105 surface sediment samples were collected in the coastal zone of the Caspian Sea: 19 samples were gathered from the coastal zone of Azerbaijan, 21 from the Russian coastal zone, 29 from Iran's coastal zone and 33 from Kazakhstan. It should be noted that data from Turkmenistan was not included, as only two sediment samples were investigated. Concentrations were evaluated based on the values specified in the National Oceanic and Atmospheric Administration (NOAA) Marine Sediment Quality Guideline and those of the Canadian Interim Marine Quality Guideline (ISQG).

The 2005 CEP contaminant screening survey was the second regional survey to be carried out after the Soviet era. In total, 84 sediment samples were taken during the survey, covering areas in the Volga delta and estuary and in coastline areas of Kazakhstan, Iran and Turkmenistan. No sampling has been undertaken in Baku Bay (IAEA 2006).

The most recent sediment monitoring activity was conducted in 2009 under the auspices of the Regional Water Quality Monitoring Programme framework, forming part of the project "Caspian Water Quality Monitoring and Action Plan for Areas of Pollution Concerns" (CaspianMAP). Four marine expeditions were carried out in 2008-2009, covering all participating Caspian Sea countries with the exception of Iran. The key areas of contaminant analysis were: Total Petroleum Hydrocarbons (TPH); some Organochlorinated pesticides (OCPs), notably DDTs and lindane; PCBs; key trace metals (Hg, Cu, Zn); artificial and natural radionuclides: 40K137Cs, 210Pb, 226Ra, 238U. 9, 14 and 16 sediment samples were taken in the national sectors of Azerbaijan, Kazakhstan and Turkmenistan respectively (TACIS 2009b).

Since the first recommendations were put forward, based on regional water quality monitoring programme findings and on various CEP recommendations, progress has clearly been made in terms of laboratory-based technical development and in creating awareness about the need for solutions to these pressing issues. However, little has actually changed in regard to the methods and implementation of regional monitoring programmes (TACIS 2009b).

Petroleum hydrocarbon (PH)

According to the 2001 monitoring programme, petroleum hydrocarbon (PH) concentrations in the Caspian Sea region ranged from 29 to 1,820 g /g and were considered to be relatively high by global standards and at some locations, notably in Azerbaijan in the area south of Baku Bay. Although it was emphasized that some of the more well-known pollution hot spots were not sampled in surveys, it was reported in 2005 that petroleum hydrocarbon (Σ-PHs) concentrations were relatively low by global standards. The distribution of n-alkanes suggested a petrogenic origin for petroleum hydrocarbons at some sites in Azerbaijan, Kazakhstan and Russia. PHs in Iran and Turkmenistan, as well as some locations in Russia, were found to come mainly from marine and terrestrial biogenic sources. In contrast, relatively fresh inputs of hydrocarbons were apparent in Iran and southern Turkmenistan (CEP 2007a). The latest monitoring survey in 2009 looked at areas of particular concern: in Baku Bay and in the coastal area of Sumgayit, high concentrations of oil products and phenols were found (TACIS 2009b). Relatively high oil hydrocarbon concentrations were also found in the area around the Satpaev oil field and the seaport of Bautino (TACIS 2009b).

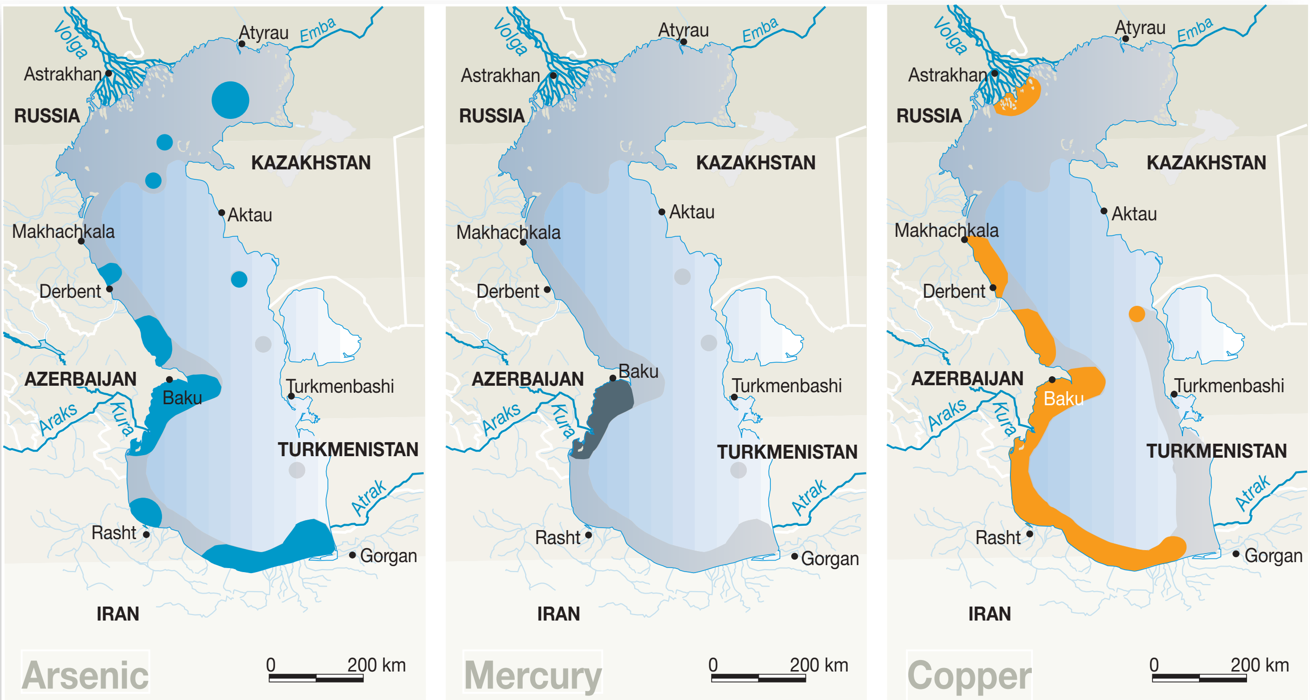
Polycyclic Aromatic Hydrocarbons

In 2001, total polycyclic aromatic hydrocarbons (PAH) concentrations were within the NOAA Sediment Quality Guideline value of 4,000 ng/g dry weight. The highest concentrations were identified in Azerbaijan, particularly south of Baku Bay, where values ranged from 280 to 3,000 ng/g (Mora and Sheikholeslami 2002). Subsequent reports indicated that concentrations of polycyclic aromatic hydrocarbons (Σ-PAHs) continued to remain within the guideline value. According to various diagnostic ratios, the PAHs tended to be derived primarily from oil along with some combustible products, particularly in the case of Azerbaijan. Minor contributions from digenetic sources were detected, principally near the Volga Delta (CEP 2007a). In the case of the Russian Federation, 2009 surveys revealed high concentrations of PAH in bottom sediments near the Dagestan coast, the Samur River, Derbent and Makhachkala (TACIS 2009b). In Turkmenistan, the bottom sediments of Turkmenbashi Bay were found to be heavily polluted by oil products (TACIS 2009b). In Kazakhstan, only in one sample out of 14 – in the Aktau seaport area – were the concentrations of oil products in water found to exceed Admissible Concentration Limits (ACL) (TACIS 2009b).

Chlorinated Organic Pesticides

Several pollutants such as HCB, DDT and lindane were investigated during the 2001 survey. Generally, concentrations were low, except that of DDT and its compounds which exceeded NOAA quality standards at a number of locations in Azerbaijan and Iran. The Kura River was identified as a main source of such contamination (Mora and Sheikholeslami 2002). Furthermore, according to the same survey, lindane concentrations exceeded the Canadian (ISQG) sediment quality guideline value in the Russian sector, with concentrations of 609 pg/g compared with the quality guideline standard of 320 pg/g. Five years later, no significant changes in DDT concentration were recorded: at some sites in Azerbaijan and Iran, concentrations were still high – three times above the ISQG standard. A persisting problem due to the use of DDT was observed in the Volga Delta, Azerbaijan and Iran, despite the global ban.

Heavy metals in sediments



Sampling areas

Arsenic concentration above ERL (8.2 µg/g)

Note: Maximum arsenic concentration in analyses measured was 22.6 µg/g

Sampling areas

Mercury concentration above ERL (0.15 µg/g)

Note: Maximum mercury concentration in analyses measured was 0.45 µg/g

Sampling areas

Copper concentration above ERL (34 µg/g)

Note: Maximum copper concentration in analyses measured was 57.6 µg/g

The Effects Range Low (ERL) is an indicator of concentrations above which adverse effects occur (National Oceanic Atmospheric Administration (NOAA) Marine Sediment Quality Guideline Values).

Source: Interpretation of Caspian Sea Sediment Data, Caspian Environment Programme, 2002; Transboundary Diagnostic Analysis Revisit, 2007

Previously, the highest lindane levels (above the NOAA standard) were noted in Russian regions. Surveys in 2005 identified the coastal area close to the Kura River as a lindane hot spot, surpassing the ISQG level of 320 pg/g with a recorded highest concentration of 1060 pg/g (TACIS 2009). In 2009, relatively fresh and high concentrations of Chlorinated Organic Pesticides and DDT were observed in the bottom sediments of Kura-Arak's alluvium and in the Russian area, also despite the global ban. In the southern part of the Terek River, β-HCCH concentrations exceeded the Admissible Limit Concentration standard (ALC) by seven times (TACIS 2009a).

Polychlorinated Biphenyls (PCBs)

The survey of 2001 showed that, in general, Polychlorinated Biphenyls (PCB) concentrations were relatively low by global standards (Mora and Sheikholeslami 2002), and did not exceed the NOAA (23 ng/g) concentration level. In 2001, the highest values were identified in the Russian sector. The 2005 survey identified the highest total PCB levels: two sites in the Kura River had concentrations of 30.0 and 28.7 ng/g, surpassing the sediment quality guideline value of 23 ng/g dry weight (CEP 2007a). PCB chlorination dispersion indicated that most sites had experienced multiple inputs of different commercial mixtures of PCBs, including Sovol and TCD of Soviet origin (CEP 2007a). Monitoring carried out in 2009 by the CaspianMAP project (TACIS 2009a) showed low levels of PCBs in the Russian sector: the survey noted that results from elsewhere were not submitted, and concluded that it was therefore difficult to assess the overall current situation.

Pesticides and heavy metals in sediments

Sampling areas
DDT concentration above ERL (1,600 pg/g)
Lindane concentration above ERL (300 pg/g)

Sampling areas
Nickel concentration above ERL (21 µg/g)
N.B.: Maximum nickel concentration in analyses measured was 68 µg/g.

Sampling areas
Chromium concentration above ERL (81 µg/g)
N.B.: Maximum chromium concentration in analyses measured was 128 µg/g.

The Effects Range Low (ERL) is an indicator of concentrations above which adverse effects occur (National Oceanic Atmospheric Administration (NOAA) Marine Sediment Quality Guideline Values).

Source: Interpretation of Caspian Sea Sediment Data, Caspian Environment Programme, 2002.

Metals

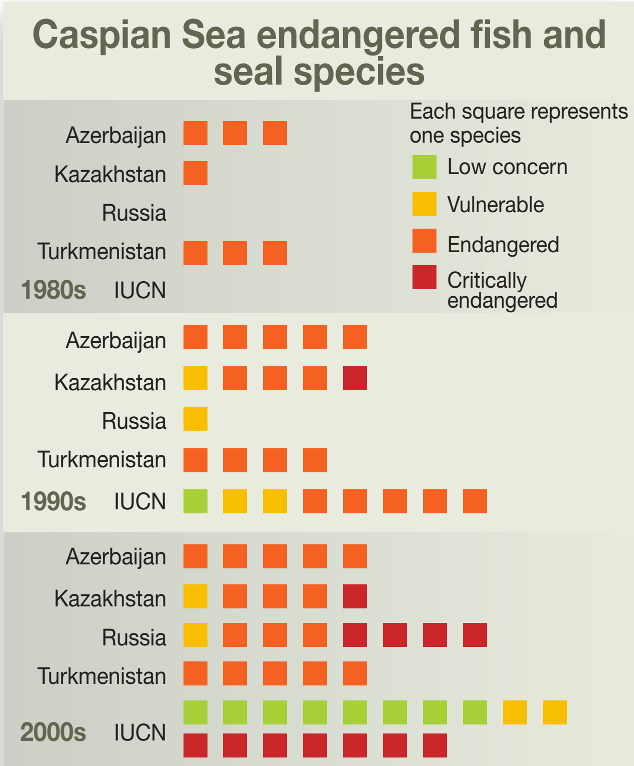
According to the first monitoring programme, 23 metals were found in Caspian Sea sediments. Some of the most significant results show: Arsenic (As) concentrations were fairly high in the region and, in some areas, exceeded the NOAA standard value of 8.2 μg/g nearly three times, with values of 22.6 μg/g in Azerbaijan, 20.1 μg/g in Iran, and 20.2 μg/g in Kazakhstan. Barium was detected at very high levels in several central Caspian Sea regions, with the highest concentration of 1250 μg/g in Kazakhstan. Barium (Ba) is used in mud drilling, and these high levels may be the result of this activity. However, this is not an element of concern with respect to environmental toxicity. Chromium (Cr) concentrations exceeded the NOAA value of 81 μg/g at almost all the locations in Azerbaijan and Iran, and at some sites in Kazakhstan. The Caspian Sea region is mineral-rich and several countries, most notably Kazakhstan, are important producers of chromium. The high concentrations of Cr stem from its natural presence in the region. Copper (Cu) dispersion in sediments was considerably lower in the North Caspian Sea, compared to those found in the Sea's central and southern areas. Copper concentrations surpassed the NOAA 34 μg/g standard values in several locations in Azerbaijan and Iran. A copper hot spot was also evident in Kazakhstan. This pattern of contaminant presence might indicate that the Kura River is the main source of Cu, and contamination likely caused by mining or agricultural activities in the catchment area. Mercury (Hg) concentration levels were quite high at some sites in Azerbaijan (0.450 μg/g), particularly south of Baku Bay where levels exceeded the NOAA standard of 0.15 μg/g. Nickel (Ni) was observed in high concentrations and exceeded the NOAA value of 21 μg/g in all the countries of the Caspian Sea, particularly in Azerbaijan and Iran where all monitored sites exceeded the standard level. The highest concentrations were found near the mouth of the Kura River, and it is clear that the Ural River also has an impact on concentration levels. These generally high levels reflect a predominantly natural nickel presence, but this could be augmented by mining activities. There have been claims of significantly higher concentrations of certain naturally occurring radionuclides, especially uranium (U), in the Caspian Sea. The highest concentrations of uranium (11.1 μg/g) were identified in the Kazakhstan coastal sector: this could be due to the uranium enrichment plant in Aktau, Kazakhstan. Zinc (Zn) concentrations were relatively high in Iran where concentrations exceeded the ISQH value of 124 μg /g (Mora and Sheikholeslami 2002).

In 2005, few metal concentrations were observed in surveys, apart from a number of sites in Azerbaijan where the highest mercury values were 0.20 μg/g, exceeding the NOAA standard value of 0.15 μg/g-1. Though concentrations of some elements - (such as As, Cr, Cu and Ni) - surveyed were high and, in some locations, surpassed sediment quality guidelines by two or three times, such metals undoubtedly have a high natural background in this mineral-rich region (IAEA 2006). An anthropogenic activity, such as mining, might also lead to more metal content in some Caspian Sea sediments: an example of this is the copper hot spot in Azerbaijan. Mercury levels in 2005 were still noticeably high at a number of sites in Azerbaijan (CEP 2007a). However, compared to 2001 surveys, the levels are lower.

In 2009, extensive pollution levels caused by metals in Azerbaijan were not evident. Nevertheless, arsenic concentrations were high compared to natural levels in Azerbaijan's soil, which could be related to natural factors such as volcanic activity peculiar to the area. Nevertheless, in all cases, its concentration did not exceed the Netherlands recommended average safety limit of 70 mg/kg and the admissible Concentration Limit Value of 30 mg/kg. In the Shrivand sewage canal, the Kura River and Baku Bay, high rates of Cr, Cu and other metal concentrations were noted in bottom sediments (TACIS 2009b). High concentrations of Cd were observed only in the Baku area. Bottom sediments in Kazakhstan contained relatively high concentrations of Cu, Cd, and Hg. However, these did not exceed the standards (Netherlands). Initial results in Turkmenistan showed a relatively low concentration of metals, except for levels of Cu, Ni and Pb, which exceeded the standards in some locations (Caspecocontrol 2009) compared to natural background levels in bottom sediments (TACIS 2009b).

5.4. State of biodiversity

The biological diversity of the Caspian Sea and its coastal zone makes the region particularly significant. One of the most important characteristics of the Caspian Sea's biodiversity is the relatively high level of endemic species among its fauna (UNDP 2009b). The highest number of endemic species across the various taxa is found in the mid Caspian Sea region, while the greatest diversity is found in the northern section of the Caspian Basin. The coastal region is characterized by a wide range of habitats; these include habitats in vast river systems and extensive wetlands such as the deltas of the Volga, Ural and Kura rivers, the wetland systems along the Iranian coast and the exceptionally saline bay of the Kara-Bogaz-Gol Gulf. At the other extreme, habitats are also found in the sandy and rocky deserts on the Caspian Sea's eastern coast (Solberg et al. 2006). The wetlands in the region play a significant role as a feeding and resting area for migratory birds. However, due to various human activities, plus threats from invasive species, climate change and fluctuations in the water levels of the Caspian Sea, coastal habitats are constantly changing and biodiversity is declining (CEP 2007a).



Note: The first Caspian species appeared in National Red Data Books in 1978. In the IUCN Red List the first Caspian species appeared in 1996. Categories in the National Red Data Books varied and changed from edition to edition. These categories had different names but similar meaning to IUCN categories

Source: personal communication with Igor Mitrofanov

As a result, 112 plant species and 240 species of animals in the Caspian Sea coastal zone have been noted by the Caspian Coastal Site Inventory (CCSI) and included in the IUCN Red List (2006) or National Red Books (1981, 1988, 1989, 1996 a, b, 1999, 2001, 2004). One species of fungi, one species of lichen, one species of moss, and 109 species of vascular plants make up the list of rare and endangered plant species. Red Book animals are represented by 77 invertebrate species, one species of cyclostomes, 18 species of fish, 7 species of amphibians, 26 species of reptiles, 79 species of birds and 32 species of mammals. The proportion of the various vulnerable and endangered species in the littoral states, as compared to the entire List of Red Book species recorded in the Caspian Sea coastal zone, is as follows (CEP 2006):

Azerbaijan: 44% of plants and 33% of animals; Iran: 6% of plants and 13% of animals; Kazakhstan: 10% of plants and 32% of animals; Russia: 64% of plants and 65% of animals; Turkmenistan: 8% of plants and 15% of animals.

The total count of species in the Caspian Sea Region is estimated to be between 1,800 and 2,000, incorporating different groups of plants and animals.

Algae

There are many **algae** species in the Caspian Sea, but in the Sea's southern sector, the number has been decreasing due to a decline in freshwater habitats. On the other hand, the number of marine species in the North Caspian Sea has increased by 10% and in the South Caspian Sea by 33%. The most abundant species are Diatoms (Bacillariophyta), green algae (Chlorophyta) and blue-green algae (Cyanophycota). Numbers of species of red algae, brown algae, pyrrophytas and golden algae are small. Most algae species are phytoplankton, but there are also some microphytobentos and periphyton algae species, and some species are small individual plants. Phytoplankton is the primary producer of organic matter in the Caspian Sea, totalling from 200 to 230 million tonnes annually.

Blue-green algae in the Caspian Sea are represented by freshwater, brackish and marine species. There are 131 species and 19 forms of blue-green algae belonging to 29 genera. However, about 30 of these species have not been found during the past 20 years. Most of these species inhabit the North Caspian Sea, while only two inhabit the South Caspian Sea. Blue-green algae can be found in phytoplankton and in one-cell membranes on the water surface and on coating rock in tide zones – and in periphyton. Blue-green algae are most abundant in August and September. The composition of the various species differs in the south and north portions of the Caspian Sea: in the north there are 88 species and forms, and 84 in the south – only 21 species are present in both areas.

Dinoflagellates are represented by only 35 species. However, these species are highly significant as they provide the main food source for many zooplankton species. The species composition tends to be very uniform. In the North Caspian Sea, pyrrophitas are not abundant; in the past, however, before the introduction of exotic diatoms, pyrrophytas dominated both the south and middle sectors of the Caspian Sea. Since the 1960s, this dominance has diminished. Over the last few years, however, pyrrophytas have increased in number in the South Caspian Sea. These algae have chloroplasts of different shapes and colors – olive, brown, yellow, red – even blue and colorless. Green is the one color that is not prevalent in pyrrophytas. The most common species in the Caspian Sea are from the genera Protocentrum and Prorocentrum.

Golden algae are represented by only two species. Both species belong to the genus Dinobryon. While both species are found in all parts of the Caspian Sea, they are considered to be rather rare.

Diatoms are dominant in number and in terms of biomass in almost all parts of the Caspian Sea. There are 275 species and forms belonging to 62 genera, with nine species endemic to the Caspian Sea. Of the total, 25 species have not been found for the past 20 years. Due to species revisions, the taxonomy of 40 species has changed in recent years. The composition of species in the North and South Caspian Sea differs. As many as 104 species in the North Caspian Sea are not found in the South Caspian Sea, and 118 species in the South Caspian Sea are not found in the North Caspian Sea. About 70 species are distributed throughout the Caspian Sea and these are the most abundant in number. Diatoms produce about 40% of the total organic matter present in the North Caspian Sea, and produce up to 98% of organic matter in the South Caspian Sea. For the most part, this organic matter is produced by only one species - R*hizosolenia* [=P*seudosolenia*] *calcar-avis*, *introduced unintentionally*, *alongside the acclimatisation of two species of mullet* (K*arpevich*, 1975). It was very abundant in the 1960s, and though its numbers have dropped somewhat, it is still dominant in all areas of the Caspian Sea.

Brown algae are small in number and in terms of diversity. Only five species are known in the South Caspian Sea and two of these are endemic.

Red algae are not abundant, mostly inhabiting the South Caspian Sea, and only a few species found in the Central Caspian Sea and one species in the Ural Furrow in the North Caspian Sea. In total, 23 species have been identified in the Caspian Sea, six of which are endemic. Brown and red algae are small metaphytas. Their presence is very significant at depths between 10 and 20 meters, where high plants are absent and where red algae dominate.

Euglena algae constitute a minor presence with only eight species known in the Caspian Sea. They are distributed in small amounts in all parts of the Sea.

Green algae constitute 138 species and 20 forms from 49 genera in the Caspian Sea, though only 70 species were found in surveys between 1990 and 2008. Most of the green algae are in freshwater and are distributed around river deltas. Maximum diversity and abundance levels were found in the Volga Delta and in the North Caspian Sea. Only 16 species were found in the Central and South Caspian Sea, along the eastern coast.

Charophytas are small metaphytas up to 20-40 cm. in length. Only seven species from two genera have been found in the Caspian Sea. They live at shallow depths in the South and Central Caspian Sea and are a preferred food source for many waterfowl.

In total, there are 620 species and 48 forms of algae in the Caspian Sea. Seventeen of these are endemic to the region while four are recognized as having been introduced.

There are 132 species of merged, submerged and fluctuant **High plants** from 44 genera. Only 25 of these are found in the Caspian Sea – the remainder are distributed in surrounding deltas and wetlands.

Giant reed P*hragmites australis* is the most common submerged plant. It can be found in all locations surrounding the Caspian Sea. Common merged plants are eelgrass, pondweed, parrot's-feather, widgeon grass, najas, and hornweed. The number of species in the Volga and Kura deltas are similar - 56 and 47 respectively - but species composition differs. Maximum species diversity was found in Dagestan (117 species), an area where the floras of the north (Volga) and the south (Kura) meet each other. Along the Iranian coast, 17 species of aquatic plants have been found, while along the coast of Turkmenistan only seven have been found. Twelve species have been listed in the Red Data Books of the Russian Federation, Dagestan, Azerbaijan, and Kazakhstan.

All known **Protozoans** from the Caspian Sea are foraminifers. Only 27 species are identified in the North Caspian Sea, and 11 species in the South Caspian Sea. Planktonic protozoans have not been studied.

There are about 400 species of **Infusoria** in the Caspian Sea of which 20 species are endemic. There are sedentary, planktonic and colonial species. Most of these species have been found over the last 15 years due to the intensive study of benthic communities in the vicinity of oil wells. These figures are, however, not definitive and are likely to change as studies continue.

Five species of **Jellyfish** currently inhabit the Caspian Sea – three are introduced while two are autochthons. One species (M*oerisia pallasi*) is endemic to the Caspian Sea. A sixth species, A*urelia aurita*, was found only once in 1999 and never found again. Some species of freshwater hydras are found in shallow-water deltas.

One **Comb jelly** species has been introduced into the Caspian Sea – M*nemiopsis leidyi*. The invasion of this jelly during the late 1990s represents one of the main environmental issues in this unique ecosystem, and is considered as one of the world's major marine ecosystem invasive species occurrences.

Many **Flat worms** are parasites and the small group of Turbellaria live in the wild. Twenty five species of Turbellaria are identified in the Caspian Sea, and 18 of them are endemic. Most studies of this group of organisms were carried out more than 100 years ago and future studies could change our understanding of this group of organisms. The same is true for **Nemertins** — never identified at a species level in the Caspian Sea and found only near the Volga and Ural deltas. Only one species of **Entoprocta** has been found in the Caspian Sea – B*arentsia benedeni*. It was probably introduced from the Black and Azov seas; it is now found only along the eastern coast of the South Caspian Sea.

Caspian **Nematodes** have not been studied very much. It is probable that there are many endemic species, but they have not been identified on the species level.

There are 62 species of **Rotatoria** in the Caspian Sea: two species are known to be endemic. Both species are found in the North Caspian Sea. There is no data relating to its introduction.

Polychaete worms are not diverse in the Caspian Sea. Only seven species have been identified, of them introduced. All native species are sedentary polychaete worms. The only vagile species is *Nereis diversicolor*, introduced intentionally in 1939 to improve the benthic community for fish feeding. One species, *Parhypania brevispinis*, is endemic to the Caspian Sea. All polychaete worms are an important part of the food chain and are a preferred food source for many fish species.

Oligochaete worms are more diverse. There are 20 species from 10 genera. Six species are endemic to the Caspian Sea. Maximum diversity is found in the North Caspian Sea with 19 species. All species are small, only measuring between 15 and 80 mm. In some locations, they are very numerous. All species serve as fish food, particularly for carp and gobies.

Suctorial annelids (leeches) are represented by only three species, all of them distributed throughout the Caspian Sea, and only one species endemic to the Caspian Basin.

Crustaceans in the Caspian Sea are numerous and diverse. Many species are endemic and are a significant part of the food chain. There are many forms of Crustaceans in the Caspian Sea, and some of them are of great importance.

Cladocerans are numerous in the Caspian Sea. The composition of species differs in the North and South Caspian Sea. In the North Caspian Sea, 39 freshwater species of cladorean are identified. A total of 25 species are identified in the Central and South Caspian Sea, while only 10 species inhabit both the North and South Caspian Sea. Cradocerans are mostly dominant in the North Caspian Sea, with relatively small numbers existing in the South Caspian Sea. All Cladocerans are an important food source for fingerlings and planktonivorous fish. The tulka species represents up to 6% of food intake. Sixteen species (30 %) are endemic to the Caspian Sea and two species, *Pleopis polyphemoides* and *Penilia avirostris*, are exotic invaders.

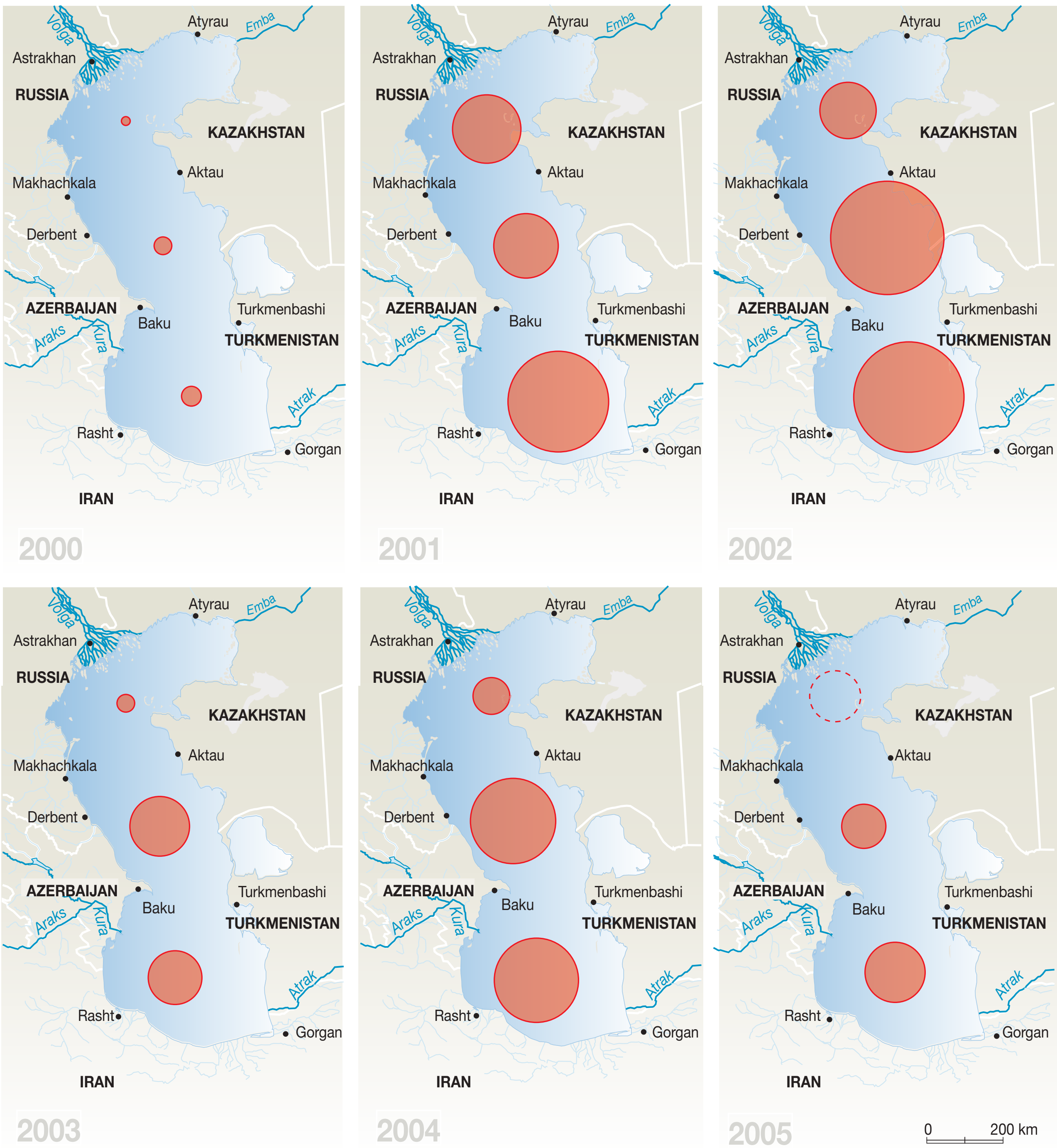
Copepods are less diverse with 31 species, but they are very abundant, especially in the Central and South Caspian Sea. Sixteen species dominate and are distributed throughout the Caspian Sea. In the North Caspian Sea, these are joined by 14 additional freshwater species; one additional species is found in the South Caspian Sea. Seven species are endemic to the Caspian Basin and four are exotic invaders. Copepods are dominant species in the zooplankton of the Central and South Caspian Sea: these are a preferred food for all planktivorous fish and constitute up to 90% of tulka food intake. Following the invasion of *Mhemiopsos leidyi*, the diversity of copepods was reduced in the South Caspian Sea, sometimes to only one species – *Acartia tonsa*. This is another invader in the Caspian Sea ecosystem, only appearing in the Sea in the 1980s. Another two species of copepods, *Oithona similis* & *Calanus euxinus*, were found only between 2000 and 2005. These two species are new invaders.

Two species of **Barnacles** were introduced into the Caspian Sea in the early 1950s. Their number is sometimes considerable – it is rare that fish feed on them.

Ostracods or seed shrimps are diverse with 48 species in the Caspian Sea. Of these 7 are endemic. All species are small – up to 1.3 mm in length.

Opposum shrimps are small organisms – up to 40 mm – represented by 21 species in the Caspian Sea. Many species are distributed throughout the Sea. Numbers of opossum shrimps have fluctuated through the years, but the cause of this is unknown. 13 species, or 60% of this group, are endemic.

Fluctuations of the population of comb jelly (*Mnemiopsis leidyi*) in the Caspian Sea



Population of species
Number of species per cubic meter

500 250 100 50 10

No data

Sources: CEP, *Monitoring study of Beroe ovata and Mnemiopsis leidyi in the Southern Caspian Summer-Autumn 2005, собственные данные Игоря Митрофанова*

A small group of **Cumaceans** is found in the Caspian Sea; there are only 17 species from the family Pseudocumidae. Most are distributed in all parts of the Sea and are the preferred food for some bottom feeding fish, especially bream. Six species are endemic to the Caspian Sea.

Amphipods are diverse and numerous. They are one of the preferred foods for all bottom feeding fish. There are 80 species - 39 being endemic species. Their distribution is scattered, with high density in some areas.

Isopods are represented by only two species. Both species are common in the Central and South Caspian Sea, but they are not plentiful.

Decapods are represented by only five species and three of these are exotic species. Two crayfish are aborigines of the Caspian Basin. Two species of shrimps were introduced from the Black Sea in the 1930s. One crab species (*Rhithropanopeus harrisii*) was introduced from the Atlantic via the Black Sea in the 1950s. All species can be found throughout the Caspian Sea, particularly along the eastern coast of the Central Caspian Sea.

Only two species of marine **mites** are found in the Caspian Sea. Little is known about these species.

No water **insects** (beetles and bugs) are found in the Caspian Sea, but are numerous in delta areas. The larva of dragonflies and dipterans have been identified, mostly near deltas. Only two species are found in the open sea — *Chironomus albidus* and *Clunio marinus*.

Mollusks in the Caspian Sea have a small number of genera, but a very high number of species.

Bivalves are not diverse but have very high biomass due to their size. Many are freshwater spe-

How the comb jelly (*Mnemiopsis leidyi*) is spreading in the European seas

cies and thus found only in the deltas of big rivers (the Volga, Ural, Kura and Terek). There are 24 bivalve species in the Caspian Sea. Invasion of three species was either intentional or accidental. The introduction of *Abra ovata* and *Mytilaster lineatus* has had a considerable impact on the benthic community. Three endemic bivalve species have not been found for 20 years and might be extinct.

Gastropods in the Caspian Sea are usually small animals. This group is very diverse and includes freshwater species from deltas as well as many marine species. In general, their biomass is not high compared to *Mytilaster* and *Abra*. There are many endemic species of mollusks in the Caspian Sea. There are 13 endemic species and 16 endemic subspecies of Bivalves (88%). There are 83 marine gastropods in the Caspian Sea, 74 of which are endemic.

There are only 10 species of **Bryozoans** in the Caspian Sea and no endemic species. One species — *Conopeum seurati* — is a possible invader.

Cyclostomes and fishes

In the Caspian Sea and surrounding low deltas, there are 110 native species belonging to 50 genera. Some species are represented by two or more subspecies. Another 24 species moved into the Caspian Sea in the 20th century. Most fish - 58 native species and 8 introduced species - can be found both in the Sea and in the contributing rivers during the different stages of their life cycles. Some of these fish live only in the sea – 28 aboriginal species and two introduced species of mullet. The number of endemic species is very high in the Caspian Sea. One lamprey species inhabits the Caspian Sea: it is endemic and belongs to an endemic genus. Six species of sturgeon live in the Caspian Sea. Five of them are anadromous: the Great sturgeon, the Russian sturgeon, the Persian sturgeon, the Stellate sturgeon and the Fringebarbel sturgeon. All of these species are fished commercially. All sturgeon species also inhabit the Black Sea. All 11 species of the herring family are endemic to the Caspian Sea. A very special group is the 36 species of Caspian gobies, 24 of which are endemic. Another 10 gobie species inhabit the Black Sea but the subspecies are endemic to the Caspian Sea. Caspian Sea marine fish include 23 endemic species and 3 endemic subspecies. In total, 37 endemic species and 19 endemic subspecies can be found in the Caspian Sea. Taking into account fish from the lower delta areas, the total number of endemic species increases to 46 species and 22 subspecies.

Nineteen species and subspecies of fish in the Caspian Sea are listed in the IUCN and some National Red Data Books.

There are 15 species of **Amphibians** in the Caspian Sea region, but only five or six of them are connected to the Sea through coastal habitats and river deltas. No species have been identified in the open Caspian Sea. Only one species is endemic (*Batrachuperus persicus*), inhabiting small mountain creeks on the Iranian coast. Along the northern coast only three to five species were identified (Genera Rana, Bufo, Pelobates, and Bombina), while 10 species were identified on the Iranian coast.

There are many **Reptile** species along the coast of the Caspian Sea, but only a few of them have habitats connected with water. In the Caspian Sea region, there are only two tortoise species (*Mauremys caspica* and *Emys orbicularis*) and two snakes (*Natrix natrix* and *Natrix tessellata*). All four species are common.

There are more than 300 species of nesting, migrating and wintering **Birds** along the coast of the Caspian Sea. The Caspian Sea plays a significant role as one of the great migration routes. During the migratory season, the presence of many millions of birds is an amazing sight. Many species spend winter in the wetlands along the coast of the mid and the South Caspian Sea. Approximately 94 waterfowl species nest around the Caspian Sea: 35 of them spend winter in the region, while 22 species arrive and spend winter only in northern regions. Forty five species of waterfowl can be observed on their migration route – they

Protected areas in the Caspian basin

Source: personal communication with Igor Mitrofanov; World Database on Protected Areas, 2010.

do not stay for long in the Caspian Sea region. In total, approximately 160 - 170 species of waterfowl can be found in the area. Recently, waterfowl numbers have slightly decreased, but they can still be counted in their millions. No endemic species are found. Thirty seven species are listed in the National Red Data Books.

In various parts of the coastal areas of the Caspian Sea, between 45 and 70 species of **Mammals** can be found. However, there is only one marine mammal – the Caspian seal. There are also a few other species inhabiting wetlands and river systems.

The Russian muskrat (*Desmana moschata*) inhabits deltas of the Volga and Ural rivers. It is very rare and listed in the Red Data Books. Water shrew (*Neomys anomalus*) inhabits the southern coast of the Caspian Sea. Water vole (*Arvicola terrestris*) is very common around the coast of the Caspian Sea. Castor (*Castor fiber*) can only be found in the Volga Delta and is considered to be very rare. Coypus (*Myocastor coypus*) and muskrats (*Ondatra zibethicus*) were introduced from North America. Coypus inhabit the deltas of the Kura and Lenkoran rivers, while muskrats are very common all around the Caspian Sea.

Otters (*Lutra lutra*) are considered to be rare, and found in the deltas of all the main rivers. European mink (*Mustela lutreola*) is also very rare. It only inhabits the deltas of the Volga and Ural rivers and is listed in Kazakhstan's Red Data Book. American mink was introduced into the region and is now taking over habitats of the European mink. Many other mammals are found in reedy areas, but these are not connected to water habitats.

The Caspian seal is the only marine mammal in the region and is an endemic to the Caspian Sea. It is listed in the IUCN Red List, but not in the National Red Data Books. It can be found in all parts of the Caspian Sea, but during winter, the pupping season is concentrated on the ice in the North Caspian. It feeds on kilka and other small fish found throughout the Caspian Sea, and undertakes a regular seasonal migration from north to south (UNDP 2004).

The total number of Caspian seals was estimated to be more than a million at the beginning of the twentieth century, but it was reported that this number had decreased to 350,000 - 400,000 by the late 1980s (Krylov, 1990; KaspNirkh annual reports, 2002–06). Surveys of pup populations during the period 2005 - 2008, plus historical census analyses and hunting records, indicate that the total number of seals in the Caspian Sea had declined in 2005 to approximately 111,000, with an average annual decline of about 4% over the past 50 years.

The main causes of this population decline are disturbance in the seal's ecosystem and pollution. One of the major food sources for the seals is the tulka. Over the years, tulka stocks have reduced dramatically: as a result, the food chain of the seals has been disturbed (CEP 2007g).

Most of the priority seal habitats and shore ('haul-out') sites around the Caspian Sea have yet to be fully inventoried and documented. The CISS survey team has assessed the distribution of seal pups and breeding seals on the ice every year since 2005. However, stakeholders are not familiar with priority seal habitats – nor do they know how many seals currently use particular shore sites or the extent of habitat disturbance or degradation (UNDP 2004).

Invasive species

The introduction of alien species has occurred both accidentally and intentionally in the Caspian Sea. Between 1930 and 1970, at least 20 species of fish were intentionally introduced for economic purposes.

The most significant invasions, causing considerable ecological disruption were:

The invasion of diatom algae *Rhyzosolenis* [=*Pseudosolenia*] *calcar-avis* in the 1960s. As a result, the numbers and distribution of many native phytoplankton species have been reduced. Rhyzosolenia has become a dominant phytoplankton.

The introduction and accidental invasion of *Nereis diversicolor*, *Abra ovata*, *Mytilaster lineatus*, and *Rhithropanopeus harrisii* caused a complete change in the benthic community. Some endemic species disappeared and these exotic species have become dominant.

The accidental invasion of *Acartia tonsa* occured in the 1980s. This species now dominates zooplankton in the Central and South Caspian Sea, producing up to 98% of zooplankton biomass.

The invasion of *Mnemiopsis leidyi* (ML) in the late 1990s is of great significance. At present, ML is found throughout the Caspian Sea, except in the extreme north and northeast. According to latest data *Mnemiopsis leidyi* is found in the North Caspian where salinity is less than 2% and in fresh waters of the Volga avandelta, where the salinity is too low (CEP 2002c). The most serious impact from the introduction of this species is on the tulka fisheries, primarily due to the competition for food between these two species and the ML eating the planktonic tulka larva. Also, because tulka is a key part of the diet of Caspian seals, a decline in sprat stocks is likely to have a knock-on effect and cause further declines in seal populations (GIWA 2006). Maximum abundance levels of *Mnemiopsis* were noted in 2002, measuring 1700 specimens per m^3 in the South Caspian Sea (CEP TDA 2007). It was noted that zooplankton diversity and biomass were reduced two to three times. In many cases, instead of the previously registered 10 - 17 species, only one species (*Acartia tonsa*) was found in 2003. Similar changes were observed in the phytoplankton community. A reduction in the phytoplankton community was observed in the vicinity of the southern coast and cannot be explained, while biomass and diversity in the benthic community increased twice over during the same period. After two years, the blooms and biomass associated with *Mnemiopsis leidyi* started to decline. As amounts of *Mnemiopsis leidyi* fluctuate across the Caspian basin, there have been continuing changes among zoo- and phytoplankton. The species composition of both communities has become richer while the diversity. Several species have been seen in healthy numbers, unobserved for several years. This applies particularly to Cladocerans and Copepods found in shallow waters along the south shore.

It is clear that the invasion of ML has disrupted the whole Caspian Sea ecosystem – however, other earlier invasive species may have also played a role in changing the Sea's ecology. It is unclear what the long-term impact of ML in the Caspian Sea will be.

Habitats

The waters of the Caspian Sea and its coasts are distinguished by a diversity of habitats which are of global importance. Species and their habitats are intertwined, one with the other. The condition of habitats is the basis for species survival, but if disrupted, can also cause their extinction. Key factors in the species sustainability are the availability of suitable habitat, their quality and size, and whether they exist over time. A wide spatial variability of habitats and a diversity of environmental conditions result in a high level of taxonomic regional diversity. Deterioration and destruction of habitats result in a loss of diversity and a reduction in numbers and quality of species populations. These include rare and endemic species (CEP 2002). Such phenomena can clearly be seen in the Caspian Sea region, with many populations of birds and valuable commercial fish decreasing.

Coastal habitats. The coastal scenery and habitats in the Caspian Sea region are degraded by a number of natural factors such as fluctuations in sea levels, earthquakes and climate change (CEP 2007a). For the whole Caspian Sea coastal zone, the most frequent human impacts are (1) agriculture (2) extraction of fossil fuels and seasonal fishing and hunting, and (3) construction, dredging and dumping (CEP 2006), as well as perepromysel living aquatic resources, the criminal trade, regulation of wastewater flowing into rivers. (2) extraction of fossil fuels and seasonal fishing and hunting, and (3) construction, dredging and dumping (CEP 2006), as well as overexploitation of living aquatic resources, the criminal trade, over-regulation of wastewater discharge into rivers. Oil production and transportation are often seen as the most dangerous potential threat for coastal ecosystems both today and in the future (CEP 2006). However, human impacts such as tourism development, degradation of forests, deforestation and infrastructure development are also seriously damaging coastal ecosystems.

The location of the coastal wetlands (freshwater, brackish and salt marsh systems) is intimately linked to water levels in the Caspian Sea. In response to rises in sea levels, coastal wetlands experience faster vertical accretion due to increased sediment and organic matter input. If vertical accretion equals sea-level rise, the coastal wetland will be elevated. Direct losses of coastal wetland due to submergence can be offset by inland wetland migration (coastal dry land conversion to wetland). The effectiveness of this process will depend on land elevations, sediment supply and the presence or absence of barriers to migration, including peripheral roads, sea walls and dikes and residential development (CEP 2007a). For example, in Gyzyl-Agachskiy Protected Area, in the south of Azerbaijan, the rise in the sea level, which once had a positive affect on ground conditions, is now negatively affecting the condition of ecosystems (CEP 2006). The rise in the sea level caused flooding of protected areas in the coastal strip and degradation of coastal ecosystems. The flooding of the land also caused salinization of soils, the development of hydromorphic vegetation and growths of reed and cane. Flooded areas are now overgrown with dense reed bushes.

Some wetlands have experienced the opposite. For example in Azerbaijan, the migration and wintering of waterfowl and shore birds has been affected by the drying out of wetlands and changes in vegetation. In Divichinskiy estuary, there are shallow water areas and the lagoons in the coastal zone are drying up. In recent years, changes in water levels in Lake Agzybir (the water entry point has been closed) have led to considerable ecological degradation of marshlands. The water level of the lake has fallen and the flood area around the lake, with lots of bird habitats, has been reduced by 40% (CEP 2006).

River deltas play an important role in the maintenance of ecological balance in the whole Caspian Sea. The most significant of these are the Volga River Delta, the Kura River Delta and the Ural River Delta.

The Kura River Delta is the spawning and fattening area for many valuable fish species, a migration route for anadromous fish and a wintering ground for birds. Regulation of the river flow, uncontrolled catches (poaching), pollution of waters and the pasturing of cattle on the river banks have resulted in considerable damage to the ecosystem. This in turn has led to a drastic fall in populations of many valuable species.

The Ural River Delta is a unique delta wetland on the shore of the north Caspian Sea comprising a large variety of marine/coastal and inland wetland types. Due to its mixed water supply and seasonal variations, the site supports considerable numbers and diversity of species, about 13 IUCN threatened bird species. The site is significant for migratory birds at the West Siberian-Caspian site of Siberian-East African migratory route, with dabbling and diving ducks, geese and whooping swans moulting here. There are such rare and endangered species as European white and Dalmatian pelicans, pond, little and buff-backed herons, spoonbills, glossy ibises and gallinules nesting in the coastal and water ecosystems. In terms of fish, the Ural River has the only remaining spawning habitats in the entire Caspian basin for all sturgeon species due still intact hydrological regime of the river (Lagutov 2008).

The Volga River Delta, including the territory of the Ramsar wetland "Volga Delta" and Astrakhan Nature Reserve, is a unique natural area which plays a very important role in the preservation and reproduction of fish resources. Overall, in the Volga Delta and the Caspian Sea there are about 76 species of bony fish. Water bodies in the Volga Delta — with its diverse vegetation and special hydrological and temperature conditions — are favourable areas for the reproduction and fattening of fish with their differing environmental requirements.

The Volga Delta together with surrounding areas of the Northern Caspian is one of the few places in Russia where numerous nesting colonies of birds are concentrated. It is the largest reserve of copepods, ciconiiformes and other semi-aquatic and natatorial birds, which has a strong impact on their population in the large parts of the adjacent arid areas of southern Russia.

5.5. Climate change

According to the findings of the Intergovernmental Panel on Climate Change (IPCC) Fourth Assessment Report of 2007, warming of the climate system is unequivocal - evident from observed increases in global average air and ocean temperatures, widespread melting of snow and ice and rising global average sea levels (IPCC 2007). Average Northern Hemisphere temperatures during the second half of the 20th century were very likely higher than during any other 50-year period over the last 500 years and likely the highest in at least the past 1,300 years. Observed evidence from all continents and most oceans — mainly based on data sets covering the period since 1970 — shows that many natural systems are being affected by regional climate change, particularly temperature increases (IPCC 2007).

The Caspian Sea, though a land-locked water basin not directly affected by global sea level rise, is being similarly impacted by climate change. The Caspian Basin plays an important role in atmospheric processes, regional water balance and also influences microclimates. Climatic phenomena in the Caspian Sea region are linked to the North Atlantic Oscillation (NAO), with fluctuations in atmospheric air pressure affecting temperatures, moisture and winter storms in areas throughout Europe including the Volga Basin and rainfall over the Caspian Basin.

Based on IPCC models and methodology, it is forecasted that mean annual temperatures in the Caspian Sea will increase by between 3.7 and 4.9 C by the middle of the next century, while annual precipitation will increase by an average of 52mm (GFDL, CCC and UKMO models) or decrease by between 4 to 8mm (GISS model)[5] (Kudekov 2006).

As in other regions, greenhouse gas emissions (GHG) from the oil and gas industry can contribute to changes in climate. Kazakhstan, with annual GHG emissions of more than 200 million tonnes of CO_2 equivalent, is by far the largest GHG emitter in Central Asia. Its energy sector generates about 80 per cent of the country's total emissions, of which about 90 per cent are emissions related to fuel combustion with the remainder made up of emissions related to extraction, transportation and processing of fuels. Meanwhile, Turkmenistan is rapidly developing its energy sector. In 1994, its GHG emissions were 52 million tonnes of CO_2 equivalent, almost all sourced from the energy sector: it is estimated that the country's total GHG emissions will increase 62% by 2010, mainly due to a growth in oil and gas production (UNDP 2007).

Caspian Sea level fluctuations

One of the Caspian Sea's unique features is the relative instability of its sea level. In 1995, UNEP experts, in the regional review "*Implications of climate change in the Caspian Sea region*", noted that changes in Caspian Sea levels were likely connected to global climate change and suggested future developments would mirror potential rises in levels of the world's oceans (UNEP 1995).

Sea levels in the Caspian Sea have been fluctuating since the Sea became a closed basin about 5.5 millions years ago. The Sea is now between -26 and -27 m below oceanic sea lev-

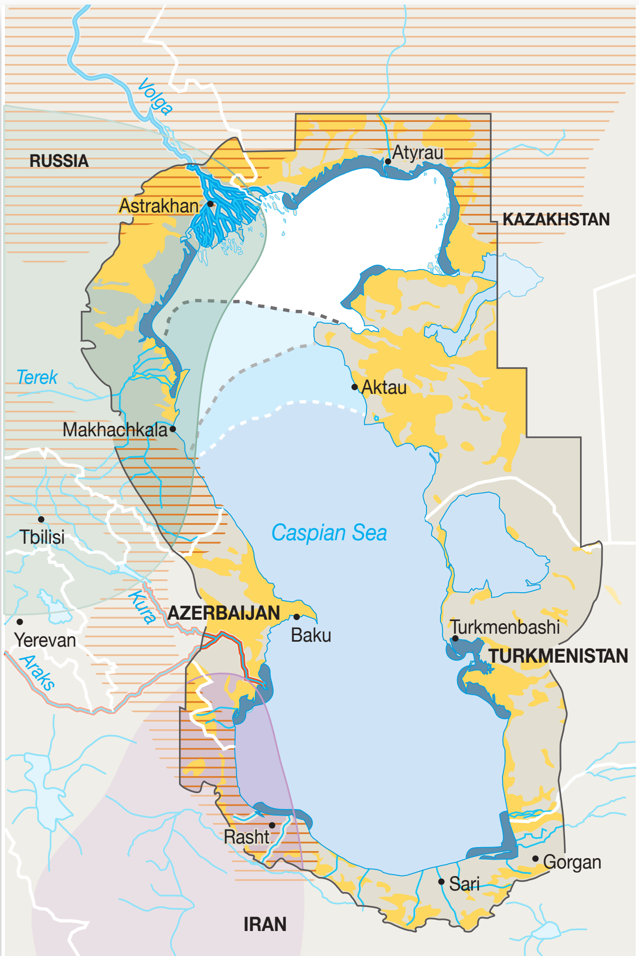
[5] GISS - the balanced model of the Goddard Institute of Space Studies, USA; CCC - the balanced model of the Canadian Climate Center; UK89 - the balanced model of the United Kingdom Meteorological Agency; GFDL - the balanced model of the Geophysical Fluid Dynamics Laboratory, University of Princeton, USA; GFDL-T - the unbalanced model of the Geophysical Fluid Dynamics Laboratory, University of Princeton, USA.

els. The Sea is known to have had peaks and lows ranging from +50 m to -80 m over the last 100,000 years – a fluctuation in levels of some 130 meters during the period.

At present, most scientists seem to agree that climate change plays a significant role in sea level fluctuations in the Caspian Sea, since temperature increases and changes in precipitation directly impact the overall water balance – termed total inflow and evaporation (Panin 2006).

Water inflows into the Caspian Sea are mainly determined by the Volga River, the largest river in the Caspian Basin, contributing more than 80% of total run off. Water levels in the Volga River also fluctuate, reflecting climate conditions and water demand and also influenced by the numbers of reservoirs and dams constructed on the river. The Volga's lowest levels were noted in 1977 and 1937 - 148 and 161 km^3 respectively; the highest levels were in 1926 and 1990 - 382 and 356 km^3 respectively. The average volume of Volga flow during an observed period is 243 km^3. However, flows are irregular: 30 per cent of annual water flows usually occur during the three months of spring, while only 11% is accounted for in the winter months (December-March) (Panin 2006). The Fourth National Communication of the Russian Federation notes that, with projected regional increases in temperature and precipitation, annual water flows in the Volga Basin could increase by 30 to 45% (UNFCCC 2009b).

Changes and rapid fluctuations of the mean sea level in the Caspian Sea occurred in the late 1970s when, following a long period of rainfalls, sea levels started to rise rapidly. In 1977, the sea level was -29 m, considered to be the lowest in 400 years. In subsequent years, sea levels rose, rising at the rate of +20.4 cm a year between October 1992 and June 1995. Then, in mid 1995, the sea level started to drop abruptly, a trend still



Selected impacts of climate change in the Caspian basin

On atmosphere

Strong increase in temperature during the cold season (more than 4.5 °C) for 2070-2099 period

On land and sea

Severe desertification

Precipitation increase recorded in 2010

Precipitation decrease recorded in 2010

Risk of flooding due to storm surges and sea level fluctuation

On sea ice

Boundaries of drifting ice during severe winters, late 1990s

Boundaries of drifting ice during moderate winters, late 1990s

Ice extent (including drifting ice) as of 01 February 2010

On water basins

River runoff increasing

Reduction of water resources due to temperature increase

Note: Precipitation variations indicate the increase or decrease between August-October 2010 and August-October's mean for 1979-2000.

0 100 200 km

Sources: Caspian Environment Programme, *Transboundary Diagnostic Analysis Revisit,* 2007; Panin, G. N., Climate Change and Vulnerability Assessment Report for the Caspian Basin, 2006; Kuderov, T., Climate Change and Vulnerability Assessment Report for Kazakhstan, 2006, and *Sea ice cover in the Caspian and Aral Seas, 2004*; Elguindi N. and Giorgi F. Simulating future Caspian sea level changes using regional climate model outputs, 2006; Global Forest Watch, on-line database, accessed on May 2010; Philippe Rekacevicz, Vital Caspian Graphics, 2006; International Research Institute for Climate and Society, Cmaps on line, accessed november 2010. .

evident in 2001. On average, the seasonal sea level variability did not exceed 25 cm during the period 1992-2003 (Lebedev 2005).

While there is general scientific agreement on the cause of such fluctuations, there is no agreement as to the extent climate change affects such events. At present, only limited assessments of the implications of climate change are available. Meanwhile, computer modeled estimates carried out in littoral states vary considerably - some predicting a drop of as much as 4.5 m while others forecast a rise of as much as 6.4 m.

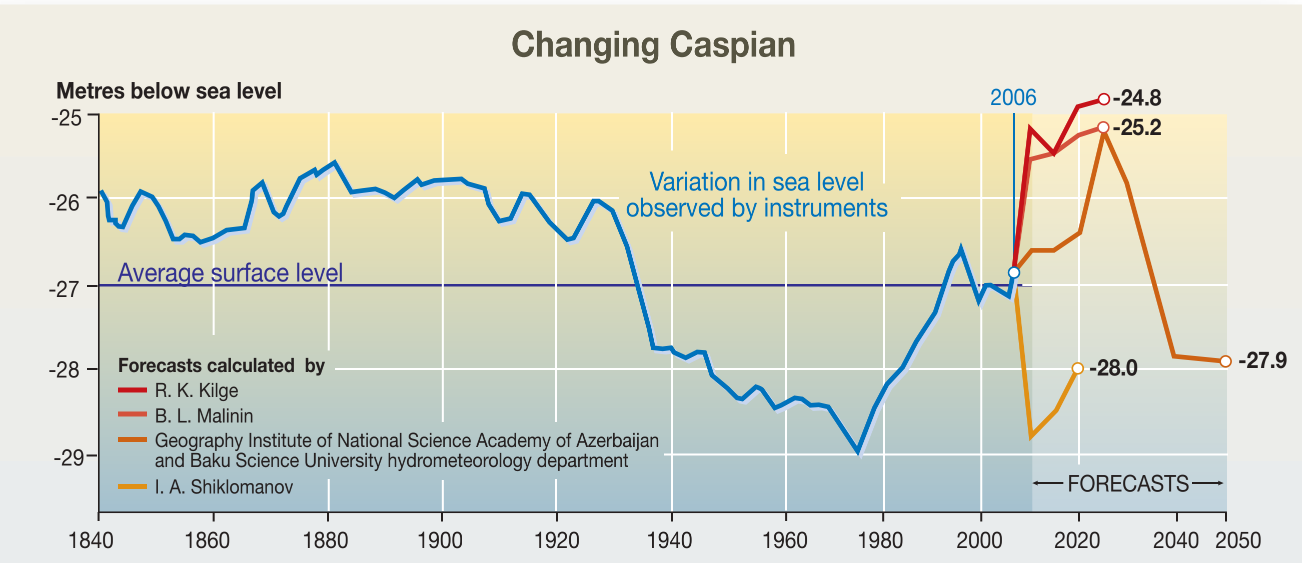
Even given maximum water inflows into the Caspian Sea, it seems very unlikely the sea level will exceed the marks of -25 m during the short to medium term (Panin 2006).

Applying different computer modules, based on an estimate of a doubling of carbon dioxide concentrations, Kazakh researchers concluded that with an annual water consumption (from rivers) of 40 km^3: the Caspian Sea may rise by 4.7 m according to the CCC model, by 6.4 m according to the UKMO model, and by 1.0 m according to the GFDL model (Kudekov 2006).

However, modeling analysis must to be handled with caution. In the past, forecasts have resulted in expectations of a catastrophic sea level decrease and the planning of mitigation projects. Such forecasts have been contradicted by events: a considerable rise in sea levels (by almost 3 m since 1977) has caused significant damage (UNEP, 1995).

Renssen as well as Elguindi and Giorgi use the model based on the A1b anthropogenic emission scenario and predict a 4.5 m sea level decrease in the 21st century (Renssen et al, 2007; Elguindi and Giorgi, 2007). They say that potentially devastating consequences for the economy and environment of the region are likely to be caused by climate change and increased evaporation loss from the basin (particularly over the sea) — exceeding cold season precipitation in the area. And if fluctuations in sea level are in the range of elevations of - 25 to - 29 m, coastal areas are likely to suffer serious environmental consequences, curtailing economic activity.

The Caspian littoral states are understandably concerned about the financial and human costs of fluctuations in sea level. In June 1992,



Source: Panin, G., N., Transboundary Diagnostic Analysis. Climate Change and Vulnerability Assessment Report for the Caspian Basin, 2007.

Turkmenistan agreed to break the artificial dam built in 1980 which blocked the Kara-Bogaz-Gol Gulf, allowing the outflow from the main water body into the bay – where the evaporation rate is much higher – in order to encourage a decrease in sea levels. This resulted in a 15 cm decrease, indicating that a regulating structure in the strait connecting the Caspian Sea and the Kara-Bogaz-Gol Gulf is needed. Such a structure could be beneficial to all Caspian Sea countries, as it would potentially offset the problems associated with sea level fluctuations (Panin 2006).

Various studies carried out by Caspian Sea littoral states vary greatly. In some countries, for example in Kazakhstan, flood defense measures are already being designed — in tandem with the development of oil resources on the north-east shelf — while in other states, planning is only just beginning (CEP 2007a).

Manifestation of climate change

Apart from sea level rise, climate change has already manifested itself through an increasing number of natural disasters in the region such as droughts, floods, dust storms, mud flows, desertification and other serious problems.

Contrasting rainfall trends have been observed in the Caspian Sea region. Rainfall over Russia has increased over the last century, while flooding incidents in the Caucasus and Elburz mountain valleys have dramatically increased, resulting in considerable loss of lives and widespread economic damage. At the same time, Iran is among those which have been severely affected by droughts.

Climate change-related land degradation or desertification is another phenomenon affecting all Caspian Sea littoral states. In the normal course of events, a lack of rainfall and extreme summer evaporation result in a high level of aridity in the Caspian Sea region, especially in coastal areas of Kazakhstan and Turkmenistan. But deserts and desertification are not limited to the eastern part of the Caspian Sea coastal zone. Land degradation hot spots stretch all around the Caspian Sea, caused by differing factors. The areas most prone to degradation are in Kazakhstan, due to degradation of vegetation and soil through oil and gas production. Flooding incidents from 1979 to 1995 and increased salinization led to further adverse consequences. The most important factor leading to degradation in Russian territories surrounding the Caspian Sea — mainly in Chernije Zemli (Black Lands) region in the Kalmykhian Republic — is wind erosion. In the more humid coastal areas of Iran and Azerbaijan, where rainfall is more than 600-1000 mm/year, deforestation and water erosion result in the degradation of vegetation. One of the main environmental problems of flatlands in the south of Turkmenistan remains high salinity

Regional land degradation

Source: *Transboundary Diagnostic Analysis for the Caspian Sea*, Caspian Environment Programme, 2002.

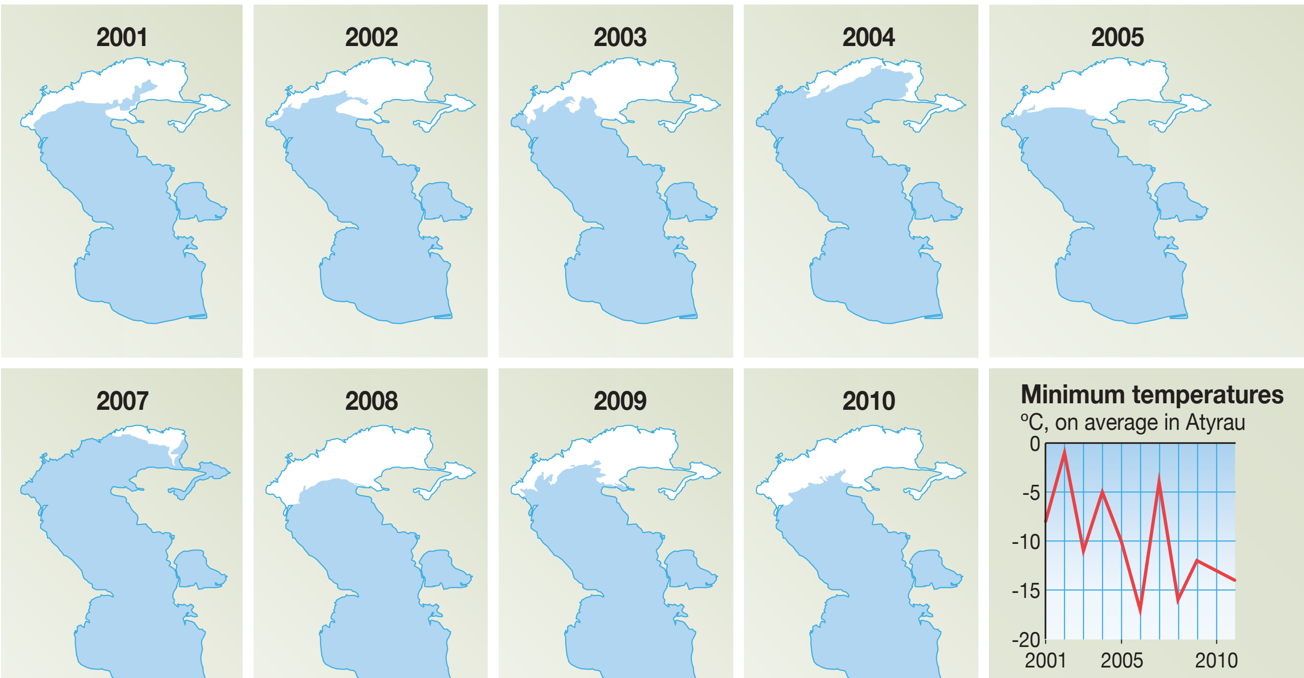
of soils (CEP website).

There have been several severe droughts in various parts of the Caspian Sea region in recent years. These would seem to confirm scientific models which, in addition to higher mean temperatures, generally predict more extreme weather events. Droughts affect both crop production and the health of livestock. For example, in Turkmenistan the breeding of Karakul sheep is closely linked to air temperature. In addition to the loss of agricultural productivity, droughts can increase the frequency and severity of fires, which may destroy grassland and crops (UNEP/GRID-Arendal 2006).

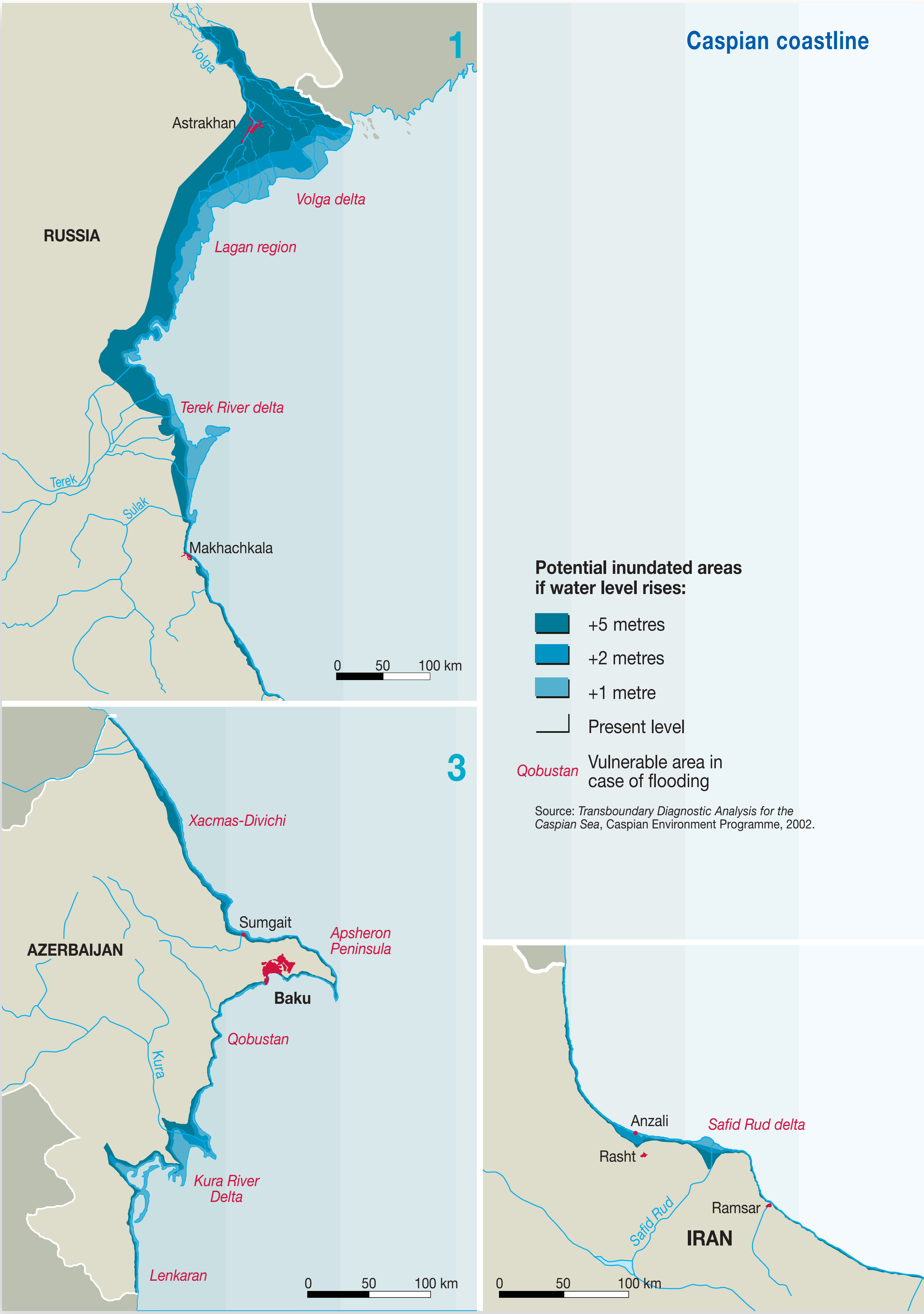
The availability of freshwater on which many sectors of the economy – and human well-being – depend, is also linked to more remote climatic processes. If glaciers in the Caucasus and Elburz mountains recede and the periods of snow cover become shorter — as has been the case in recent years —, less water will be available for irrigation and for domestic use. Warmer mean temperatures also increase the risk of natural disasters associated with changing environmental conditions. For example, in the last 30 years, mud flows in the Terek Basin in northeast Caucasus have occurred almost annually (ENVSEC 2004). Meanwhile, heavy rains during the spring of 2010 caused flooding in 20 villages surrounding the Kura River in Azerbaijan, destroying about 50,000 ha of farmland and causing an increase in numbers of internally displaced people (Eurasia News May 25, 2010).

Higher winter temperatures may be attributed to changes in global climate observed in recent years. While the hypothesis of a warming trend is still under consideration, several possible consequences are already visible in the Caspian Sea region. There has been a reduction in both the duration of the ice season and in the length of winters since the winter of 1993/1994 (Kouraev 2004). This has already affected the living conditions of the Caspian seal - listed as vulnerable on the IUCN Red List of Threatened Species - degrading its breeding conditions (CEP 2007a).

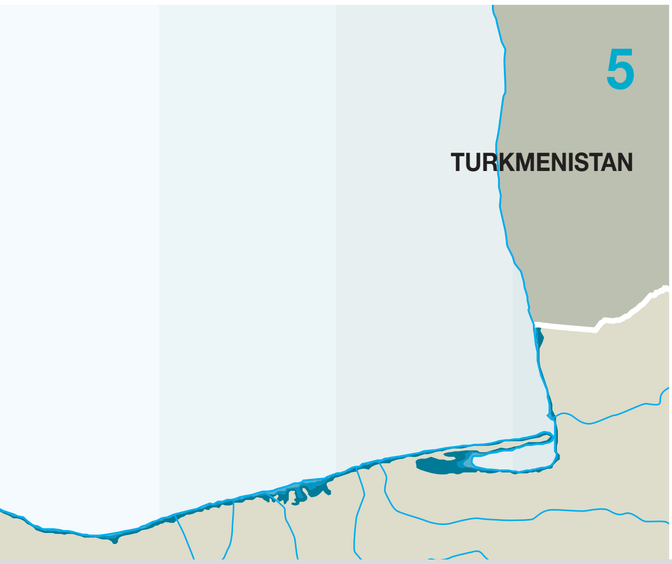
Caspian Sea ice extent



Source: MED-Ingegneria analysis based on MODIS documents


Caspian coastline
1
Volga
Astrakhan
RUSSIA
Volga delta
Lagan region
Terek River delta
Terek
Sulak
Makhachkala
0 50 100 km
3
Xacmas-Divichi
Sumgait
Apsheron Peninsula
AZERBAIJAN
Baku
Qobustan
Kura
Kura River Delta
Lenkaran
0 50 100 km
Anzali
Safid Rud delta
Rasht
Safid Rud
Ramsar
IRAN
0 50 100 km
Potential inundated areas if water level rises:
+5 metres
+2 metres
+1 metre
Present level
Qobustan Vulnerable area in case of flooding
Source: Transboundary Diagnostic Analysis for the Caspian Sea, Caspian Environment Programme, 2002.

vulnerable to flooding



There is a lack of reliable data, information and analysis on the impacts of climate change on the Caspian Basin, particularly its impact on water level fluctuations and related social, environmental and economic consequences. This is partly due to a lack of resources, but is also due to a lack of awareness on the impact and cost of climate change in some countries and the need for mitigation and adaptation measures in order to lessen economic losses.

The institutional and legal framework for regional cooperation on issues regarding climate change and water level fluctuations is also weak and not in tune with other regional and international bodies dealing with related issues.

Caspian Sea littoral states should further develop trust and confidence-building measures that will ultimately lead to greater regional cooperation. This would enable states to respond more effectively to new challenges, including climate change (ENVSEC).

The Caspian Framework Convention for the Protection of the Marine Environment of the Caspian Sea (Tehran Convention), which came into force in 2006, provides a mechanism for regional cooperation on issues related to climate change in general terms, but littoral states must make commitments, effectively addressing and collectively dealing with the challenges of the region.

6. Impact

6.1. Consequences on social and economic sectors

The health and well-being of residents in the Caspian Sea coastal area are critical indicators linked to the overall environmental situation. The pressures created by anthropogenic or natural changes, including decline in biodiversity, pollution or wastes, could consequently impact the livelihood of the populations. The consequences of changes in the overall environment are usually reflected in environmentally sensitive sectors, such as agriculture and fisheries.

Changes in climate, usually reflected by changes in atmospheric conditions, can affect all sectors of the economy, particularly the agricultural sector where production depends on soil productivity and regular applications of water and other inputs. In Turkmenistan for instance, water resources are most vulnerable to climate change, and agriculture is the most vulnerable sector of the economy (Atamuradova). According to the climate change model UK 89 calculations, the pasture efficiency in Turkmenistan could decrease by 10-15 per cent. Experts estimate that the number of lambs could decrease by 5-25 per cent, and wool production by 10-20 per cent (Atamuradova). Over an extended period, climate change can also impact many other sectors, influencing water quality, water levels, soils and biological diversity.

The depletion of biological resources can have a knock-on effect — also depleting various other parts of the economy. In the Caspian Sea region, the fisheries sector is particularly affected by such depletions of biological resources, both at the large-scale industrial level and within coastal communities with a large dependence on fish as a food resource. The depletion of fish and seal stocks, as a result of deteriorating habitat conditions and unsustainable use of fishery resources, negatively affects the economic performance of the sector and the social conditions of coastal communities.

Changes in sea levels might also have a negative effect on coastal infrastructure. Increases in sea levels could contribute to water pollution from waste dump sites, abandoned oil wells and other intrusions. An indirect consequence of sea level change is the potential loss of aesthetic values in coastal areas resulting, among other things, in a possible loss of tourism (Panin 2007).

The Agricultural sector

In the Caspian Sea region as a whole, there is a general decline in agriculture as a percentage of GDP. This is largely due to an increase in industrial production in the area, particularly with increases in oil production and consequent increases in earnings. The decline in agricultural production is also due to a general decline in state subsidies for farming: these were a major factor underpinning production during the Soviet era (CEP 2007a).

In **Azerbaijan,** the agricultural sector percentage share of GDP is steadily falling: agricultural production represented 17 per cent of national GDP in 2000, falling to 6 per cent in 2009 (WB 2010, State Statistical Committee of the Republic of Azerbaijan).

In **Iran,** the agricultural and fishery sectors constitute more than 25 per cent of the economy in the coastal provinces of Gilan, Golistan and Mazandaran (18%, 33% and 27% respectively), which is considerably higher than in the country as a whole (11%). The share of employment in agriculture and fisheries has changed little in recent years - from 32 per cent of total employment in 2004 to 29 per cent in 2008 (CEP 2007e).

Arid areas of **Kazakhstan** are used for sheep, goat, camel and horse farming in order to supply the rising demand for meat, milk and wool: neither Atyrau nor Mangystau oblasts contribute significantly to agricultural production. In Kazakhstan's Caspian Sea areas, agricultural production (in monetary terms) has increased over the past decade, though there has been a decrease in the productivity of land in some areas. In Atyrau oblast, agricultural activities have decreased, es-

Table 5. Yield of wheat in Caspian Sea littoral states, tonnes/hectares

Country	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Azerbaijan										
Whole country*	2.38	2.65	2.67	2.65	2.65	2.65	2.65	2.71	2.79	2.66
Iran, Islamic Republic of (including irrigated)**	1.7	1.99	2.1	2.21	2.06	2.37	2.2	1.56	2.03	
Golestan(rainfed only)						2.22				
Guilan(rainfed only)						1.03				
Mazandaran(rainfed only)						1.21				
Kazakhstan										
Atyrau oblast***	0.96	0.57	0.53	1.18	0.31	0.11	0.09	0.12	0.65	
Mangystau oblast	na	na	na	Na	na	na	na	na	na	na
Russian Federation****										
Astrakhan oblast									1.21	1.79
Dagestan, Republic of									2.25	1.79
Kalmykiya, Republic of									1.81	1.5

Source: Source. * - http://www.azstat.org/statinfo/agriculture/en/index.shtml; ** - FAOSTAT database at http:// faostat.fao.org;*** - http://www.atyrau.stat.kz; ****-

pecially in the livestock sector, and investments have fallen to an average of 0.035 per cent of the total investments during the period 2005-2009. While nominal monthly wages in agriculture over the same period increased almost twice (103% for Mangistau and 102% for Atyrau), they still only amount to about 26% of average monthly wages in the region (The Agency of Statistics of the Republic of Kazakhstan, Department of Statistics of Atyrau region and Mangystau region).

In the future, envisaged climate change, the redistribution of precipitation, an increase of frequency and intensity of droughts based on air temperature increase, will entail negative consequences particularly in agriculture and water management in Kazakhstan (Kudekov 2006).

In other Caspian Sea countries, the agricultural sector percentage share in the national economy has not significantly changed and varies at between 5 to 10 per cent of GDP.

Environmental indicators suggest that crop and soil conditions have deteriorated over time, reflected in the number of abandoned crop production areas.

The crops most dependent on general climatic and environmental conditions are those which are least dependent on fertilizers, irrigation and manual inputs during the growing period. Therefore, the performance of these crops, in terms of production and areas planted, can be used as an indirect indicator of general soil conditions, climatic changes and the overall state of agricultural production.

In the Caspian Sea region, this applies to wheat and other grains, mostly grown without irrigation and not generally requiring other inputs [6]. In Table 5, wheat production in certain areas is compared. While production has increased in Azerbaijan and Iran since 2000, land productivity has decreased in the Caspian Sea regions of the Russian Federation (except Astrakhan) and Kazakhstan.

The production area for wheat and beans in the Russian coastal area of the Caspian Sea has reduced significantly during last 10 years. While the total sowing area was reduced by about 4 per cent in the period 2000-08, the area of land for wheat and bean production was reduced by 11% — from 407.2 thousand hectares to 363.7 thousand hectares (Russian Federation Federal State Statistics

[6] It is to be noted that Turkmenistan's grain production in the east of Balkan velayat requires intensive irrigation. Closer to the Caspian Sea, in the southern areas (Atrek region), there is small-scale dry farming.

Service 2009). A reduction in agricultural land use was also evident in the Atyrau oblast of Kazakhstan, where the wheat production area decreased from 1,170 ha to 520 ha in 2005-09 (The Agency of Statistics of the Republic of Kazakhstan, Department of Statistics of Atyrau region 2010).

Fisheries

Reports indicate that the privatization of fishery production and processing plants in **Azerbaijan** in 2001 resulted in an increase in unemployment and illegal fishing in coastal areas such as Hachmaz, Siazan, Divechi, Lenkoran and Astara (Mamedli 2009). The latest official statistics show that 4,100 were employed in the fishery sector in 2009. Other sources suggest the number of employed in the sector could be around 4,500 (Mamedli 2009). In total, it is estimated that the number of people employed in the fishery sector is between 4,100 and 4,500.[7]

Employment data relating to fisheries in the coastal areas of **Iran** is available only up to 2004. This data shows a reduction in employment of about 2.5 per cent - from 14,558 to 14,213 over the period 2000 to 2004. The number of officially registered vessels on the Caspian Sea coast of Iran has reduced from 1,799 in 1993 (878 in 2000) to 825 in 2003, or by 54% (Shilat).

In the fishery sector of **Kazakhstan,** the offical employment figures show a reduction in numbers of those employed — from 4,989 to 3,667, or 27 per cent, in two coastal regions in the period 2006 to 2009 (The Agency of Statistics of the Republic of Kazakhstan, Department of Statistics of Atyrau region). According to experts, there are 100 boats or 300 fishermen (3 per boat) operating in the coastal watershed illegally (Kim Yu). In Kazakhstan, during the period 2005-09, the average annual investment in the fishery sector of Atyrau oblast was 0.006 per cent of the total investment in the region.

Employment levels in the Caspian Sea fishery sector of the **Russian Federation** shrunk by 22% during the period 2005-07 — from 8,145 to 6,313 (Russian Federation Federal State Statistics Service 2009). The largest decrease was in Astrakhan and Kalmykia (-24% and -28%), while in Dagestan an almost twofold increase in fish catch employment took place during the same period. In Russia, the sharpest decline in the fishery sector was noted in Astrakhan oblast. Official oblast statistics show that the volume of fish catches has shrunk by 3.8 times, falling from 175,000 tonnes to 45,500 tonnes[8]. Investments in the fishery sector fell 2.5 times during 2007-08, from 193,828 million rubles to 100,125 million rubles. Official statistics also indicate that the profitability of investments in the fishery sector was -20.4% in fish catching but +15.2% in fish processing. This indicates that the major share of investments in the fishery sector of Astrakhan oblast went into processing rather than into fishing and hatchery activities.

The reduction of the fishing fleet in **Turkmenistan** has played a major role in a decrease in sector employment. From 2000 to 2008, the fleet was reduced by 29 per cent, mostly involving large boats, with crew levels reduced by at least 42 per cent.

Infrastructure

Sea level rise in the Caspian Sea region has considerable impact on infrastructure. The sea level in the Caspian Sea has been fluctuating for many years - between -26 and -27 metres. Over the past 2,000 years, the range in water level fluctuation has been 7 m, with the lowest sea level observed in the 6th–7th centuries. Between 1880 and 1977, the level of the Caspian Sea dropped four metres — from -25 metres to -29 metres below mean sea level. During this time, local people became accustomed to the gradual drop in water levels and carried out various shoreline activities. The sudden reversal of trends post 1977, with a rise in the water level of about two me-

[7] Official sources state the number of the people employed in fisheries was 4.1 thousand in 2009. Other reports (Saria Tariel Mamedli 2009) suggest that around 980 boats with an average of 4 people in each privately operate in the whole Azerbaijan coast of the Caspian, which makes in total 4,520 (3920+600 officially employed)

[8] On the activities of fishery enterprises of Astrakhan oblast, see Territorial body of Federal Service of State Statistics on Astrakhan oblast, Astrakhan 2009

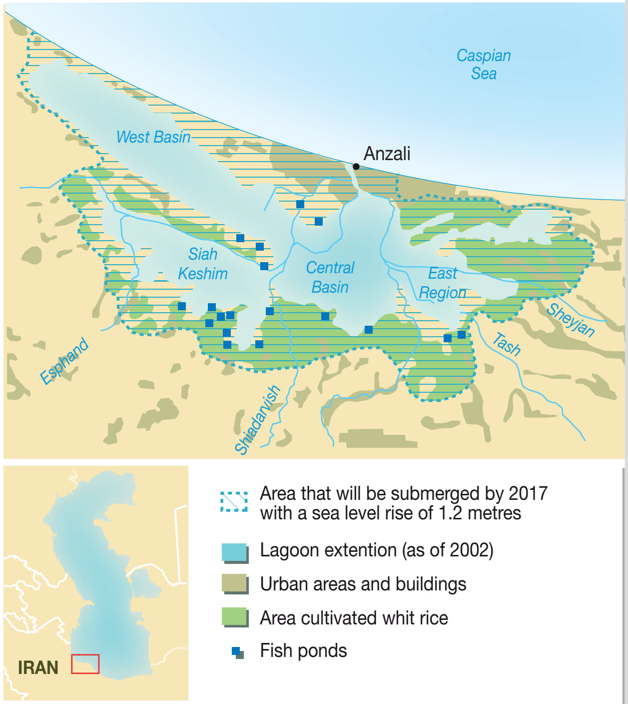
tres, took everyone by surprise and caused widespread problems in several areas. Predicting long-term water fluctuations in the Caspian Sea is difficult due to the unknown impact of factors such as climate change, run off levels from rivers and rates of evaporation from the sea surface.

The immediate effect of sea level rise in the Caspian Sea is flooding in various areas, causing economic damage to coastal infrastructure and industrial entities. The flooding could also result in pollution by hydrocarbons and wastes stored in the coastal zones which can cause significant damage to habitats and to the general water quality. It is believed that, in the near future, the sea level will continue to rise in the Caspian Sea region.

According to the 2007 Transboundary Diagnostic Analyses, more than 48,000 ha of land in Azerbaijan were affected by sea level rise up until 1995. Should the sea level increase to -25 metres, an additional 140 thousand hectares would potentially be impacted (CEP 2007a). A sea level rise of 1.5m will impact four main regions in Azerbaijan.

Flooding in the northern coastal zone from Samur creek to Absheron Peninsula will vary from 50 to 300 metres, resulting in a loss of 8,170 ha of land. The impacted areas will include tourist resorts, 17 industrial enterprises and a 60 km stretch of highway. Flooding of the Absheron Peninsula will have a considerable impact on the urban areas of Baku, Sumgayit, Sangachal, Gobustan, Primorskiy and Pirallahi. In **Turkmenistan**, the induction has negative and positive effects: on one hand habitats like on Osushniye Islands are reducing, on the other - new wetlands in the eastern part of the Turkmenbashi bay are created. There are also threats of flooding on highways including on the 10 km between Sangachal and Primorsky, and on fixed oil platforms, the Oily Rocks and Bibi-Eybat oil fields, Baku harbour and a number of industrial enterprises located along the coast. The total flooded area is estimated to be about 6,010 ha. Flooding in the Kura River Delta

Sea level rise in Anzali Lagoon, Iran



The scenario predict a sea level rise of 1.2 metres assuming a constant rise over a period of 10 years.

Sources: Caspian Environment Programme, *Transboundary Diagnostic Analysis Revisit*, 2007.

– Gizilagach Bay area will impact 10 urban centres and 23 industrial enterprises, while approximately 111,800 ha of land will be lost. Flooding in the Lenkoran-Astara area will lead to the loss of 5,980 ha of land and will impact Lenkoran and Astara and 13 other urban centres.

About 77,800 hectares are currently flooded in **Iran** as a result of sea level rise. Infrastructure is under threat. For example, the power station in Neka region has already been damaged. The rise in sea level has increased the hydrostatic pressure on the underground walls of the power station, and there is great concern that a storm surge may eventually flood the power station itself. The recent flood in Neka caused damage amounting to US$26.5 million (UNOCHA-ROMENACA). The Anzali lagoon and Anzali Port city project has revealed a potential threat of a 1.2 m sea level rise to the project site, not only threatening an internationally important habitat, but also posing a threat to residential houses and port infrastructure (CEP 2007a)

Kazakhstan reports losing more than US$1 billion due to damage related to flooding over the last decade (CEP 2007a). One million hectares of coastal land has been inundated, including 357,000 ha of agricultural land. Large land areas are now under the threat of storm surge flooding, including the city of Aktau, Bautino village, 23 settlements (20 in the Atyrau and 3 in the Mangystau region) and 28 oil and gas fields. Another 19 villages are to be relocated[9], 40 km of railway has to be removed and six other oil fields are to be protected in case of a sea level increase to -25 m. Coastal erosion due to storm surges threatens the Karagol waste field north of Aktau city (CEP 2007a).

Coastal areas in the **Russian Federation** have not been significantly affected by the increase in the sea level. Erosion processes did occur on the banks of Sulak River in Dagestan and in coastal zones of Kalmykiya, but these were compensated by drifts in the Volga River. As in Kazakhstan, a significant threat to infrastructure comes from storm surges, when the sea level could increase by 2.0 metres.

The sea level rise posed a significant threat to communications and oil and gas infrastructure on the Khazar peninsula in Turkmenistan. During the sea level rise of 1995, the peninsula actually became an island, cutting off the population — about 20,000 people – from the mainland. Water and gas pipelines and roads were flooded. The sea level rise and increased size of waves then resulted in damage to coastal areas around the town of Khazar, partially flooding the municipal wastewater processing plant, holiday houses and other structures. In the last decade the situation has stabilized, regular monitoring of the sea level is conducted.

[9] According to the 2007 TDA revisit report, the protection of 17 villages in the Isataysky and Makhambetsky region, and 2 small settlements in the Kurmangazinsky region will not be economically viable, therefore relocation should take place.

6.2. Consequences on environmental services and bioresources

There are many stress factors impacting on the Caspian Sea region's coastal and marine ecosystems and on its biodiversity — some are of natural origin while others are the result of human activities. The most notable stress factors in the region are climate change, sea level rise and desertification. These factors are of complex origin and could be partly anthropogenic and partly the result of natural processes. Though less is known about the influence of earthquakes and underwater volcanoes, these are also important influences on the region's environment. Sedimentation processes, which over the years have been responsible for the formation of present-day conditions in river deltas and wetlands, could also be a significant factor, depositing water surpluses into certain wetland areas and altering fish migration patterns.

Among the main anthropogenic factors impacting the region are the oil industry associated activities, water pollution from various sources and of varying levels of intensity, resource extraction including oil, fishing and hunting, the development of coastal infrastructure, and invasions of exotic species.

Up to the present time, little has been known about the impact of climate change on the region's biodiversity. Climate change does not generally affect habitats directly, but change does take place through factors which are often associated with climate change, such as sea level rise and desertification.

Along the coasts of Azerbaijan, Turkmenistan and Iran, desertification is apparent in several specific locations, though the reasons behind such environmental problems are often very different. There are indications that periodic inundation of the land leads to soil salinization and desertification in the Kura lowlands. In Iran and Azerbaijan, a growth in population in some areas has led to extensive deforestation, with local people using up wood resources for domestic fuel.

The desertification process begins with deforestation and is difficult to stop. On the Turkmenistan coast, desertification is a more natural process due mainly to water shortages and a reduction over time in amounts of precipitation.

A rise in sea levels can lead to the inundation of lowlands. In some locations such inundations can result in the loss or reduction of wetland habitats — as has occurred in the Anzali lagoon in Iran – while in other areas inundations are a positive factor, creating new wetlands – as in Komsomolets Bay in Kazakhstan. While sea level change does not substantially impact most Caspian species, it does affect some – in particular, it leads to the loss of seabird nesting grounds and seal "hauling out" sites – land areas where seals rest.

Earthquakes and underwater volcanoes are a relatively common feature of the region and do not usually have any significant impact on marine habitats and biodiversity levels. However, such events can have the effect of concentrating oil related materials in sea waters; most Caspian species can cope with such events. Volcanic activity was thought to be one of the main reasons behind a mass tulka death in 2000.

Oil extraction, both offshore and onshore, is an actual as well as a potential danger in the region. Luckily, up to the present time, there has not been a large oil spill in the area. Due to the closed nature of the Caspian Sea, such spills have the potential of causing considerable loss of life in seawaters and along the shoreline, causing even small leaks to have a large impact. Oil pollution hot spots include those on the Azerbaijan coast where there are many old oil wells, and where onshore wells near the shoreline presenting a particular problem. Due to the geography of the Kazakhstan coast in the northeast of the Caspian Sea, small changes in sea levels can lead to the inundation of large areas, with many dozen kilometers of seawater intrusion. As a result, oil wells can be inundated and sea waters polluted with oil residues and other toxic substances. The development of the oil industry has also resulted in the presence of larger and smaller vessels in the Caspian Sea and the growth of coastal infrastructure. This has often had a negative impact on various habitats and species, the most important of which is the disturbance of bird nesting and seal pupping cycles.

Water pollution and the accumulation of pollutants at lower depths in the Caspian Sea have long been recognized as having a significant impact on bioresources and biodiversity. Diseases which have affected all sturgeon species are believed to have been the result of long-term exposure to pollutants. There are many sources of pollution in the Caspian Sea region, where river waterways are considered to be the main pollution factor. The pollution might originate far from the Caspian Sea, but due to the Sea's closed nature, pollution accumulates within the its vast basin. The most important pollutants found in the Caspian Basin are heavy metals, and various forms of pesticides and other chemical substances. Though such pollutants have differing origins and effects, they can cause liver disease, other ailments in animals, and even the death of organisms. Many species of phytoplankton and zooplankton are very sensitive to very low concentrations of pollutants and are therefore very vulnerable.

Agriculture is one of the main sources of pollution in the region. Beside pesticides, the agricultural sector also uses large quantities of fertilizers and produces sizeable quantities of livestock waste. Historically, eutrophication was not a problem in the Caspian Sea region. An increase in fertilizer inputs plus the accumulation of livestock waste, along with a rise in temperatures, could have been the cause of a massive algae bloom in the South Caspian Sea in 2005. A similar but smaller bloom appeared again in 2006. However, the reasons for such blooms are not fully understood: climate change – with higher temperatures and less winds experienced over lengthy periods – is one likely cause. Another is seawater plant growth due to fertilizer and livestock waste runoffs.

Hyrdro schemes are not currently a feature of the region, yet dams constructed 30 to 40 years ago are still having a regional impact. The construction of dams altered the water flow of all rivers in the area. The hydrological balance in deltas was changed, with consequent large-scale impacts on wetlands, water temperatures and on other factors. While the long-term impact of these changes is still not fully understood, there is no doubt that the whole ecosystem of the Caspian Sea is affected. One of the clear impacts of the dam construction programme was the interruption of fish migration paths to spawning grounds and the destruction of those spawning areas. In total, about 80% of sturgeon spawning grounds were inundated as a result of dam-building. Sturgeons were cut off from their normal spawning ground in the Volga, Terek, Kura and Sefid-Rud rivers. Over the course of only two generations, this resulted in a dramatic reduction of sturgeon reproductive capacity and an overall decline in bioresources.

Demographic factors such as population growth rarely have a direct impact on habitats and biodiversity. However, demographics can have many indirect consequences, with specific impacts. An increase in population around the Caspian Sea has led to an increase in effluent runoff and more eutrophication. Other features of population growth are developments in coastal infrastructure including recreation centers and roads, and more agricultural activities with the conversion of wild areas to fields and pastures. An increase in night-time lighting can be a significant disturbance factor for birds, particularly in wetlands during nesting periods. Roads can interrupt the natural migration paths of gazelles and other mammals.

Fishing and hunting are traditional human activities in the region and it is now clear that fishing is exhausting many species resources. Stocks of lamprey, sturgeon, tulka, salmon, coregonids and several other species are depleted. The depletion of tulka stocks could have a large impact as it was the most abundant species in the Caspian Sea and functioned as a key part of the Caspian Sea food chain. Many predator species, especially seals, depend on tulka stocks.

Species invasions, both accidental and intentional, have been occurring in the Caspian Sea region for hundreds of years. The majority of these species became integrated into the ecosystem without too much disturbance. However, the recent invasion of the comb jelly or M*nemiopsis liedye*, disturbed the balance of the Caspian Sea ecosystem, resulting in a reduction of zooplankton diversity. This has had a large impact on many fish species, particularly tulka.

7. Response

7.1. Regional-level governance structure

Historically, starting from the 17th century, the Caspian Sea was managed by two major powers—the Russian Empire (later the USSR) and Persia (later Iran). While the two entities had various bilateral agreements, these did not cover environmental issues or contain any declarations about safeguarding the environment of the Caspian Sea region.

After the break-up of the Soviet Union each Caspian littoral state addressed environmental problems separately, largely through existing networks of scientific research institutions such as the Caspian Fishery Research Institute, the St. Petersburg Oceans Institute, the Sturgeon Institute and others. There were also government environmental agencies such as the Department of Environment, Shilat, the USSR Committee on Nature Protection and local authorities. It was only in 1998, with the strong support of the international donor community, that the Caspian Environment Programme came into being, with the aim of encouraging international cooperation between the Caspian Sea littoral states on a number of issues; the main goal was to halt the deterioration of environmental conditions in the Caspian Sea and to promote sustainable development in the area for the long-term benefit of the surrounding population. All Caspian Sea littoral states ratified the Framework Convention for the Protection of the Marine Environment of the Caspian Sea (the Tehran Convention), which entered into force in in 2006 - the most significant legal outome so far of the Caspian Environment Programme.

The Tehran Convention

The Tehran Convention serves as a legal umbrella, specifying general requirements and institutional mechanisms. The objective of the Convention is the protection of the Caspian environment from all sources of pollution including the protection, preservation, restoration and sustainable and rational use of the biological resources of the Caspian Sea. It is based on a number of internationally acknowledged environmental standards including the precautionary principle, the polluter pays principle and the principle of access to information. The Convention includes provisions on the sustainable and prudent use of the living resources of the Caspian Sea, as well as provisions on environmental impact assessment and environmental monitoring, research and development. In addition to the general obligations contained in the Tehran Convention, littoral states are required to take all appropriate measures—individually or jointly—which can help achieve the Convention's objectives; states should also cooperate with international organizations which might help achieve those ends.

Four ancillary Protocols to the Convention are currently under negotiation, with some likely to be signed in the near future. The Protocols cover the four priority areas of concern: 1) Protocol on the Conservation of Biological Diversity, 2) Protocol on the Protection of the Caspian Sea against Pollution from Land-based Sources and Activities, 3) Protocol concerning Regional Preparedness, Response and Cooperation in Combating Oil Pollution Incidents, 4) Protocol on Environmental Impact Assessments in a Transboundary Context.

The first meeting of the Conference of the Parties to the Tehran Convention in 2007 requested UNEP to carry out the functions of the Convention Secretariat ad interim until a permanent Convention Secretariat was established.

The Caspian Environment Programme

The Caspian Environment Programme (CEP) was established as a regional umbrella organization with the mission "to assist the Caspian littoral states to achieve the goal of environmentally sustainable development and management of the Caspian environment for the sake of the long-term benefit for the Caspian inhabitants".

CEP, supported by the littoral states with participation of the European Union (EU), the Global Environment Facility (GEF), the World Bank, the UN Environment Programme (UNEP), the UN Development Programme (UNDP), and the UN Office for Project Services (UNOPS), has been the main driving force behind many important initiatives. CEP has addressed multiple environmental issues by developing an effective coordinated management structure which includes regional thematic centres, strategic and national action plans and various transnational measures such as the Transboundary Diagnostic Analysis, joint monitoring activities and implementation of educational programmes.

At present, the Global Environment Facility (GEF) supports Restoring Depleted Fisheries and Consolidation of a Permanent Regional Environmental Governance Framework or the CASPECO project (2009-2012). The objective of the project is to strengthen regional environmental governance and apply new thinking to the sustainable management and conservation of the Caspian's bioresources (UNDP 2004).

The project has two main components: the first—"Economy-Based Management of Aquatic Bioresources"—focuses on the introduction of ecosystem-based management by establishing new analytical tools, initiating a cohesive monitoring programme and increasing capacity in bioresource governance and management. It seeks to make recommendations on ballast water regional management and to establish a regional M*nemiopsis* control process. Pilot projects aimed at improving the efficiency of hatcheries and rehabilitating or expanding natural spawning grounds for diadromous fish species are also being implemented. Stakeholders are involved through a Special Protection Area (SPA) network of well-established protected areas around the Caspian Sea. A modest matching grant programme will continue to finance small-scale investment projects in local communities.

The second component in the project—"Strengthened Regional Environmental Governance"—aims to support the Tehran Convention and its protocols at the national and regional levels. Apart from institutional support and coordination, the project seeks to engage stakeholders and improve public access to information on the Caspian Sea environment, involving NGOs and creating information-sharing mechanisms through a web-based Caspian Information Centre. The project also aims to coordinate the project with other Caspian Sea initiatives, including promoting partnership with the private sector. This component of the project also helps the update and implementation of the Strategic Convention Action Plan (SCAP) at a regional level, and the National Strategic Caspian Action Plan at a national level.

The International Commission on Aquatic Resources of the Caspian Sea

The International Commission on Aquatic Resources of the Caspian Sea (ICARCS) was created by four littoral states in 1992. The objective of the Commission was to regulate fisheries in the Caspian Sea region by defining the Total Allowable Catch (TAC) and distributing the catch quota regarding major commercial fish species (sturgeon, kilka, seals) between the countries concerned. The Commission also coordinates conservation activities and the sustainable use of Caspian aquatic bioresources. The Commission supports scientific cooperation and data exchange and coordinates scientific research. The Commission constituted four countries until 2003, and was then joined by Iran. The Commission accepts the methodology proposed by specialists at the Caspian Fishery Research Institute (КаспНИРХ) in order to calculate distribution quotas between countries. The methodology is based on the contribution of each country to species reproduction, including volume of freshwater inflow, number of fingerlings from natural spawning grounds, number of released fingerlings from hatcheries, habitat feeding grounds and resources, as well as other indicators. The Commission meets twice a year and works under a two-year rotating chairmanship of each country.

Coordinating Committee on Hydrometeorology and Pollution Monitoring of the Caspian Sea (CASPCOM)

A regional committee of the national agencies aimed at dealing with hydrometeorological activities—CASPCOM—was established in early the 1990s. The committee encourages regional cooperation on meteorological issues. Initially, the main reason for the establishment of CASPCOM was a perceived need for cooperation in the field of environmental monitoring in order to deal with the negative consequences of the rapid sea level rise in 1980-1990, and the subsequent flooding of coastal areas. Since 1995, the sea level has changed only marginally. CASPCOM's role is, however, still important, focusing now on the consequences of the rapid development of economic activities in the region and in areas of the Caspian Sea. CASPCOM meets regularly, but its achievements have been fairly limited, mostly because its activities lack a regional legal and institutional framework (http://caspcom.com/). The Caspian Environment Programme (CEP) and CASPCOM maintain an ongoing dialogue, but activities are limited due to budgetary constraints, the absence of a legal and institutional framework for CASPCOM, and sectoral rivalry.

National-level institutional structures

Analyses of national-level institutional structures are based on a questionnaire requesting Caspian Sea littoral states to list changes or developments in institutional structures at the federal, national or local level that have occurred since January 2008—or in some cases, since 2007—in relation to the environment of the Caspian Sea and adjacent coastal areas. The National Caspian Action Plan was also utilized in order to analyse latest developments.

Azerbaijan: The main party responsible for Caspian environment protection is the Ministry of Ecology and Natural Resources (MENR). Apart from participating in developing the National Caspian Action Plan, Azerbijan has initiated preliminary activities for a strategic environmental assessment (SEA)[10], supported by UNDP and the Environment and Security Initiative. Activities include the analysis of capacity needs, improvement in capacity to perform the SEA and pilot testing of the SEA.

Bioresources management is the responsibility of the Department of Protection and Reproduction of Aquatic Bioresources at the MENR. In 2010, there was a reorganization of the department, aimed at restructuring and strengthening capacities (Questionnaire AZ 2010). The department represents Azerbaijan in the Commission on Aquatic Resources of the Caspian Sea and prepares and approves quotas for sturgeon and other resources. The department, in cooperation with border troops and police, coordinates the protection of resources and has its own fleet division as well as seven regional offices. Scientific support is provided by the Azerbaijan Fishery Scientific Research Institute.

As far as biodiversity is concerned, several new protected areas have been established in recent years, but these are not in the Caspian Sea coastal zone. These are Goygol National Park in Dashkasan and Goranboy regions, Korchay State Nature Reserve, and Zagatala State Nature Sanctuaries in Zagatala and Balakan regions—all established in 2008, Arpachay State Nature Sanctuaries in Nakhichevan and Sharur region, and Rvarud State Nature Sanctuaries in Lerik region—established in 2009 (http://www.eco.gov.az/en/).

The Department of Environmental Protection (MENP) is responsible for pollution control, including solid and liquid wastes monitoring. MENP focuses on nine sectors, which include dangerous wastes, protection of surface water resources, protection of atmospheric conditions plus other ecological issues. The laboratory of the Caspian Complex Environment Mon-

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10 Strategic environment assessment (SEA) is "a range of analytical and participatory approaches that aim to integrate environmental considerations into policies, plans and programmes and to evaluate the inter-linkages with economic and social considerations" (OECD, 2006).

itoring Administration (CCEMA) is responsible for monitoring the environmental status of the Caspian marine environment and has its own fleet, regional divisions and ground laboratories. In order to improve the monitoring of the transboundary Kura and Araz rivers, two laboratories under the National Monitoring Department of MENR have been recently set up. have recently been set up and supplied with the necessary equipment.

A new structural unit under the State Oil Company of the Republic of Azerbaijan has been established to manage and coordinate the clean-up of oil-contaminated areas. A system monitoring pollution control of the environment has also been established (CEP 2007b).

In 2008, by order of the Minister of Ecology and Natural Resources, the Centre for Implementing Measures Against Pollution of the Caspian Sea from Land-based Sources was established under the Department of Environmental Monitoring (Questionnaire AZ 2010). The aim was to ensure coordinated exploitation of modular wastewater treatment stations. In 2008, a Centre for Monitoring and Ensuring Ecological Standard Compliance of Potable Water from the Kura and Araz rivers was established. The aim of the centre was to monitor the quality standards of potable water, in line with environmental standards (Questionnaire AZ 2010).

No institutional changes have been made in regard to air pollution or air quality.

Iran: The Department of the Environment (DoE) is responsible for the management of environmental issues in the country. In 2008, there was a restructuring and reinforcement of the DoE's Marine Environment Division at both the head office in Tehran and in the three Caspian Coastal Provinces' Offices. The aim of the restructuring was to boost monitoring and the enforcement of rules and regulations regarding the protection of the Caspian marine environment (Questionnaire IR 2010).

The initial National Caspian Action Plan (NCAP, 2002) included measures "to develop an environmental assessment programme" under the heading of "Reduction of Contaminants Loads from Land-based Sources of Pollution". With the support of UNDP, the Department of Environment established a project—"Sustainable Development Strategy and Strategic Environmental Assessment (SEA): enabling activities and capacity building". The project includes capacity building and training; needs assessment in energy, transport and water sectors; creating a SEA national regulatory framework; facilitating knowledge sharing for stakeholders, and creating and enabling the right conditions for the achievement of Millenium Development Goals (MDGs) (http://www.undp.org/fssd/priorityareas/sea.html).

The management of fishery resources and aquaculture are the responsibility of the Iranian Fisheries Organization (Shilat). The organization is responsible for data on fishing stocks and for issuing licenses. It supervises fishing and fish processing. Shilat has five main offices and 50 fishing stations (WB 2009). The questionnaire reveals poor governance and imperfect management concerning exploitation of marine bioresources. It also reports poor enforcement capabilities at the lower level. More coordination, as established within the sector of domestic fishery in Iranian rivers, and including the establishment of proper regulatory frameworks, is also needed (Questionnaire IR 2010). No changes were reported on biodiversity protection.

According to the National Strategic Convention Action Plan (NSCAP, 2007), a lack of integrated land and sea use planning and management, together with unsustainable development planning including the construction of roads, constitutes major factors contributing to the unsustainable development of the coastal zone. In 2007, the National Coordination Committee for the implementation of the Integrated Coastal Zone Management Plan of the Caspian Sea (article 63 of the 4th Five-year National Development Plan) was established. The Ministry of Housing and Urban Development is the body's lead institution, with the cooperation of related organizations such as the Department of the Environment and the Ports and Maritime Organization. The aim is to coordinate efforts by local authorities in order to improve the Caspian Sea coastal area environment and also to enforce rules and regulations. In addition, the National Integrated Coastal Zone Management Plan, covering the Persian Gulf, the Sea of Oman and the Caspian Sea, was completed in 2008. The lead agency is the Ports and Maritime Organization (PMO), in cooperation with the relevant authorities.

Kazakhstan: Fishery resources are managed by the Fishery Committee of the Ministry of Agriculture which is responsible for the monitoring, protection and regulation of fishery resources in the country. It is supported by the Kazakh Fisheries Scientific Research Institute (KazNIRh), which has a regional branch in Atyrau. In the Caspian Sea area, the committee is represented by the Ural-Caspian Basin Inter-regional Fishery Inspection Group. No changes were reported in the fisheries sector.

Biodiversity is managed through a network of 76 protected areas (IUCN categories I-V), including strictly protected areas (categories I-II, 1672 thousand ha) and others (categories III-V, 6070 thousand ha). They are supervised by the Committee on Forest and Hunting of the Ministry of Agriculture. In February 2009, the "Akzhayik" State Nature Reserve in the Ural River estuarine sea area was established by the government. Protected areas are, however, limited, making improvement difficult.

Pollution control in the Caspian Sea, including compliance with environmental legislation and surveillance data collection programmes, is provided by territorial divisions or inspectorates of the Ministry of Nature Protection. It has two laboratories, in Aktau and Atyrau. The state agency responsible for Caspian Sea monitoring programmes is the State Enterprise KazHydromet of the Ministry (TACIS 2009). There are several regional hydrometeorological centres of KazHydromet which undertake regular sampling programmes in the Caspian Sea: Mangystau in Aktau city, and one in Atyrau. No institutional changes have been reported.

The main focus of the current system of governance of the Caspian environment is on monitoring capacity. While there have been increased attempts at improving monitoring capacity by both environmental and industrial organizations (GEF project 2007), inefficiencies in the system are seen as a barrier to achieving a better environment (Questionnaire KZ 2010). Another problem is the enforcement of legislation, which is generally weak in regard to prevention and punishment; consequently, there is a high level of poaching, especially by outsiders (Questionnaire KZ 2010).

Russian Federation; Bioresources of the Caspian Sea in the Russian Federation are managed by the Federal Agency for Fishery of the Russian Federation (Rosrybolovstvo). It is an executive authority that has the following functions: conservation of marine biological resources, their protection, rational use, research, preservation, and reproduction of marine biology resources and their habitat (with the exception of marine resources in Specially Protected Natural Territories (SPNTs) of federal importance and listed in the Red Book of the Russian Federation); to exercise control and supervision over marine biology resources and their habitat in the inland waters of the Russian Federation, excluding inland sea waters and the Caspian Sea and the Sea of Azov until their legal status is determined. The Agency adopts the normative legal acts related to: methodology for calculating the amount of damage to aquatic biological resources, the order of fishing for fish breeding, reproduction and acclimatization of marine biological resources, management arrangements for fisheries' reclamation of water bodies. The Agency conducts: a comprehensive study of marine biological resources for conservation and restoration, with the exception of marine resources in SPNTs of federal importance and listed in the Red Book of the Russian Federation. Agency maintains the state inventory of species which are the objects of fishing, as well as state fishing registry, development and presentation for the state environmental review of proposals for total allowable catches of marine biological resources, state monitoring of marine biological resources; approval of an annual total allowable catches of aquatic biological resources in the Caspian Sea, development of federal targeted, departmental and other programs in the mandated activities of the Agency,

The Agency exercises the state control and supervision over compliance with the legislation of the Russian Federation in the sphere of fisheries and conservation of marine biological resources, with the exception of marine resources in specially protected natural reserves of federal importance and listed in the Red Book of the Russian Federation. Agency decides on compulsory termination of the right to harvest (catch) of aquatic biological resources assigned to the objects of fishing.

Scientific support by the Caspian Fisheries Research Institute (KaspNIRKh), producing a resource assessment.

Rosrybolovstvo together with the Marine Inspection border services and special units of the Ministry of Interior, provides protection of fisheries resources.

The Ministry of Natural Resources and Environment performs the functions of public policy and legal regulation in the field of study, use, reproduction and protection of natural resources, the field of hydro-meteorology, environmental monitoring, as well as environmental protection, including matters pertaining to the production and consumption waste treatment, SPNTs and state environmental expertise. Ministry of Natural Resources and Environment of Russia issues normative legal acts concerning:

- Standards for emissions of pollutants into the environment;
- Methodological guidance on the drafting of standards for waste production and quotas on its placing, as well as management of the state register of waste disposal facilities;
- Methodological documents on the fines for a negative impact on the environment and the methodology for calculating the damages caused to the environment;
- Maintenance of the state cadastre of SPNTs and objects of wildlife;
- Organization and implementation of state environmental monitoring and management of the Unified state database on the environment;
- Requirements for the assessment of the impact of materials on the environment.

A lack in the effectiveness of enforcement mechanisms, including measures to counteract poaching, is seen as a serious barrier to the improvement of the Caspian environment (Questionnaire RF 2010). More effective enforcement would greatly improve the situation, particularly relating to poaching in the region. The lack of cooperation between countries to prevent poaching is acknowledged as a problem by the Russian Federation. The establishment of a bilateral system of cross-border cooperation between Russia and Kazakhstan would improve the situation regarding illegal extractions of the resources, especially in Kazakhstan rivers, currently the main poaching area in the North Caspian Sea region (WB 2009).

Turkmenistan: Aquatic resources are managed and controlled by the State Committee for Fisheries of Turkmenistan (Goskomrybhoz), who is also responsible for the use of biological resources and licensing procedures. In addition, Goskomrybhoz compiles a list of prohibited activities and describes the powers of state inspectors. The committee has a fishing inspection of Turkmenistan, which is responsible for monitoring compliance with laws and use of fish resources in the Caspian Sea.

The Ministry of Nature Protection of Turkmenistan is a state body which controls compliance with environmental legislation, oversees protection of ecosystems and natural resources, including flora and fauna, the marine environment and natural resources in the territorial waters of Turkmenistan. Balkan velayat environmental protection Department of the Ministry of Nature

Protection monitors compliance with environmental legislation in the Balkan velayat. Service "Caspecocontrol" of the Ministry of Nature Protection is continuously controlling and monitoring the state of the environment of the Turkmen sector of the Caspian Sea and its coastal zones, the implementation of environmental regulations by foreign national oil companies, and other commercial entities.

The State Enterprise on Caspian Issues under the President of Turkmenistan is responsible for the sustainable development of the Turkmenistan sector of the Caspian Sea. Its main objectives include Caspian Sea delimitation, sustainable development planning and other issues.

In 2007, the Interagency Commission of Turkmenistan on Caspian Sea issues was established to coordinate all economic activities carried out on the coast of the Caspian Sea. This includes the evaluation of projects carried out, and the establishment of international cooperation agreements in the field of navigation, environment protection, and hydrometeorology. The commission also provides recommendations concerning improvements in national legislation of the Caspian Sea (Questionnaire TK 2010).

In regard to climate change, an interagency commission on Mechanisms of Pure Development (MPD) of the Kyoto Protocol of the United Nations Framework Convention on Climate Change was established in 2009 (Questionnaire TK 2010).

In connection with oil exploitation and transportation, the primary environmental concern in the Caspian Sea region focuses on what response can be given in the event of any potential emergency in the coastal areas of Turkmenistan. At present it is the Department of reaction to emrgency situations within the Ministry of Defence. The State Service of Maritime and River Transport of Turkmenistan responsible for management of ports, is also responsible for oil spills in port areas. Foreign oil companies operating offshore, have their own plans for the prevention and response to oil spills. Water quality monitoring is performed by "Caspecocontrol", which compiles monthly monitoring reports for the whole Caspian coast of Turkmenistan.

7.2. Policy and legislation

Analyses of the development of legislation in the various Caspian Sea littoral states are based on the questionnaire which requested these states to list the acts, regulations, decrees and other executive and legal and legislative instruments at a federal, national or local level relating to the environment of the Caspian Sea and adjacent coastal areas. Such legislation shall have been enforced since January 2008, and shall have been seen to have had a noticeable impact on the region's environment. The questionnaire asked to what extent such changes have taken place in line with the provisions and/or implementation of the Tehran Convention, the Strategic Caspian Action Programme (SCAP) and associated protocols.

Directly relating to the Caspian Sea, there are two main streams of documents, namely, SCAP and the five National Caspian Action Plans (NCAP) developed under the Caspian Environment Programme (CEP). Until 2007, The SCAP and NCAPs, in most cases, were without direct legal status; however, there were some examples of enforced legislation that aimed to achieve the same environmental objectives as the SCAP/NCAPs (CEP 2007a). As of today, Turkmenistan has approved the NCAP through the presidential decree in early 2008. The NCAP of the Russian Federation was agreed upon (approved) by Caspian administrative units in 2007, i.e. Astrakhan oblast, the Republic of Dagestan and the Republic of Kalmykiya of the Russian Federation.

Changes in legislation relating to the Caspian Sea environment are presented in Table 7. These changes, compared with the environmental quality objectives (EQO) of the existing Regional Strategic Action Plan for the Caspian States, are also shown (minus the public participation objective). These legislative changes were adopted by the Caspian Sea littoral states under the Caspian Environment Programme.

Decline in biodiversity

Azerbaijan has adopted rules governing trade in endangered species. **Iran** has introduced a decree allowing the privatization of fishing harbours, which aims to reduce the pressure on Caspian Sea biological resources, mainly fish species, by allowing alternative activities in these harbours. **Kazakhstan** has adopted a number of measures aimed at halting the decline in biodiversity in its fishery sector. These include the introduction of a monopoly on sturgeon catches and processing; the introduction of a "zero" charge for the use of resources; adoption of rules governing internationally important wetlands and a listing of such wetlands. A state monopoly on sturgeon fishing in natural habitats, including processing and caviar marketing, will be initiated in January 2011 in Kazakhstan (Questionnaire KZ 2010). The main goal is to improve conservation efforts and fishery efficiency in the most significant areas. In order to create favourable conditions for marine fishery development, a zero interest rate policy relating to the exploitation of marine fish species was approved by a governmental resolution in 2007. This has attracted investments in fishery and fish processing sectors. On top of that, in 2010, Kazakhstan initiated a moratorium on commercial fishing of sturgeon until 2015.

Turkmenistan joined the Convention on Wetlands of International Importance (the Ramsar Convention) and, in 2008, the Cartagena Protocol on Biosafety of the Biodiversity Convention.

Resource extraction

Two countries have joined international conventions relating to pollution caused by the extraction and transportation of resources. In 2010, **Azerbaijan** joined the International Convention On Civil Liability for Bunker Oil Pollution Damage; **Turkmenistan** joined the same convention in 2008. Moreover, in 2008, Turkmenistan has adopted a new version of the Law "On Hydrocarbon Resources", which meets all international standards, including those, which apply to the use of equipment.

In addition, Turkmenistan also joined two conventions relating to potential oil spills.

A special chapter governing economic and other activities in the state protected area of the Northern part of the Caspian Sea of the Ecological Code of the **Republic of Kazakhstan** adopted in 2007 provides the legislative framework for safeguarding protected areas and safeguarding habitats from oil pollution.

Runoffs

Azerbaijan adopted legislation in 2008 relating to improved wastewater management under the Administrative Order "On Additional Measures for the Protection of the Caspian Sea from Pollution". The main purpose of the Order was to construct wastewater treatment modular units on the Absheron Peninsula coast, along the Nardaran-Sumgait and Gurgan-Sangachal routes.

Azerbaijan also adopted two additional measures in 2008-09, improving the provision of clean water services to the population. In 2008, based on the decree "On Certain Measures for Improving Provision of the Population with Ecologically Clean Potable Water", activities were initiated aimed at providing clean, safe and potable water to remote settlements. In 2009, an Administrative Order "On Additional Measures to Ensure Water Supply to Population" was enforced.

The new Water Code (2007) and the Water Strategy Action Plan (2009), adopted by the **Russian Federation**, include provisions for the sustainable use of water resources, including services that supply clean water.

It should also be noted that in the Russian Federation major companies and associations engaged in economic activities in mining, transportation and processing of hydrocarbons and other natural resources establish standards to ensure the environmental safety of their production activities to meet the requirements of Russian and international legal acts. For example, in 2009, the public corporation "Gazprom" developed and adopted a series of standards for environmental

Table 7. **Improvement**

Items (general and following Environmental Quality Objectives)	Azerbaijan	Iran, Islamic Republic of
Overarching items		
EQO: Conservation and sustainable use of bioresources (fishstock)		
EQO: Conservation of biodiversity	● Law "On Ecological Agriculture" (2008) ● Resolution of the Cabinet of Ministers "On Adoption of Rules Regulating International Trade in Endangered Species of Wild Fauna and Flora" (2009)	
Improve the water quality of the Caspian	● Presidential decree"On Additional Measures for the Protection of the Caspian Sea from Pollution" (2008) ● Law "On Accession to the International Convention "On Civil Liability for Bunker Oil Pollution Damage", of March 23, 2001" (2010)	
EQO: Sustainable development of the coastal zones	● Presidential decree "On Measures to Improve the Greenery Management in the Republic of Azerbaijan" (2008) ● Presidential Decree "On Approval of the Standards for Vibration and Noise Pollution Generating a Negative Impact on the Environment and Human Health" (2008) ● Presidential decree "On Adoption of the Rules for Transboundary Movements of Hazardous Wastes" (2008) ● Presidential decree "On Additional Measures for Improving Provision of the Population with Ecologically Clean Potable Water" (2008) ● Presidential decree "On Additional Greenery Measures in Baku city" (2009)	Privatization of National Fishing Harbors including the Caspian Sea
EQO: Strengthen civil society participation in Caspian environmental stewardship		
Others items	Presidential decree "On Additional Measures to Ensure Water Supply to Population" (2009)	

of legislative settings

Kazakhstan

- Environmental Code of the Republic of Kazakhstan. A special section "Environmental requirements for implementation of economic and other activities in the state protected area in the northern part of Kazakhstan's sector of the Caspian Sea" (2007)
- Resolution "On Setting the "Zero" Rental Rate to Exploitation of Marine Fish Species"(2007)
- Law "On Introducing Amendments and Addenda Related to Fisheries into the Certain Legislative Acts of the Republic of Kazakhstan" (2010)

- Ecological code of Kazakhstan (2007)
- Order "About adoption of the Rules of attribution of water bodies to the wetlands of international and republican importance" (2010)
- Resolution "On Approval of Regulations for Wetlands of International and National Importance" (2010)

Amendments to the Law "On Industrial Safety at Hazardous Production Facilities" (2010)

Russian Federation

- Water Code (2007)
- Action plan to up to 2020 to realize the Water Code
- Energy strategy of Russian Federation (2030)

Turkmenistan

Special decree "Approval of National Caspian Action Plan of Turkmenistan" (2008)

- Decree "About Joining Convention on Wetlands of International Importance, mainly, as Habitats of Waterfowl» (2008)
- Decree «About Joining Cartagena Protocol on Biosafety to the Convention on Biological Diversity» (2008)

- Additions and changes in the law «On Hydrocarbon Resources» (2008)
- Decree about joining "International Convention on Civil Liability for Oil Pollution Damage» (2008)
- Decree "About Joining International Convention for the Prevention of Pollution from Ships» (2009)
- Decree "About joining the Convention on the International Regulations for Preventing Collisions at Sea» (2009)
- Decreee "About Joining International Convention on Civil Liability for Oil Pollution» (2009)

- Sanitary code of Turkmenistan (2009)
- Decree "Concepts of Social and Economic Development Balkan Region for the Period till 2012" (2009)

- "National Program of the President of Turkmenistan on far-reaching changes of social and household conditions of life of population in the villages, settlements, cities, etraps and etrap centers until 2020"
- Decree "About joining the International Convention for the Safety Life at Sea» (2009)
- Resolution «Reliable and Stable Transit of Energy and its Role in Ensuring Sustainable Development and International Cooperation» (2009)

protection, including: The procedure of organization and management of production control for protection of water bodies and air; instructions for calculating emissions, discharges and industrial waste at the transport and storage facilities; Design Guide for the section "Measures for environmental protection" in the design documentation for construction of gas distribution objects and other regulatory documents.

In order to implement the provisions of water legislation of the Russian Federation and normative acts of the Government by the Ministry of Natural Resources and Environment in 2009, a number of legal documents, including: Methods of calculating the amount of damage caused to water bodies due to violation of water legislation; Guidelines for the establishment of sampling (withdrawal) quota from a water facility and wastewater discharge quota, the relevant quality standards, within the boundaries of river basins, sub-basins and water areas, as well as the Conduct of the monitoring of the volume of intake (withdrawal) of water from water bodies and the volume of wastewater and (or) drainage water and their quality by owners of water bodies and water users.

Air emissions

Azerbaijan approved measures in 2008 that aim to improve air quality; these measures include enhanced forest management throughout the country, and the extension of green zones in and around Baku. The Government of Turkmenistan has organized the planting of circa 200 thousand trees in the coastal zone.

Solid waste

Azerbaijan has adopted rules governing the transboundary movement of hazardous wastes. Improving waste management in Baku, in line with modern standards, was another solid waste management measure undertaken.

Other documents

A number of other legislative documents have been adopted which contribute to the implementation of Environmental Quality Objectives. However, they do not apply to the environmental pressures and problems identified in this report, as they tend to be general in nature and not specific to a particular issue.

Among these documents is the legislation of **Azerbaijan** on standards of noise and vibration pollution, which can contribute to the sustainable development of coastal communities.

The **Russian Federation**'s Energy Strategy up to 2030 will significantly improve energy security for Caspian Sea communities.

The signing of "International Convention on Protection of Human Life on the Sea" by **Turkmenistan** will provide security for Caspian Sea communities during emergencies. In 2009 Turkmenistan has adopted a new Sanitary Code, sanitary standards of which cover the whole spectrum of possible effects of environmental conditions on human health, environmental health and environmental safety.

Policy changes

While some policy initiatives adopted by some countries are aimed at bringing about change throughout the nation, and are not solely aimed at the Caspian Sea, other policy initiatives have a more specific approach.

Azerbaijan has endorsed the State Programme for Poverty Reduction and Sustainable Development in the Azerbaijan Republic covering the period 2008-2015. The programme has a strong environmental component, aiming to increase protected areas to 12% (from 11.5% in 2007), reduce greenhouse emissions in the power sector by 20%, achieve full treatment of sewage and wastewater throughout the country, together with various other goals. These activities will definitely have a positive environmental impact on the Caspian Sea region.

Another policy document is the State Programme for the Socio-economic Development of the regions of the **Azerbaijan** Republic for the period 2009-2013 (2009). This document includes measures related to the treatment of wastewater, the construction of water supplies and sanitation systems and the rehabilitation of the Caspian Sea environment and its coastal territories.

Current policy of **Iran** in the Caspian Sea region focuses mainly on the modernization of fishing ports with the aim of diversifying activities, improving operational efficiency and bringing benefits to local communities. A study aimed at developing an operational master plan for fishing harbours is in its final phase. Pressures on the Caspian Sea environment and its resources could be alleviated by improving the efficiency of the fishery industry and by diversifying economic activities among the local population.

Another issue related to the development of Iran's coastal areas is the creation of buffer zones along the shoreline, a move which is supported by presidential decree. The decree stipulates the removal of all physical barriers in the buffer zone in order to provide free access for the population and to reduce uncontrolled pollution sources to the Caspian Sea.

Kazakhstan has adopted a number of policy documents relating to the Caspian Sea environment. The programme of environmental protection for 2008-2010 has a specific task in relation to the Caspian Sea: "2.4: Prevention of pollution of Caspian Sea shelf and adjoining areas". The development programme relating to mineral resources in Kazakhstan for 2003-2010 lists the liquidation and conservation of oil and self-emission hydrogeological wells among its tasks. The implementation of these measures will directly reduce pressures caused by the existing sources of pollution in the sea.

Another set of policy issues is aimed at the improvement of the fishery sector. Measures for sustainable development of the agricultural industrial complex of the Republic of Kazakhstan for 2009-2011, as well as the concept of development of fisheries for 2007-2015, are aimed at the production and economic efficiency of hatcheries and the rational use of water resources. This will have positive impact on fish stocks and mitigate a decline in bioresources.

A policy project regarding the protection of other Caspian Sea bioresources and included within a programme of conservation, ensures the rational use of water resources and fauna, and the development of a network of protected areas up to 2010. Another document, the Scientific Technical Programme "The complex of ecologic-epidemiological research of biocenosis of Caspian water areas and the development of measures for its improvement for 2008-2010", ensures measures for a complex monitoring programme of water conditions, and prepares the way for an improvement in the environment. This will contribute to mitigating a reduction in biodiversity.

Two documents set forth the environmental policy of Caspian Sea coastal areas. The environmental protection programmes of Mangistau (2008-2010) and Atyrau (2006-2008) regions are aimed at achieving an ecological balance—finding favorable living conditions for the local population while at the same time lessening the impact of man-made components on the environment. In general, these two policy documents will contribute to a reduction of pressures on the environment.

7.3. Monitoring and compliance

Monitoring involves the regular gathering of data on different aspects of the environment; it usually includes monitoring water quality, air pollution, species presence and numbers and many other relevant measurements. It is the first and most important part of a lengthy process of decision making aimed at improving the environment and bioresource management. It is also important for measuring the implementation of political commitments already made.

In the Caspian Sea region, the most important agreement is the Framework Convention for the Protection of the Marine Environment of the Caspian Sea and its four protocols—land-based sources of pollution; preparedness, response and cooperation in combating oil spill incidents; environmental impact assessments in a transboundary context. The protocols are expected to be adopted at the COP III. If the various Contracting Parties commit themselves to developing the protocols, then it should follow that these measures aimed at safeguarding the Caspian Sea environment will be implemented: in so doing, a proper legal basis for coordinated decision making will also be adopted.

Up to the present time, no integrated monitoring system in the Caspian Sea has existed. Each country has its own monitoring programme: while the Russian Federation, Azerbaijan and Kazakhstan follow similar methods. In Turkmenistan, the number of organizations, involved in monitoring, is smaller, but the Ministry of Nature Protection, in the framework of the National Caspian Action Plan (NCAP), has implemented in 2009-2010 the upgrade of the "Caspecocontrol" state service with modern equipment for monitoring of the state of Caspian environment.

Meteorological data, air and water quality.

In general, all countries have a network of stations gathering data on water quality, weather conditions and air pollution which is then passed on to National Meteorological Organizations. This network was created in the Soviet era and preserved for many years, with only minor changes. In general, each station makes regular use of a substantial number of parameters including air temperature, humidity, winds, water temperature and currents. Some marine stations also include sea level measurements and a number of other parameters including O2 concentrations, BOD, ion composition and heavy metal concentrations. While this monitoring is ongoing and is the most widely applied in the Caspian Sea region, the Regional Water Quality Monitoring Program notes that "all littoral countries suffer from a lack of dedicated resources, limited analytical capabilities and a lack of proper cooperation and data exchange mechanisms between institutions and countries".

The most recent regional exercise aimed at promoting regional cooperation on environmental protection was the Regional Water Quality Monitoring Programme of 2009 (RWQMP), financed by the TACIS Programme of the European Union (EU). This programme examined the development and implementation of a regional water quality monitoring project, and focused on critical contaminants and hot spots. This has become a key objective in the Strategic Action Programme for the Caspian Sea. The project suffered, however, from Iran's limited involvement caused by its observer status; this was due to eligibility constraints in the TACIS Programme .

The information obtained within the framework of the RWQMP was based on fragmented, ad hoc and incomplete assessments of existing environmental conditions. The information did not originate from any specifically designed marine monitoring programmes, but resulted mostly as a by-product from inspectorate work and diverse scientific research activities. Despite earlier efforts to improve the situation within the TACIS and CEP frameworks, the existing monitoring system is not coordinated. Moreover, differences in legislation, differing priorities in natural resources management, poorly formulated regulations, inadequate use of quality standards, confusion over inspectorate and ambient monitoring functions, and generally poorly defined monitoring programmes signify that the development of an operational system of environmental protection is difficult (RWQMP 2009). The RWQMP includes specific recommendations for the improvement of monitoring capacities; however, the report states that "their implementation will be impossible if there are no detailed plans and schedules adopted at national level and if there is no further development of methodical support centres and research programmes."

A number of specific monitoring activities have taken place in the Caspian Sea region. Ad hoc monitoring of the anomalous algal bloom

(AAB) in the South Caspian Sea was initiated in response to the unprecedented bloom which appeared in August 2005. Monitoring which began in the summer of 2006 was based on remote sensing techniques, with the objective of predicting and identifying an AAB event at an early stage. The three-year monitoring exercise resulted in the recommendation that research be continued.

The rise in sea levels was identified as an event of concern for Caspian Sea littoral states; the most recent revision of the TDA (Transboundary Diagnostic Analysis) for the Caspian Sea recommended that countries jointly address this issue. At present, the various state institutions have their own sea level measuring techniques. A specific study under CEP looked at the situation in Anzali Lagoon, Iran. Again, there is no coordination of such monitoring activities by the various countries.

Pollution

Since 2007, selected programmes and projects on pollution have been initiated, for example, the large-scale "Caspian Water Quality Monitoring and Action Plan for Areas of Pollution Concern (CaspianMAP)" which also included "The Regional Pollution Action Plan for the Caspian Sea (RPAP)." Specific focus has also been given to selected river basins such as the Volga River Delta and the deltas of the Terek and Kura rivers. These projects were undertaken with the aim of meeting a key target of the Strategic Caspian Action Programme—to "undertake a comprehensive regional inventory of pollution emissions from land-based sources." The CaspianMAP noted that quantitative assessments of pollution at a regional scale ceased to exist after the Soviet Era. Consequently, all other activities such as monitoring, the implementation of assessment methods and the development of various areas of competence were also terminated. Various internationally-financed projects focusing on pollution levels in the Caspian Sea have been initiated during the last ten years. The CaspianMAP project concluded that the next phase should focus on qualitative assessments, which would then serve as a basis for the planning of monitoring activities and the assessment of possible protection measures. Issues of regional cooperation would also be examined.

Biodiversity

In 2007, the key recommendation of the TDA was the establishment of a regionally integrated biodiversity monitoring programme based on an agreed-upon Monitoring and Evaluation (M&E) framework, with permanent consultation mechanisms and training programmes for experts within the region. Trends could then be identified, including various changes in the structure of communities related to biodiversity. It also recommended that further ecotoxological studies be undertaken on seals and sturgeon populations to determine the impact of persistent toxic substances on higher trophic levels, especially on the more long-living species. Some remarkable work was done under the Biodiversity Monitoring Programme (BMP) phase of the project entitled "Development of Caspian Sea Coastal Sites Inventory (CCSI) and identification of areas of special importance and/or sensitivity within an ecosystem approach and framework". An international team established optimal protocols for sensitive site monitoring along with methods of data collection and presentation. The team made general recommendations concerning site selection, monitoring objectives, parameters to be measured and measurement techniques to be used. A lack of funding, particularly in regard to monitoring marine sites—requiring the rental of a vessel— was noted as a challenge for overall site monitoring. Another problem noted was the shortage of qualified specialists for field work and general site monitoring. The project also looked at biodiversity monitoring in selected areas, such as annual monitoring of nesting and migratory birds, ongoing seal monitoring and a five-year monitoring programme on Mnemiopsis leidyi abundance in the sea.

All countries apart from Turkmenistan undertake special fishery monitoring. Such activities include some parameters relating to water quality, but mainly concentrate on the presence and abundance of specific species of fish, benthos, zooplankton and phytoplankton. Zooplankton, phytoplankton and benthic communities are observed in order to assess potential food supplies for valuable fish species. Data is gathered several times a year in different seasons and stored at various fishery institutions. Data from such activities is usually made available through the publication of scientific articles or, in some cases, may be obtained by special request. The quality of such data depends to a large extent on the budgets of the various institutions; in many cases, data is shared between countries on a bilateral basis. Data relating to quotas allocation—particularly that relating to fish stocks—is discussed annually by countries at sessions of the Intergovernmental Commission of Aquatic Bioresources (CAB). CAB is the only official regional organization conducting joint fishery-related research and making decisions on the sharing of stocks, including those of sturgeon, tulka and seals. This intergovernmental effort has already resulted in considerably improved cooperation and consultation amongst states with stocks of sturgeon, and has provided a powerful incentive for future collaboration. However, some criticism has been expressed about the scientific and technical expertise of CAB: the TDA said it was "essential to establish and implement a consistent, region-wide benthic and fisheries monitoring programme".

All countries have given their support to monitoring. In general, this covers maximum parameters on both environmental quality (water and air) and on marine biodiversity. Such data is considered to be reliable and complies with international standards. While such monitoring often covers only limited areas for which international oil companies are responsible, there are also regular broader surveys round vast marine areas. This data belongs to oil companies and is only made available by special request.

All specific monitoring activities such as the monitoring of migratory birds or of invasive species were initiated as stand-alone projects for a limited period, constrained by available project funding. Though data is often limited, these monitoring activities often provide a broad outline picture of environmental conditions and biodiversity in the Caspian Sea.

In general, data- and information-sharing is still limited in the region, as the various data is held by different institutions and organizations, and rarely analysed as a whole.

7.4. Public Participation

Effective environmental management should involve the public in the formulation and adoption of decisions relating to the management of natural ecosystems, such as water and land. The state of natural resources, especially water, is of vital importance to everyone since economic well-being and health depend on it. Every citizen has the right to a healthy environment—and every citizen should care about its preservation. The right of the public, and particularly the right of affected stakeholders to participate in decision-making processes, is now widely acknowledged in both national and international law (UNEP, UNDP, TACIS 2009).

A number of reports have been produced as part of an effort to understand levels of public participation in environmental matters in the Caspian Sea region. One such report is the regional Stakeholder Analysis Report carried out in 2001, along with a revised version in 2004 (Matthews 2004). The objectives of these analyses were to identify major stakeholder groups and their interests and impact on the Caspian environment. The revised report observed trends in stakeholder interests and analyzed perceptions and concerns relating to the activities of the Caspian Environment Programme.

Based on the findings of these reports and conclusions reached after a lengthy regional consultation process, the Caspian Environment Programme formulated a Strategy for Civil Society Engagement in the Caspian Sea Marine Environment known as the Public Participation

Strategy (PPS) for the Caspian Sea (UNEP, UNDP, TACIS 2009). The objectives of the strategy are to promote effective mechanisms for public participation and engagement, and to improve public access to information and participation in decision-making processes.

The strategy aims to formulate a comprehensive, long-term agenda which will help in the implementation of the Tehran Convention and its Protocols over a 10-year period; the strategy will be fed into National Action Programmes, supported by the biennial Programmes of Work of the Convention Secretariat.

Several regional projects have helped foster public engagement, including the creation of the Caspian Stakeholders Database (CSD) in 2009. The database includes non-governmental and community-based organizations, academic bodies, media, local authorities and others, supporting communication with and between the major stakeholders and creating partnerships.

Engagement of civil society at the national level

Analyses of stakeholders' engagement in these processes at a national level are based on results of the questionnaire. Littoral states were asked to list the changes and developments in the involvement of stakeholders at the federal, national and local levels initiated or enforced since January 2008—in some cases from 2007. Such developments would be seen to have a noticeable impact on the environment of the Caspian Sea and its adjacent coastal areas. The material compiled—at a national level—does not include the views of non-governmental organizations nor those of others. It provideds a broad picture, but the data in it is limited and could not be verified independently. Therefore, it only provides a rather incomplete picture of what's going on.

Azerbaijan: In 2007, aiming to support the development of stable and efficient cooperation between the state and non-governmental organizations, Azerbaijan developed the idea of a body concerned with State Support to Non-governmental Organizations of the Azerbaijan Republic. Environmental protection is a priority area and NGOs involved in it should receive state support (Questionnaire AZ 2010).

In late 2007, the Council of State Support to Non-governmental Organizations was established. The Council promotes cooperation between the state authorities and NGOs and functions as a dedicated body offering state support to NGOs. In early 2010, the Council, in partnership with the "Garadagh Cement" OJSC, announced a joint call for proposals to finance NGO projects (The Council of State Support to NGO website, Questionnaire AZ 2010).

In 2010, the Community Council was established under the Ministry of Ecology and Natural Resources. It promotes cooperation with environmental NGOs for the implementation of state programmes for environmental protection. It also encourages the involvement of the wider public in nature protection, environmental guidance, education and awareness building (Questionnaire AZ 2010).

Iran: In 2009, the National Agricultural Research Institute, in partnership with the Ministry of Agriculture and the International Sturgeon Research Institute, promoted the idea of rewarding collection of spawn-ready female sturgeon. Those fishing on a small scale were given the possibility of collecting and selling such spawners to fisheries' authorities. This participatory initiative was launched in order that sturgeon could be spawned artificially and then released back into the sea. Through this initiative, fishermen were discouraged from catching mature sturgeon—the reward for selling spawn-ready fish being higher.

Kazakhstan: The National Caspian Action Plan of 2007 has two aims as regards engagement in environmental issues: to increase public awareness of environmental problems and to support public participation in the management of the Caspian Sea environment.

In 2003, an Interdepartmental Commission for stabilizing and protecting the environment was established. The purpose of the Commission was to strengthen coordination of various environment protection activities spread between different ministries, agencies and departments (UNECE 2008). Three meetings of the Interdepartmental Commission were held, with broad public participation. These meetings addressed issues concerning environmental safety in connection with oil operations in the Caspian Sea and also environmental issues linked to economic activities in the Caspian reserve zone. Following the Commission's recommendations, additional environmental measures were included in draft laws on subsoil, exploitation of subsoil resources and oil operations (Questionnaire KZ 2010).

It was reported that representatives of civil society took an active role in Environmental Impact Assessment discussions, which included issues relating to the development of offshore hydrocarbon deposits (Questionnaire KZ 2010).

A lot of work was reported to have been done at the local level in terms of education and raising awareness on environmental issues. In Atyrau oblast in 2006, schoolchildren were awarded diplomas and given gifts for promoting awareness in environmental protection. In Mangystau oblast, "Mangystau ecotourism" magazine has been published in three languages.

Russian Federation: The Government of the Russian Federation in November of 2008 has adopted the "Concept of Long-Term Socio-Economic Development of the Russian Federation until 2020." The Concept defines the goals of environmental policy - a significant improvement in environmental quality and ecological conditions of human life, the formation of a balanced eco-oriented model of economic development and ecologically competitive industrial objects. In August of 2009 the Government approved a package of measures providing for improvement of: standardization in the field of environmental protection, fines for negative environmental impact and environmental performance indicators assessment of the; increase of the efficiency of state environmental control, as well as greater interaction with public environmental organizations in order to involve them in the resolution of environmental problems in the Russian Federation. (Questionnaire RF 2010).

Turkmenistan: According to the questionnaire, the public is regularly informed about conservation in the Caspian Sea region and the area's resources. Such information is published in the «Neutral Turkmenistan» (HT) newspaper and also in «Turkmenistan» magazine.

Acronyms and Abbreviations

AAB Anomalous Algal Bloom
ACL Admissible Concentration Limits
AGIP KCO Agip Kazakhstan North Caspian Operating Company
ASTP At Sea Training Programme
AZ Azerbaijan
bcm Billion Cubic Meters
BMP Biodiversity Monitoring Programme
BODs Biological Oxygen Demand
BP British Petroleum
BTC Baku-Tbilisi-Ceyhan Pipeline
CAB Commission of Aquatic Bioresources
CASPCOM Coordinating Committee on Hydrometeorology and Pollution Monitoring of the Caspian Sea
CASPECO The Caspian Sea: Restoring Depleted Fisheries and Consolidation of a Permanent Regional Environmental Governance Framework Project
CCC Canadian Climate Center
CCEMA Caspian Complex Environment Monitoring Administration
CCSI Caspian Sea Coastal Sites Inventory
CDV Canine Distemper Virus
CEH Caspian Economic Hinterland
CEP Caspian Environment Programme
CO2 Carbon dioxide
COP Conference of Parties
CPC Caspian Pipeline Consortium
CSD Caspian Stakeholders Database
DDE Dichlorodiphenyldichloroethylene
DDT Dichlorodiphenyltrichloroethane, an insecticide
DoE Department of the Environment
DPSIR Driving Forces-Pressures-State-Impacts-Responses
EIA Energy Information Administration
ENVSEC Environment and Security Initiative
EQO Environmental Quality Objectives
ERL Effects Range Low
EU European Union
FAO Food and Agriculture Organization of the United Nations
GDP Gross domestic product
GEF Global Environment Facility
GEO Global Environment Outlook
GFDL Geophysical Fluid Dynamics Laboratory
Gg Giga gram
GHG Greenhouse gas
GISS Goddard Institute for Space Studies
GIWA Global International Waters Assessment
GRID Global Resource Information Database
HCB Hexachlorobenzene, a fungicide
HCH Hexachlorocyclohexane, a pesticide
HDR Human Development Report
IAEA International Atomic Energy Agency
ICARCS The International Commission on Aquatic Resources of the Caspian Sea
IISD International Institute for Sustainable Development
IMF International Monetary Fund
IOC Intergovernmental Oceanographic Commission
IPCC Intergovernmental Panel on Climate Change
IR Islamic Republic of Iran
ISIC International Standard Industrial Classification
ISO International Organization for Standardization
ISQG Interim Sediment Quality Guidelines
ITC International Trade Centre
IUCN International Union for Conservation of Nature
KaspNIRKh Caspian Fisheries Research Institute
KZ Kazakhstan
M&E Monitoring and Evaluation
MAC Maximum Allowable Concentration
MCL Maximum Contaminant Level
MDGs Millennium Development Goals
MENR Ministry of Ecology and Natural Resources

ML	Mnemiopsis Leydyi
MPC	Maximum Permissible Concentration
MPD	Mechanisms of Pure Development
MPL	Maximum Permissible Level
NAO	North Atlantic Oscillation
NATO	North Atlantic Treaty Organization
NCAP	National Caspian Action Plan
NGO	Non-governmental Organization
NH4	Ammonium
NOAA	National Oceanic and Atmospheric Administration
NSCAP	National Strategic Convention Action Plan
OCPs	Organochlorinated Pesticides
OECD	Organisation for Economic Co-operation and Development
OSCE	Organization for Security and Cooperation in Europe
PAHs	Polycyclic Aromatic Hydrocarbons
PCBs	Polychlorinated Biphenyls
PH	Petroleum Hydrocarbon
PMO	Ports and Maritime Organization
POPs	Persistent Organic Pollutants
PPP	Purchasing Power Parity
PPS	Public Participation Strategy
RAPS	Rapid Assessment of Pollution Sources
RF	Russian Federation
RPAP	Regional Pollution Action Plan for the Caspian Sea
RWQMP	Regional Water Quality Monitoring Programme
SCAP	Strategic Convention Action Plan
SCAP	Strategic Caspian Action Programme
SEA	Strategic Environmental Assessment
SoE	State of the Environment
SPA	Special Protection Area
STF	Sewage Treatment Facilities
TAC	Total Allowable Catch
TACIS	Technical Aid to the Commonwealth of Independent States
TCO	Tengizchevroil
TDA	Transboundary Diagnostic Analyses
TK	Turkmenistan
TPHs	Total Petroleum Hydrocarbons
TRACECA	Transport Corridor Europe-Caucasus-Asia
TSS	Total Suspended Solids
UK	United Kingdom
UKMO	United Kingdom's Meteorological Office
UNCCD	United Nations Convention to Combat Desertification
UNDP	United Nations Development Programme
UNECE	United Nations Economic Commission for Europe
UNEP	United Nations Environmental Programme
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNFCCC	United Nations Framework Convention on Climate Change
UNOCHA-ROMENACA	United Nations Office for the Coordination of Humanitarian Affairs, Regional Office for the Middle East, North Africa and Central Asia
UNOPS	United Nations Office for Project Services
UNSD	United Nations Statistics Division
US	United States of America
US EIA	Energy Information Administration of United States of America
USSR	Union of Soviet Socialist Republics
VAB	Value Added Base
WB	World Bank
WEO	World Energy Outlook
WHO	The World Health Organization

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2011