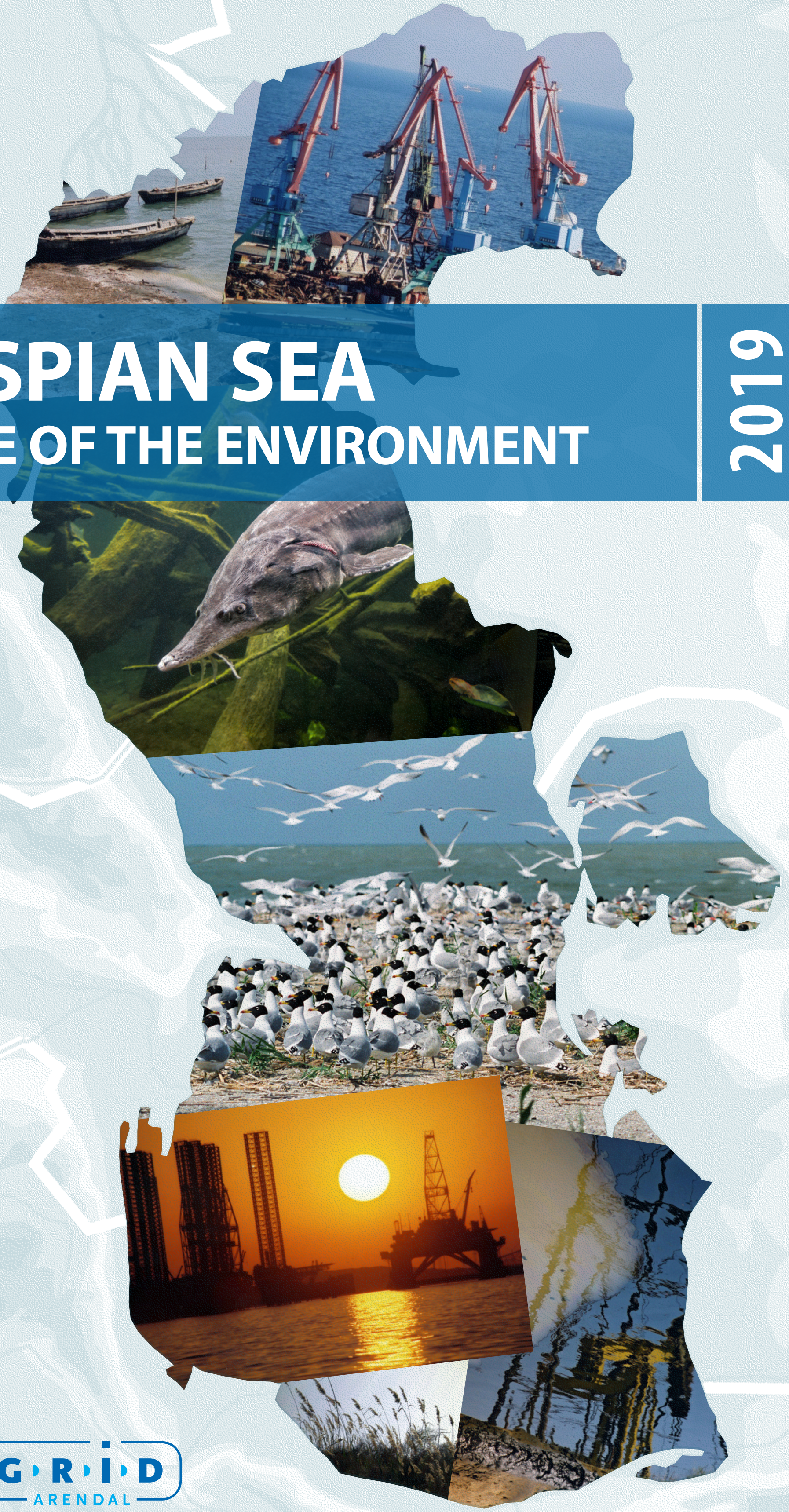
CASPIAN SEA

STATE OF THE ENVIRONMENT

2019



Tehran Convention

GRID ARENDAL

Interim Secretariat of the Framework Convention for the Protection of the Marine Environment of the Caspian Sea (Tehran Convention)

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Preface

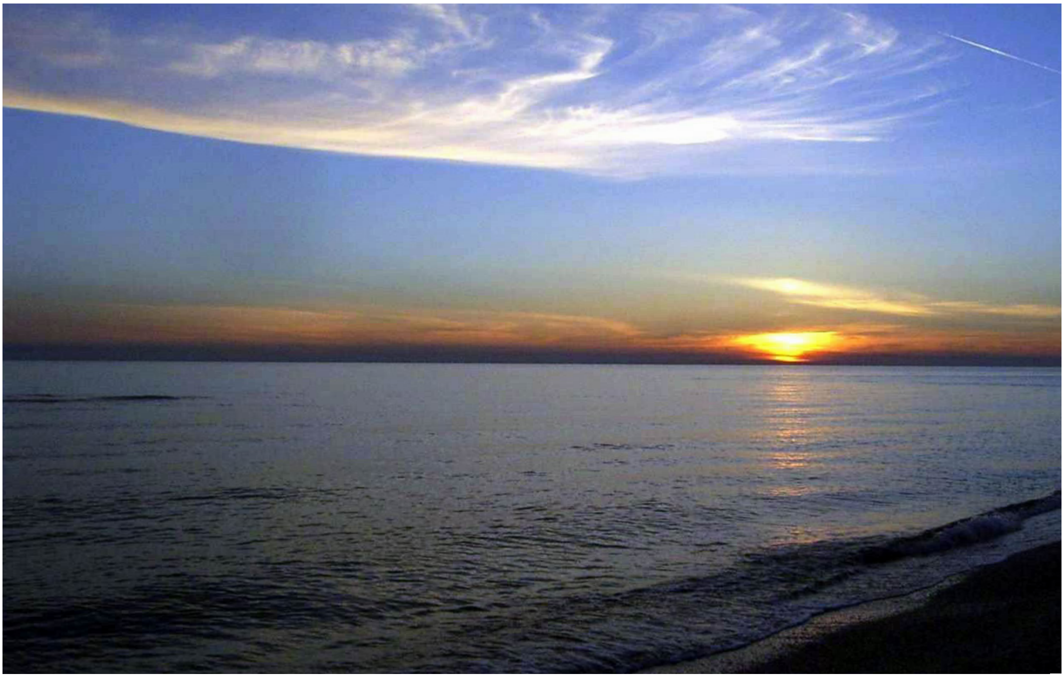
The present report on the State of the Environment of the Caspian Sea was developed in accordance with the requirements of the Framework Convention for the Protection of the Marine Environment of the Caspian Sea (Tehran Convention, 2003) and is one of the regional environmental cooperation mechanisms to assess the state of the marine environment of the Caspian Sea, in particular, pollution and its impact, based on the reports provided by the Contracting Parties and any competent international organization.

One important priority of the Tehran Convention, determined by its Programme of Work for 2009–2010, which was adopted by the Caspian littoral states at the second Meeting of the Conference of the Parties to the Tehran Convention (2008, Tehran, Islamic Republic of Iran), is the development of the State of the Environment of the Caspian Sea Report.

The first State of the Environment of the Caspian Sea Report aimed to highlight the main trends in the Caspian Sea's marine and coastal environment and was developed using the materials and documents of the Caspian Environment Programme (CEP). This first report provided the basis for the development of the second State of the Environment of the Caspian Sea Report, in line with the requirements of the Convention and its protocols.

The third Meeting of the Conference of the Parties to the Tehran Convention, which took place in 2011, in Aktau, Republic of Kazakhstan, welcomed the presentation of the first State of the Environment of the Caspian Sea Report as the review document on activities implemented under the CEP and Tehran Convention. In addition, it was decided that the next report would be issued in four years and would include information and basic indicators on the state of the environment of the Caspian Sea.

The development of the second State of the Environment of the Caspian Sea Report was carried out in accordance with the decision of the fifth Meeting of the Conference of the Parties to the Tehran Convention, which stressed the importance of the regular preparation of reports on the State of the Environment of the Caspian Sea and



requested that the interim Secretariat of the Convention coordinate the preparation of this report.

The main aim of this second report is to provide the necessary information on changes and trends in the state of the marine and coastal environment of the Caspian region for the 2012–2016 period, based on regular reporting of the Caspian littoral states and other literature sources.

This report presents the current state of the Caspian Sea's marine environment, taking into account sea level fluctuations and its pollution, including pollution from land-based sources, pursuant to the provisions of the Tehran Convention and its protocols.

The report is based on the United Nations Environment Programme (UNEP) DPSIR methodology (Driving Forces-Pressures-State-Impacts-Reponses), which was successfully applied in the first report of the interim Secretariat of the Tehran Convention on the state of the Caspian Sea's environment for the 2007–2010 period and shows the relationship between human activities, the state of and trends in the environment and the well-being of society.

Following the DPSIR methodology, the report provides a brief description of the region's current socioeconomic situation, including the state of the population.

The report reveals that certain industries, specifically mining (in particular the oil and gas sector), fishing, agriculture and tourism industries, are driving forces, influencing the state of the Caspian Sea's environment.

Information on indirect natural driving forces that are affecting the state of the Caspian Sea's marine and coastal environment, related to climate change and sea level fluctuations, which are characteristic of this closed water body, is of particular importance.

The main objective of the state of the environment reporting is to assess the current state of the Caspian Sea's environmental and social conditions and coastal areas. Such information could serve as a decision-making tool for the Parties to the Tehran Convention, with the reporting provided by the Contracting Parties themselves. Describing the general situation in the Caspian Sea basin and analysing compliance with the Con-

For information. *In the preparation of both the first and second State of the Environment of the Caspian Sea Report, the interim Secretariat of the Tehran Convention, administered by the UNEP Regional Office for Europe, was assisted by GRID-Arendal, a UNEP Collaborating Centre of Excellence in the field of environmental assessment, training and information exchange.*

The first State of the Environment of the Caspian Sea Report was developed under the project The Caspian Sea: Restoring Depleted Fisheries and Consolidation of a Permanent Regional Environmental Governance Framework (CaspEco) of the Global Environment Facility (GEF) and the United Nations Development Programme (UNDP).

The preparation of this second report was carried out within the framework of the activities of the interim Secretariat of the Tehran Convention by national experts recommended by the relevant ministries and departments of the Caspian littoral states responsible for collecting and processing the necessary information, as well as preparing the report, under the coordination and with the organizational support of GRID-Arendal and the financial support of British Petroleum (BP) Azerbaijan. National environmental information specialists of the web-based Caspian Environmental Information Center (CEIC) of the Tehran Convention assisted in the collection and systematization of information.

The Working Group on Monitoring and Assessment of the Tehran Convention also contributed to the development of the report.

The editor-in-chief, contracted by GRID-Arendal, was responsible for consolidating national materials into a single document.

vention enables the Parties to make conclusions regarding environmental trends and to develop recommendations that could tackle challenges related to the state of the environment.

Well-organized, updated and accessible information is essential for properly founded decision-making. Knowledge of the Caspian Sea's environmental conditions, as well as 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 natural resource base for present and future generations. State of the environment reporting is a recognized method for capturing environmental information and making it accessible to policymakers and the general public.

In the Caspian region, state of the environment reporting will remain a "work in progress" for some time, since the list of information needed for collective decision-making in areas of common interest has not yet been fully identified. The Tehran Convention and its protocols have determined various tasks that need to be addressed to change this, and the systematic monitoring process underlying future reporting is under development.

Common water quality standards and objectives as well as indicators for measuring change and progress in managing such change need to be further developed and agreed upon. An inventory of countries' available capacity must also be developed, to help determine how monitoring and reporting requirements can be met and what type of support is needed. Furthermore, the web-based CEIC, the common database and information centre established to receive, store and disseminate the data and information collected, has only just become operational. The Parties to the Tehran Convention have also agreed to develop a protocol to assist them in developing a foundation for collective decision-making by encouraging Parties to make commitments related to monitoring assessments and information exchange.

The second State of the Environment of the Caspian Sea Report intends to provide stakeholders with information on the state of the Caspian Sea's environment in the context of the activities of the Tehran Convention, including the promotion of public awareness.

Executive summary

The socioeconomic situation in the territories of the countries bordering the Caspian Sea was analysed. Direct drivers, such as population growth, tourism, fisheries, agriculture and the mining industry, as well as the indirect drivers of climate change and sea level fluctuations were discussed in the report. Depending on the indicator chosen, the report's findings suggest that the drivers putting the most pressure on the state of the Caspian Sea's environment are urbanization, oil and gas activities, illegal fishing and agricultural activities.

These drivers have been causing major changes in the state of the Caspian Sea's biological resources for the past 10 years. Recent surveys show that anthropogenic influences are negatively impacting the region's biological diversity, with some species of vegetation and fauna on the verge of extinction and listed as strictly protected (Goodman and Dmitrieva 2016; LUKOIL, 2015).

Air pollution

Caspian littoral states all note that transport and industrial emissions are the main sources of air pollution, with industrial areas and urban centres as the main concern in terms of air quality. Due to the lack of a unified reporting system, it is difficult to determine the extent of air pollution and overall air quality in the Caspian region.

In general, the air quality of large cities along Caspian Sea's coast is critical, though it has been improving over the last few years. Like other regions, environmental pollution in the Caspian Sea is having a negative impact on both the littoral states and individuals.

Population growth and waste

Urbanization in the region is increasing the pressure on the Caspian coast's environment. The most significant impacts of population growth are loss or degradation of cropland and the generation of domestic waste and sewage. In the western part of the Caspian Sea, such issues are deteriorating the quality of seawater.

Depending on the area of the Caspian Sea, the quality of seawater ranges from polluted, as is the case in the open areas along the Russian coast, to clean, as seen at the Karazhanbas oilfield in the Kazakh part of the sea (Russian Federation, State Oceanographic Institute 2012–2016).

Although waste generation has decreased in some countries, it has grown in others due to higher levels of consumption and increased urbanization as more people move to cities. The most common means of disposal for solid waste remains landfill sites, where there are limited opportunities to process valuable secondary materials. Only a small proportion of the waste generated in the Caspian region is made harmless and reused. For example, in the Russian Federation, around 5 per cent of total waste is recycled, while only 2.6 per cent of the waste is reused (Russian Federation 2017; Russian Federation 2018; Russian Federation 2003).

The generation of both industrial and municipal waste is associated with overall economic development and therefore varies within the region. The Caspian littoral states have introduced urgent measures to solve the waste accumulation issue, such as building waste incineration plants to transform household waste into energy (as in Azerbaijan, where a solid household waste incineration plant with fourth generation technology was commissioned in 2014). In the Russian Federation, measures include constructing waste sorting complexes, improving waste disposal landfill sites, establishing waste transfer stations in Astrakhan Oblast, the Republic of Dagestan and the Republic of Kalmykia (Russian Federation 2017; Russian Federation 2018; Russian Federation 2003), and cleaning oil-contaminated territories (Orujova 2012; Kazakhstan, Ministry of Energy 2018).

Oil and gas industry

The oil and gas industry continues to be one of the main drivers of economic development in the region's countries and is putting significant pressure on the Caspian Sea's environment. One example of this is the volume of oil and gas exported in Iran. It is at least 45 percent of the total revenue of its export. Every country in the region plans either to explore potential oilfields or begin oil and gas production both in the Caspian Sea and in coastal areas in the near future.

The increase in oil and gas production and the transportation of these products raise concerns about potential environmental risks. The Caspian Sea has previously been contaminated by the oil and gas industry, which is causing its further deterioration through activities such as drilling, rig maintenance, oil transportation and technological oil and gas leakages. Processing, in addition to accidental spills, transportation and other industries' activities also increase the burden on the environment through water and air pollution.

Comparing the main indicators for seawater contamination in areas with oil and gas projects has shown an increase in the concentration of pollutants.

Fisheries

Poaching remains one of the factors that are negatively impacting the Caspian littoral states' economies, despite their implementation of various measures. While fisheries provide employment for local populations and are an important supplier of food, their gross value in the Caspian Sea has been declining due to reduced valuable resources, which is affecting the stability of total catches (Strukova et al. 2016). Compared with 2011, total fish catches have decreased markedly in all countries, except the Russian Federation, where they increased by 11 per cent in the same period. Overall, the total volume of fish caught in the Caspian Sea is stable due to the diversification of the fish species caught (Strukova et al. 2016).

Although there is still no consensus on the possible consequences of widespread aquaculture activities, this sector is actively developing and becoming increasingly important in the Caspian Sea basin (Salmonov et al. 2013). However, the contribution of fish farms to the volume of fish produced remains small in all countries.

Agriculture

Although the agricultural sector experienced a declining share of gross domestic product (GDP) in the years leading to 2011, it has grown in recent years and is a significant source of pollution to the Caspian Sea. Poorly managed use of pesticides, fertilizers and untreated livestock waste not only pollute the Caspian Sea, but also contribute to its eutrophication (GRID-Arendal 2011). Information on agricultural impacts and trends are currently not satisfactory and need further attention.

Climate change

Climate change and its consequences, including changes in sea level, are having a significant negative impact on the region's environment, affecting different sectors of the countries' economies, such as fisheries, transport and construction.

The volume of greenhouse gas emissions is increasing in the Caspian littoral states, where energy, industry, agriculture and waste are the main contributing sectors. The energy sector is the largest source of emissions, accounting for 75 per cent of total emissions in Azerbaijan (Azerbaijan 2018) and 90 per cent in Iran (Iran, Department of Environment 2003).

In the Caspian Sea, increases in the water temperature and air temperature over the water are of great importance. There is a high probability that during this century, temperatures in the Caspian littoral states will continue to increase on average (Intergovernmental Panel on Climate Change [IPCC] 2013).

It should be noted that average air temperature increases for the last 50-year and 10-year periods show a slight decrease, and are negative for the 2012–2016 five-year period. This indicates that the warming of the Caspian Sea climate has slowed in recent years (Coordinating Committee on Hydrometeorology and Pollution Monitoring of the Caspian Sea (CASPCOM, 2017)).

As a closed water body, the Caspian Sea has significant sea level fluctuations. While such fluctuations are normal in this sea, global warming has altered its natural rhythm, resulting in dry, warm years for the 1996–2015 period, with 2006–2015 being especially unfavourable years.

The Caspian Sea is a closed reservoir. It is characterized by significant fluctuations in sea level. And this natural rhythm was inherent in the Caspian Sea. However, global warming disturbs it. As a result, the dry years coincided with the warm ones in 1996–2015. The period 2006-2015 was especially unfavourable.

The faster the change in sea level occurs, the more severe its consequences. In the 20th century, the fastest sea level decline was observed between 1931 and 1940. During this period, it amounted to 1.7 m. Sea level growth was the fastest between 1978 and 1995, amounting to about 2.5 m. Since 1996, sea level has been declining. A particularly noticeable drop (almost 1 m) was noted between 2006 and 2015. In 2016–2017, sea levels stabilized.

In addition to these significant drivers are the expected increases in shipping activities and tourism, which will most likely put further pressure on the environment in the future. Marine litter in the Caspian Sea is yet another issue, though it receives little attention and there is no reliable information on the volumes of debris discharged into the region's coastal or marine environment.

Response

The region's countries are responding to challenges and addressing emerging issues, taking into account any complexities to unite their efforts. One area of their activities is the development and strengthening of international cooperation at the regional level.

The current forms of international environmental cooperation in the Caspian region include:

- bilateral cooperation under relevant agreements
- joint activities under multilateral environmental agreements.

Multilateral cooperation includes collaboration and joint work with the Commission on Aquatic Bioresources of the Caspian Sea and the Coordinating Committee on Hydrometeorology (CASPCOM). The main interactions between CASPCOM and the Tehran Convention include monitoring the pollution of the Caspian Sea's marine environment and providing hydrometeorological information to regularly assess its state.

In addition to multilateral cooperation, several interstate agreements have been signed, with countries actively seeking to improve national environmental management. This includes improving institutional structures and national legislation.

Non-governmental organizations (NGOs) working on various environmental aspects, including the communication of information on the state of the environment, are active in the region. Such NGOs participate in developing strategic environmental assessments and environmental impact assessments, as well as in implementing various international environmental projects.

Measures

In accordance with their obligations under the Tehran Convention, the Caspian littoral states both independently and jointly take necessary measures to prevent, reduce and control pollution in order to protect, preserve and restore the Caspian Sea's marine environment. Over the past decade, countries have made great efforts to protect the region's most valuable areas, both on land and in the marine environment. Countries are also paying attention to the creation of protected areas and the maintenance of existing ones.

However, challenges persist. It is therefore necessary to establish an integrated planning approach to develop the territory and economies of specific sectors, taking into account changing natural conditions, including climate change. Determining whether there are any environmental risks related to economic activities in coastal marine areas is crucial, as is the regulation of any other activities, as well as those that may harm or affect biodiversity or jeopardize the conservation of ecosystems.

1. Introduction

The Caspian Sea is a unique natural reservoir, located between Europe and Asia. Covering an area of around 392,600 km^2, the Caspian Sea is the world's largest landlocked water body, lying 27 m below sea level (Baltic elevation system). The water area is equal to the area of the Baltic Sea (387,000 km^2) and is larger than that of the Adriatic Sea (139,000 km^2).

Based on the features of its morphological structure and physical and geographical conditions, the Caspian Sea is divided into three distinct regions: the Northern Caspian (25 per cent of the area), the Middle Caspian (36 per cent of the area) and the Southern Caspian (39 per cent of the area). The conditional Northern–Middle Caspian border passes through Chechen Island and Tyub-Karagan, while the Middle–Southern border passes through Chilov Island and Cape Gan-Kuuli The maximum depth of the sea's southern basin, known as the Southern Caspian depression or Lankaran depression, is 1,025 m with a mean depth of 208 m.

The sea measures 1,030 km in length, from north to south, and 435 km in width, from east to west. The Caspian Sea is bordered by Azerbaijan, Iran, Kazakhstan, the Russian Federation and Turkmenistan, whose estimated coastlines are 955 km, 1,000 km, 2,320 km, 695 km and 1,200 km respectively. The sea's total coastline measures 6,170 km (Panin et al. 2005), while its low and smooth coastline is estimated to be between 6,500 and 6,700 km, reaching 7,000 km if island coastlines are included (Lomonosov Moscow State University [MSU] and Russian Geographical Society [RGS] 2017).

There are 25 small and big rivers flowing into the Caspian Sea from Azerbaijan. The major rivers

are Kura, Samur, Gudyalchay, Valvalachay and Lankaranchay. The Kura River's watershed area is 188,000 km^2 and the annual run-off is 18.0 km^3 (Imanov 2016).

Two major rivers flow into the Caspian Sea from Iran: the Sefid-Rud River and the Gorgan River. The Sefid-Rud River's catchment area is about 56,200 km^2 and the average long-term run-off is 4.1 km^3. Run-off from the Gorgan River is used for irrigation and therefore does not have a permanent flow into the sea (Jalalvand and Gaidukova 2017).

The Ural River, which flows through Kazakhstan and the Russian Federation, is 2,428 km and drains an area of 237,000 km^2. It is the third-longest river in Europe after the Volga and the Danube. The average water discharge at the mouth of the river is 400 m^3/second (Chibilev 1987). The Emba River in west Kazakhstan rises in the Mugodzhar Hills and flows 720 km, though its waters only reach the Caspian Sea when water is abundant. The river has a watershed area of around 40,400 km^2 (Zonn et al. 2010).

From Russia, the following rivers flow into the Caspian Sea: Volga, Terek, Sulak and Samur (which is the border river with Azerbaijan). The average long-term run-off of the Volga River is 255 km^3 or about 80 per cent of surface run-off into the sea (Monakhov 2014a; Monakhov 2014b; Monakhov 2015).

One river stems from Turkmenistan: the Atrek River. Like the Gorgan River in Iran, run-off from the Atrek River is used for irrigation and therefore does not have a permanent flow into the Caspian Sea (Shults 1965).

The Caspian Sea is a brackish water body, with an average salinity of 12.7 grams per litre, though it ranges from 12.6 to 13.2 grams per litre. In the northern part, the range varies more greatly from 1 to 8 grams per litre. The water temperature on the sea surface in summer reaches 24–27°C and in winter ranges from 0°C in the north to 11°C in the south. In summer, hypoxia occurs in the bottom layer of the north-western part of the sea (Zonn et al. 2010).

The Caspian region is rich in biological resources and is the world's largest spawning grounds of sturgeon. Although biological diversity in the Caspian Sea is relatively small, over 130 fish species and rare lotus fields can be found in its water. The area also has wetland habitats that provide nesting and migration grounds for over 100 species of bird. The Caspian Sea is also home to the native Caspian seal, the sea's only marine mammal (Ivanov 2000).

Oil production, fishing and shipping are the most common economic activities in the Caspian Sea's waters. In the first half of the twentieth century, offshore oilfields in the Southern Caspian were developed. At present, exploration and production continues in the sea and in the adjacent territories. In the Caspian Sea basin, industry and agriculture are well developed, though the sea's western coast is more developed than its eastern coast.

Certain ports in the region, namely Makhachkala, Bautino, Aktau, Baku, Turkmenbashi and Anzali, are currently being reconstructed and expanded. Baku is the largest port on the Caspian Sea and is also the largest capital city on the southern shore of the Absheron Peninsula. It covers an area of 2,130 km^2 and has a population of over 2.2 million (Azerbaijan, State Statistical Committee of the Republic of Azerbaijan 2017). Three more cities on or nearby the sea's coast have more than half a million people: Resht (Iran), Makhachkala and Astrakhan (Russian Federation). There are also several cities close to the sea with populations of 100,000–500,000 inhabitants.

2. Methodology

This report aims to describe the overall situation in the Caspian Sea, bringing together reports from the five littoral states and other academic sources. This State of the Environment of the Caspian Sea Report is based on recent assessment reports prepared in accordance with the decision of the third Meeting of the Conference of the Parties to the Tehran Convention, which took place in 2011, in Aktau, Kazakhstan. While the original intention was to describe the overall situation in each chapter, national experts instead focused on the specific situation in each country and did not integrate information into an overview.

This report applies the *DPSIR framework*, which identifies the relationship between human activities, the state of and trends in the environment and the well-being of society.

- *Driving forces* of environmental change (e.g. demography, industrial production)
- *Pressures* on the environment (e.g. discharges of wastewater)
- *State* of the environment (e.g. climate change, water quality)
- *Impacts* on the population, the economy, ecosystems (e.g. water unsuitable for drinking)
- *Response* of the society (e.g. watershed protection) (SoE 2011).

A UNDP decision framework for assessment methodologies (2016), which takes into account the type of assessment, available time, resources and the purpose of the assessment, was used to prepare assessments carried out for this report.

Three main methods were used for the state of the environment assessments: indicator-based assessments, literature-based assessments and expert consultation-based assessments.

These three methods are not exclusive and a combination of the methods could be used. For chapters of the report that have sufficient data and information available, a methodology based on indicators or literature sources could be applied, while chapters with insufficient reference data could be developed based on expert information.

The method selected depends on the type of information available and the budget, in consideration of the following questions:

- Are existing assessments available that enable a synthesized approach to be used for the assessment or sections of the assessment?
- Are recent data or literature available that enable an analysis approach to be used for the assessment (or sections of the assessment)?
- Are there knowledgeable experts available on the different subjects of the marine assessment (e.g. biodiversity and ecosystems, the physical and socioeconomic aspects of the marine environment)?

The DPSIR approach was used in the 2011 State of the Environment of the Caspian Sea Report and was also applied for this report. Results from the 2011 report were used as the basis for this report, which focuses on developments from 2012 to 2016.

For the development of this report, existing and new data and information collected in connection with the preparation of the CEIC report were used.

3. Drivers

3.1. Socioeconomic situation

3.1.1. Population

The five littoral states have highly uneven population densities surrounding the Caspian Sea. Some regions have a large population, such as big urban centres, whereas other regions are more sparsely populated. On the eastern coast of the Caspian Sea, for example, the population density does not exceed one person per square kilometre, while on the western coast it fluctuates between 1,049 in urban areas (Baku) to 77 in rural areas (Azerbaijan, State Statistical Committee of the Republic of Azerbaijan 2017).

Most of the population along the coast of the Caspian Sea is concentrated in major urban centres such as Baku, Astrakhan, Makhachkala and in cities on the southern coast. The northern and eastern coasts have extremely small populations (Figure 3.1).

It should be noted that population numbers vary depending on the season. From April to September (the peak season on the western coast) tourists visit the region's centres, which are mainly located around Baku. According to the State Statistical Committee of the Republic of Azerbaijan (2017), there is a positive trend, with the number of visitors increasing by 8.5 per cent annually. A similar situation occurs on the southern coast, where the population also varies considerably depending on the season (Iran, Statistical Centre of Iran 2016).

In general, the region's population density is increasing, most rapidly growing in urban centres, with the greatest increases recorded on the western and north-eastern coasts. However, declines have been observed in some areas, though these tend to be limited to agricultural and rural regions.

The largest population growth recorded on the west and north-east coasts. On the western coast, the annual population growth over the past six years ranges from 1–1.4 per cent, which is 698,000 people, placing the total population at 9.8 million people. This growth is centred primarily in Baku, which grew by around 153,400 people (5.8 per cent) between 2011 and 2016 (Azerbaijan, State Statistical Committee of the Republic of Azerbaijan 2017). Here, the population growth on this coast was evenly distributed between urban and rural areas, which grew by 6.4 per cent and 6.1 per cent respectively (Azerbaijan, State Statistical Committee of the Republic of Azerbaijan 2017).

In the southern part of the Caspian Sea, the Iranian provinces of Gilan, Golestan and Mazandaran comprise the coastline. These provinces have experienced respective growth rates of 0.40 per

Figure 3.1: Population by number in the Caspian Sea region per cities and administrative units

cent, 1.01 per cent and 1.33 per cent since 2011 (Iran, Statistical Centre of Iran 2016). On the southern coast of the Caspian Sea, the general population trends can also be seen, with the urban population increasing by 1.97 per cent in the last five years, and decreasing by up to 0.73 per cent in the same period (Iran, Statistical Centre of Iran 2016).

The share of the north-eastern coast located in Kazakhstan comprises the Mangystau and Atyrau Regions. In Mangystau, the population increased by 27 per cent from 2009 to 2018, while in Atyrau, the population growth for the same period was 16 per cent.

In recent years, the Caspian region of Kazakhstan has seen a significant population increase, exceeding the general population growth rate throughout the country (Kazakhstan, Ministry of National Economy of the Republic of Kazakhstan Statistics Committee 2009–2018).

As of 1 January 2018, the Atyrau and Mangystau Regions accounted for 3.4 and 3.6 per cent of the total population of Kazakhstan, numbering 18.157 million people (Kazakhstan, Ministry of National Economy of the Republic of Kazakhstan Statistics Committee 2009–2018).

In the Caspian region of the Russian Federation (Astrakhan Oblast, Republic of Dagestan, Republic of Kalmykia), the total population as of 1 January 2017 was 4,339,000 people, or 2.96 per cent of the country's total population. At this time, 23.5 per cent of the total population, or 1,019,000 people lived in Astrakhan Oblast, 6.4 per cent or 278,000 people in the Republic of Kalmykia and 70.1 per cent or 3,042,000 people in the Republic of Dagestan. Furthermore, the population of eight urban settlements and 12 rural coastal areas accounted for 1,712,000 people, of which 65 per cent lived in cities. The population of coastal municipalities in Astrakhan Oblast was 1,734,000 people, which was 17 per cent of the Astrakhan's population or 6.4 per cent of the total population of the Russian Federation's Caspian region. The permanent population of the coastal municipalities of the Republic of Kalmykia is 18,500 people (6.6 per cent of the population of the Republic of Kalmykia or 0.4 per cent of the population of the Caspian region). The resident population of the coastal municipal formations of the Republic of Dagestan was 1,520,000 people (50 per cent of the population of the Republic of Dagestan or 35 per cent of the population of the Caspian region) (Russian Federation, Federal State Statistics Service 2017a).

From 2010 to 2017, the population growth in the Russian Federation's Caspian region was 3 per cent, though it was uneven across the regions. The population increased by 4.5 per cent in the Republic of Dagestan, 0.8 per cent in Astrakhan Oblast and 0.9 per cent in the Republic of Kalmykia (Russian Federation, Federal State Statistics Service 2017a).

The Balkan Region in Turkmenistan makes up the eastern coast of the Caspian Sea and is the country's largest region, accounting for 28.4 per cent of its total landmass, though it has a relatively small population for its size, comprising only 8.5 per cent of the total population, 82.3 per cent of which is urban (Turkmenstat 2012). Despite its scarce population, the region has a well-developed infrastructure thanks to the implementation of a large-scale economic project – the National Tourist Zone (NTZ) in Avaza (Turkmenistan Golden Age 2013).

3.1.2. Economy

Since 2011, the Caspian littoral states have all had to mitigate the effects of global economic fluctuations in the price of hydrocarbons and raw materials, as each relies to some extent on exporting natural resources. All acknowledge the need to focus on diversifying their exports and economies.

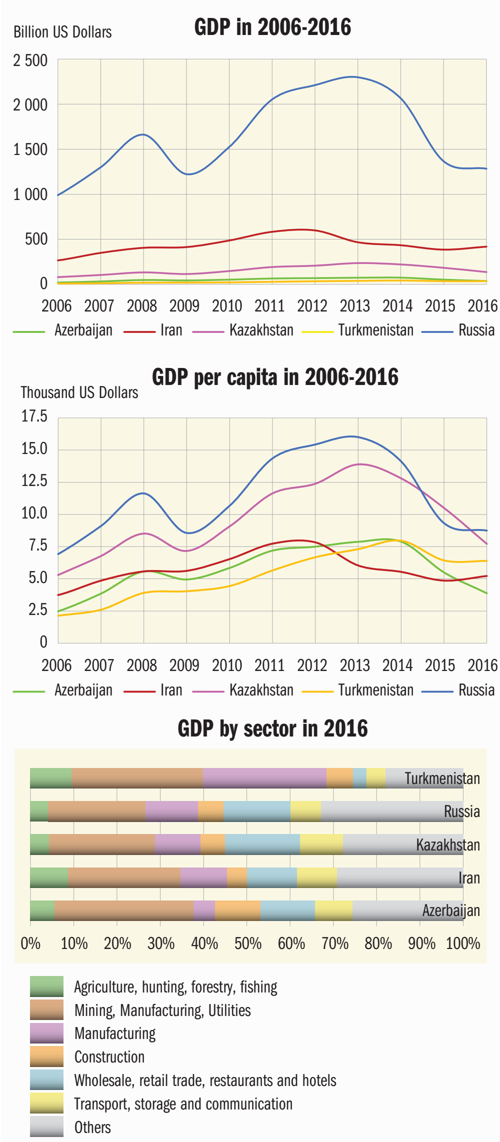
Azerbaijan has made a conscious effort to diversify its economic portfolio to reduce the negative effects of a global decline in hydrocarbon resources. Before 2010, oil continued to be the main driver behind economic growth in Azerbaijan, but between 2010 and 2014 non-oil sectors were the major contributors. According to the State Statistical Committee, in 2014 the non-oil sector grew by 7 per cent, the construction sector by 8.8 per cent and the service sector by 7.6 per cent. An analysis of the share of these sectors in GDP shows that natural resources contributed the most to economic growth in 2014 with 37 per cent, followed by the construction sector with 14 per cent. Since 2014, the Azerbaijan has been categorized as a high-middle-income country (National Contribution).

Despite the global economic downturn of hydrocarbon demand and prices, Azerbaijan remained comparatively buoyant, with its GDP experiencing a 3.2-fold increase between 2003 and 2013 to reach US$74.164 billion. Following the adoption of the "Azerbaijan 2020: A Look into the Future" concept for the implementation of the path set out in the development strategy, the country focused on economic diversity and inclusive growth, institutional capacity development and effective governance, as well as environmental degradation and vulnerability to natural disasters (Azerbaijan, State Statistical Committee of the Republic of Azerbaijan 2017).

The Caspian coast of Iran has some unique characteristics and unlike some of the other Caspian littoral states, has not used the Caspian Sea as its primary source for oil and gas resources. Instead, the Iranian coast has a larger and more established tourism industry, with more secondary homes, that are used on a seasonal basis. In 2016, the World Bank (2017a) reported an annual growth rate of 13.4 per cent compared with a 1.3 per cent decrease the year before. The growth was largely boosted by the industry sector (25 per cent), primarily due to the 62 per cent growth in oil and gas production as a result of sanctions relief. Non-oil GDP grew at 3.3 per cent and although it was lower than the oil sector, still reported the highest growth since 2011 (World Bank 2017a).

In 2017, the gross regional product (GRP) was US$17.5 billion for Atyrau Region (growth rate of 112.9 per cent on 2015) and US$7.8 billion for Mangystau Region (growth rate of 100.1 per cent). GRP per capita amounted to US$29,800 and US$12,500 respectively, with an average of US$8,800 for the Republic of Kazakhstan. Investments in Mangystau and Atyrau totalled more than US$8.9 billion.

In 2016, the Aktau International Sea Trade Port and ferry complex in the Kuryk Port were expanded. In 2018, the 897 km-long Atyrau-Aktau Republican highway was put into operation and the reconstruction of the Zhetybai-Zhanaozen (73 km) and Beyneu-Uzbekistan border (85 km) Republican roads was also started. The "Concept of Tourism Industry Development of the Republic of Kazakhstan until 2023" envisages the development of some established tourist clusters in western Kazakhstan (Official Internet Resource of Akimat of Mangystau Region 2018).



Sources: Azstat; UNSD; WB-WDI.
Graphs by Manana Kurtubadze, GRID-Arendal, April 2018.

Figure 3.2: GDP of the Caspian littoral states in 2006–2016

The Russian Federation's Caspian regions differ substantially in the sectoral structure of the GRP. The main contribution to GRP is oil and gas production in Astrakhan Oblast (25 per cent in 2015), agriculture in the Republic of Kalmykia (32 per cent in 2015) and wholesale and retail trade in the Republic of Dagestan (29 per cent in 2015). Fisheries and agriculture in the Republic of Kalmykia and the Republic of Dagestan comprise only 0.1 per cent of GRP and 0.4 per cent in Astrakhan Oblast (Russian Federation, Federal State Statistics Service 2017a).

In 2015, the GRP of the Russian Federation's Caspian regions was equal to 927.7 billion roubles, to which the Republic of Dagestan contributed 60 per cent, Astrakhan Oblast 35 per cent and the Republic of Kalmykia 5 per cent. GRP capita for this year was highest in Astrakhan Oblast, where it was 314,000 roubles, followed by the Republic of Dagestan with 186,000 roubles and then the Republic of Kalmykia with 169,000 roubles.

From 2012 to 2013, GRP growth rates were highest in Astrakhan Oblast, then in the Republic of Dagestan and lastly the Republic of Kalmykia. From 2014 to 2015, GRP (in comparable prices) decreased in all of the Russian Federation's Caspian regions.

In general, economic activity in the Russian Federation's Caspian regions is most diverse on the Dagestan coast, where agriculture is combined with industry and there is better transport infrastructure and a higher level of urbanization than other territories. On the Astrakhan coast, agriculture is developed and the number of people engaged in fishing activities is higher than in other coastal regions. The smallest economic burden falls on the coastal territory of the Republic of Kalmykia (Russian Federation, Federal State Statistics Service 2017).

The Balkan Region in Turkmenistan is the largest oil-producing and oil-refining region in the country, with the fuel industry accounting for more than 81 per cent of industrial output (for which oil production was over 47 per cent and oil processing was around 28 per cent). In attempts to diversify the region's economy, the tourism sector is being expanded and the volume of medical and therapeutic services is increasing (Turkmenstat 2018).

The Balkan Region is the most capital-intensive region in Turkmenistan. When developing its economy, 37.3 per cent of the country's total investments was dedicated to the region, which was the most invested in a single region. These investments were made in oil and gas fields, industry and construction facilities of the Avaza NTZ. Industrial production in the Balkan Region accounted for 40.6 per cent of total industrial production in Turkmenistan in 2011. In terms of the country's GDP, contributions from the energy sector totalled 76.1 per cent, or 79,976.1 million manat, while industry contributed 49.3 per cent (39,417 million manat) and agriculture contributed 10 per cent (8,023.5 million manat) (Turkmenstat 2012)

Despite pressure from the ongoing global economic crisis, GDP grew by 6.2 per cent in 2016 and 6.5 per cent in 2017 (Turkmenstat 2018). In response to the consequences of declining revenues from hydrocarbon exports, the Government of Turkmenistan defined its priorities for national economic diversification, stimulating exports of domestic products and import substitution.

The national programme of the President of Turkmenistan for the reform of social and living conditions in villages, towns, cities and districts and etrap centres for the period until 2020 is being implemented. The programme's main objective is to create high living standards for the rural population and to bring them as close as possible to urban conditions to ensure balanced social development of all settlements throughout the country. In 2017, 1,845.9 million manat (around US$528 million) was invested in the programme, including 210.6 million manat (around US$60 million) in the Balkan Region. Investments were directed to the construction of housing, hospitals, medical facilities, schools, water and sewer networks, roads and improved power supply (Turkmenistan Today 2016).

The coastal Balkan Region, like other Caspian coastal regions, is characterized by vast reserves of fuel and mineral resources (polymetals, coal, lignite, bentonite, building stone). The region also has unique climatic conditions and large agricultural areas, the vast majority of which are pastures (Shamuradov 2000).

Due to the peculiarities of production development and the territory's natural and climatic conditions, agriculture has a secondary role in the Balkan Region. The main type of agricultural activity is animal husbandry, with the region placing fifth in the country in terms of the volume of animal products produced (DN Tours n.d.).

3.2. Direct drivers (sectors)

3.2.1. Oil and gas

Each of the Caspian littoral states' economies largely depend on the oil and gas industry. All countries in the Caspian region are currently involved in oil and/or gas exploration and production in the sea. A drastic drop in oil prices in 2014 left countries facing economic issues, but the International Monetary Fund (IMF) predicts annual GDP growth in all coastal states over the next few years. Over the past decade, oil and gas rents[1] as a percentage of GDP have declined on average in all Caspian littoral states. However, the oil and gas industry still has a very important role in all the countries, as it makes significant contributions to their total exports (Azerbaijan 2018; Iran, Statistical Centre of Iran 2016; Kazakhstan, Ministry of National Economy of the Republic of Kazakhstan Statistics Committee 2009–2018, Turkmenstat 2018).

In Azerbaijan, oil, gas and oil-refining products accounted for 89 per cent of total exports in 2017. In Iran, fuels and mining products accounted for 44.7 per cent of total exports in 2015, while in Kazakhstan, they accounted for 75.1 per cent of the country's exports (World Trade Organization [WTO] 2016). Hydrocarbons accounted for 60 per cent of exports from Turkmenistan in 2014 (Turkmenstat 2018).

The biggest oil production sites in Azerbaijan are the Azeri-Chirag-Deepwater Gunashli (ACG) and Shah Deniz complexes, the latter of which is one of the biggest gas condensate fields in the world that will soon increase its outputs to the Turkish market. A further structure, the Shafag-Asiman complex, is in the exploration planning process, which is supported by a production sharing agreement between BP and the State Oil Company of the Republic of Azerbaijan (SOCAR) (BP Azerbaijan n.d.)

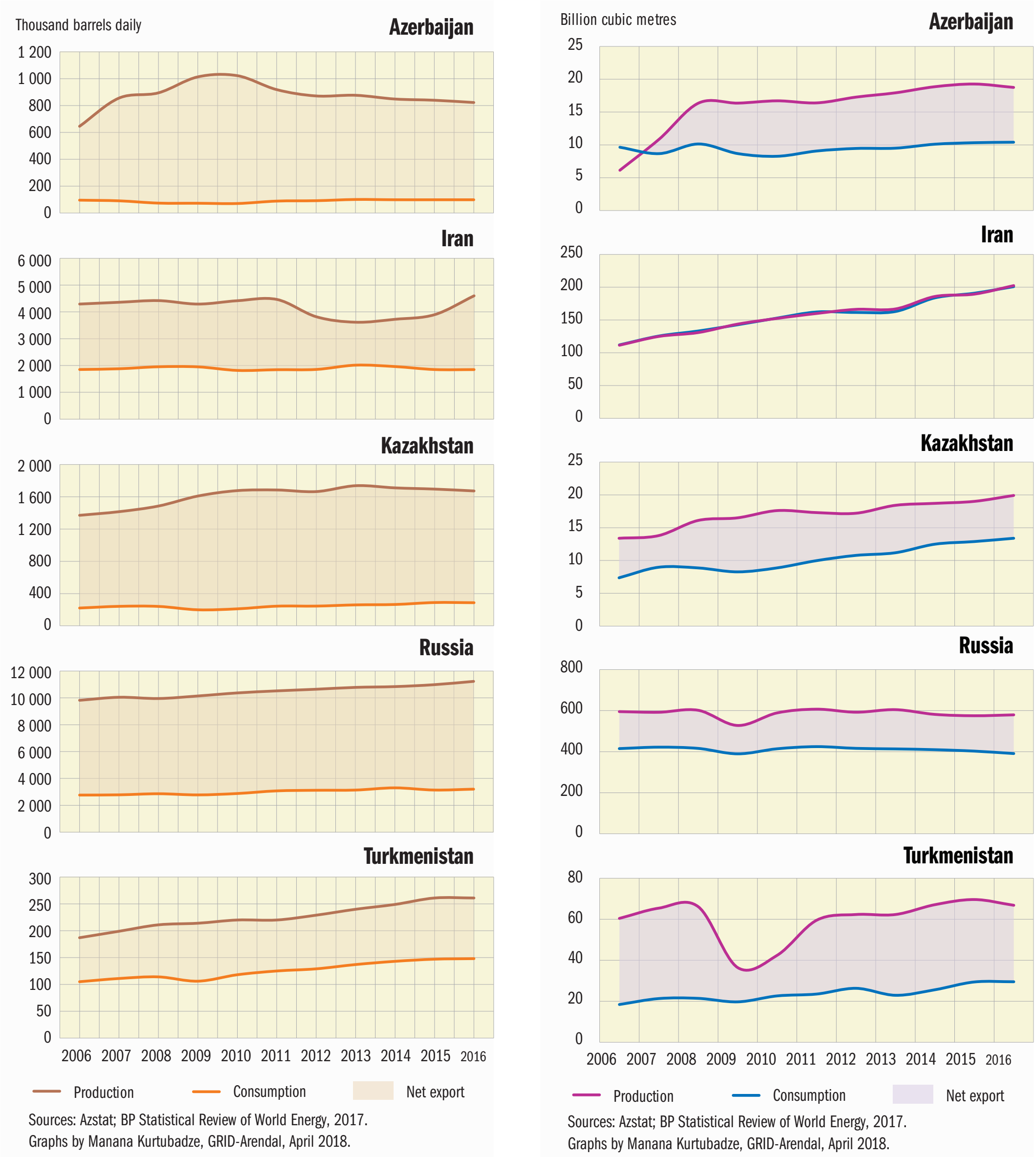


Figure 3.3: Production and consumption of oil (left) and natural gas (right) by the Caspian littoral states for 2006–2016

While the county's crude oil exports declined from 39 million tons in 2011 to 35 million tons in 2016 (10.4 per cent decrease), gas exports increased from 6.8 billion m^3 to 8 billion m^3 during the same period (18 per cent increase) (Azerbaijan 2018).

Although the economy in Azerbaijan suffered from the decline in oil and gas prices in global commodity markets, the oil and gas sector is still the largest contributor to the state budget. According to the State Statistical Committee, the sector's contribution to GDP is about 40 per cent. Total oil and gas production varies in Azerbaijan, with oil production ranging from 50.4 million tons in 2009 to 41.1 million tons in 2016 and gas production from 16.8 billion m^3 in 2007 to 29.3 billion m^3 in 2016 (Azerbaijan 2018).

The development and condition of oil production in Kazakhstan classifies it as a traditional oil and gas producing country, with the industry representing one of its economy's leading sectors.

There are 202 oil and gas fields in Kazakhstan, which have projected recoverable oil and gas resources worth 7.8 billion tons 7.1 trillion m^3 respectively. Around 70 per cent of these resources are in the western regions of Kazakhstan. Furthermore, potential oil and gas reserves on the sea shelf are equal to their total reserves on land (Kazakhstan Business Magazine n.d.).

More than 10 multilayer oil and gas condensate fields have been discovered on the Caspian Sea's sea shelf in the Russian Federation sector.

PJSC LUKOIL, a Russian energy corporation, holds licences for the development of eight hydrocarbon fields on the Caspian Sea shelf. The total recoverable reserves of these fields are about 386.3 million tons of oil and gas condensate and more than 650 billion m^3 of gas, the deposits of which are in the Korchagin, Filanovsky, Yuri S. Kuvykin, Rakushechnoye, Zapadno-Rakushechnoye, Khvalynskoye, Tsentralnoye fields and the 170 km field. The development of these fields is carried out by OOO LUKOIL-Nizhnevolzhskneft (a limited liability company under Russian Federation law).

OOO LUKOIL-Nizhnevolzhskneft has been operating in the Northern Caspian since 1995. Currently, the company owns licences for three areas: Severny, Central Caspian and East Rakushechnoye.

The Korchagin oilfield was discovered in 2000 and started production in 2010. The field has 16 production wells, with the deposit located 180 km from Astrakhan and 240 km from Makhachkala. The depth of the sea in this area is 11–13 metres. In 2015, the field produced more than 5 million tons of oil.

The Filanovsky deposit is located in the Russian Federation sector of the Northern Caspian in the subsoil use zone. The field was discovered in 2005 and has an estimated oil production worth 6 million tons per year. The field became commercially operational in October 2016.

The Rakushechnoye deposit is also located in the Russian Federation sector of the Northern Caspian on the sea shelf. The field was discovered in 2001 by the Rakushechnaya-1 exploratory well and is the next project to be developed in the Caspian Sea.

The Khvalynskoye oil and gas condensate field is located on the Kazakhstan-Russian Federation border in the Northern Caspian on the sea shelf, 260 km from Astrakhan, where the sea depth varies from 25 to 30 metres. The deposit was discovered in 2000 (LUKOIL 2015).

In Turkmenistan, the Balkan Region in the west of the country produces the most oil. Development of oilfields in the region began in the late 1890s, with regular industrial production beginning in 1933. There are about 200 oil and gas fields explored in Turkmenistan. Potential domestic hydrocarbon resources are estimated at 71.2 billion tons of oil equivalent, of which 53 billion tons are found inland and 18.2 billion tons in marine areas (Trend News Agency 2016). Reserves in the Galkynysh and Yashlar fields are estimated at 26.2 trillion m^3 of gas, which increases to 27.4 trillion m^3 when considering the reserves of the newly discovered Garakel site that is also part of this block (Gurt 2012).

3.2.2. Fisheries

Fisheries contribute to the development of the economies of all Caspian littoral states, providing employment for local populations and a high-protein food source. In the agricultural sector in Iran, for example, fishing is one of the most important activities, providing food and employment opportunities, and creating high potential for export earnings (United Nations Environment Programme [UNEP] and GRID-Arendal 2014).

The industry officially employs about 2,200–2,400 people in Azerbaijan (excluding those involved in processing), who mostly work near the sea or other water bodies (Salmonov et al. 2013).

The Russian Federation was the first of the Caspian littoral states to introduce and initiate a ban on sturgeon fishing (in 2000 for beluga and in 2005 for all anadromous Caspian sturgeons). At present, all the Caspian littoral states have adopted the ban on commercial sturgeon fishing.

Iran and the Russian Federation both have access to other seas (and in the case of the Russian Federation, an ocean), which provides them with more fishing opportunities than Azerbaijan, Kazakhstan and Turkmenistan, as these are surrounded by land. These countries therefore have no alternative but to stabilize their fish consumption or increase their seafood consumption through fish farms. In 2009, only 11.3 per cent of Iranian production occurred in the Caspian Sea, with the remaining 87.7 per cent taking place the Persian and Oman Gulfs in the south (Strukova et al. 2016).

In Azerbaijan, in 2014, the Government amended the old law on fisheries to introduce new aquaculture provisions, as well as to ensure the sustainable development of fish farming in rural areas, create new sources of income and improve the well-being and health of local coastal populations.

According to data for 2014 (Iran, Statistical Centre of Iran 2002–2014), the total catch of fish decreased by 15 per cent in Iran and by more than 60 per cent in Kazakhstan (Kazakhstan, Ministry of National Economy of the Republic of Kazakhstan Statistics Committee 2009–2018). In the same period, the total catch increased by 11 per cent in the Russian Federation, which was the only country that reported higher volumes.

Iran is one of the largest exporters of caviar and sturgeon meat in the world (Harlioglu and Farhadi 2017). However, fisheries only contribute 0.4 per cent to GDP, while agriculture contributes 4 per cent. In 2010, the industry employed 189,900 people, of which 35,900 were involved in fish farming. In 2000 there were 14,558 workers in this industry in the Caspian region of Iran, though this number has been declining (Food and Agriculture Organization of the United Nations [FAO] 2016).

In Kazakhstan, the total catch of commercial fish by fish farms in the 1990s was about 9,800 tons. From 1990 to 2005, commodity fish farming in Kazakhstan stagnated, with production in the following years amounting to around 150 tons (Kazakhstan, Ministry of National Economy of the Republic of Kazakhstan Statistics Committee 2009–2018).

Table 3.1: Number of fish farms (aquaculture) and their activity in 2011–2016 in Azerbaijan

Indicators	2011	2012	2013	2014	2015	2016
Number of physical and legal persons engaged in pond and lake fishery (people)	106	99	92	85	161	108
Total area of pond and lake surface(ha)	1,381	1,435	1,283	1,109	1,847	1,093
Amount of grown fish product (tons)	404	376	387	370	603	645

Source: National Contribution.

In the Mangystau Region of Kazakhstan, 123 fishing brigades and 434 fishers were involved in coastal fishing in 2015; in 2018, these numbers had increased to 148 fishing brigades and 598 fishers. The Ural-Caspian basin is an extremely important source of biological resources for Kazakhstan, providing around 20,000 tons of fish per year (Kazakhstan, Ministry of National Economy of the Republic of Kazakhstan Statistics Committee 2009–2018).

In a 2005 report, the World Bank suggested that the informal and unreported part of the fishing industry exceeds that of the formal sector in Kazakhstan. According to estimates, there may have been as many as 110,000 people employed in the fisheries sector, with most working on a seasonal basis in rural areas that lack other opportunities. This number suggests that roughly 300,000 people may be dependent on this sector for their livelihoods (World Bank 2005), demonstrating that while fisheries may have small significance in terms of the national economy, they may be of great importance to Caspian Sea communities.

Turkmenistan has completely banned sturgeon fishing and the use of drift nets (Strukova et al. 2016), and has special regulatory acts to protect fish stocks (Turkmenistan 2011). In 2017, the monetary value of the industrial output of fisheries in Turkmenistan was 0.2 per cent (Turkmenistat 2018). Fishing activities are carried out by private entrepreneurs of the Union of Industrialists and Entrepreneurs of Turkmenistan. Marine fishing is the most common type of activity of the State Committee for Fisheries. Fishing vessels and equipment have been designed for sprat fishing, which comprises 40 per cent of the total catch.

3.2.3. Agriculture

Agriculture is an important sector affecting the state of the Caspian environment, as well as national food security and employment, especially in rural areas. Since 2004, some Caspian littoral states have experienced a decline in agriculture as a percentage of GDP, largely due to increases in industrial production and a decline in government farming subsidies (Caspian Environment Programme (CEP 2007)).

However, in recent years, the situation has changed. In Azerbaijan, for example, the aggregate volume of agricultural products has increased by 38 per cent compared with 2005. In addition, crop output and livestock production increased by 25 per cent and 54 per cent respectively. Furthermore, the share of agricultural production in GDP increased from 5.5 per cent to 6.2 per cent from 2010 to 2015, with the country's total added value worth US$2.1 billion in 2016, which was 5.6 per cent of the national GDP (World Bank 2015a).

In the Russian Federation, agriculture is most developed in the Republic of Dagestan, where the largest contribution comes from animal husbandry. The size of sown areas and the number of large and small cattle in the Republic of Dagestan is roughly twice as large as that of the Republic of Kalmykia and is also more than in Astrakhan Oblast. In the Republic of Kalmykia, agriculture is important to the economy, with livestock farming accounting for 84 per cent of agricultural output in value terms in 2015. Crop production plays a major role in Astrakhan Oblast, contributing 61 per cent of agricultural output in value terms in 2015, though its sown areas are smaller than in the Republic of Dagestan and the Republic of Kalmykia, and have not exceeded 80,000 hectares in the last five years (Russian Federation, Federal State Statistics Service 2017).

In Kazakhstan, the agricultural sector contributes the same percentage as that of the Russian Federation, which in 2017 was 4.8 per cent of total GDP (World Bank 2017b). In the coastal region of Kazakhstan, gross agricultural output increased by 1.5 per cent in 2016 compared with 2015. During the same period, the number of cattle increased by 15 per cent, which is the region's main agricultural contribution.

In Turkmenistan, the natural and climatic conditions and lack of fresh water for irrigation are barriers in the development of irrigated agriculture. The country's total area of agricultural land is 40.1 million hectares, with around 5 per cent or 2 million hectares used for irrigation and the remaining as pasture (Esenov and Durikov 2007). The number of people engaged in agricultural activities is 1.5 per cent of the total population of the Balkan Region.

The Balkan Region has the largest area of agricultural land, most of which is pasture. The cultivated area of the Balkan Region is the smallest in the country, at just 1,100 hectares, and is used for growing fruits and vegetables (Turkmenstat 2012). The main crop produced in the region is wheat. The Balkan Region's contribution to the total agricultural production in Turkmenistan is 4 per cent of fruits and berries, 0.5 per cent of potatoes and 3.6 per cent of vegetables. There is minimal risk of the coast becoming polluted by chemicals due to the lack of irrigated areas (Annamukhamedov et al. 2014).

More than 33.4 per cent of the country's total camel herd is concentrated in Balkan Region, which is also home to 16.7 per cent of the country's sheep. In addition, the region produces meat (8.5 per cent of the national total), eggs (6.8 per cent of the national) and wool (15.1 per cent of the national total) (Turkmenstat 2018).

The soil condition of 7,013,300 hectares of land reserves could be improved, which can be broken down in terms of soil salinity: no salinization – 1,659,500 hectares (23.7 per cent); light salinization 1,098,800 hectares (15.6 per cent); average salinization – 1,183,700 (16.9 per cent); high salinization – 2,251,300 hectares (32.1per cent); very high salinization and solonchaks – 820,000 hectares (11.7 per cent) (Turkmenistan 2002).

Agriculture is important for people's livelihoods and is a contributing sector to the economy. In Azerbaijan, the agricultural sector provided 36.3 per cent of total official employment, demonstrating people's dependence on the sector for work, though it contributed little to the country's GDP (Azerbaijan 2018). This situation is seen in all Caspian littoral states, but the gap between GDP contributions and total employment is generally smaller than in Azerbaijan.

The agricultural sector employed 18 per cent of official employment in Iran in 2015, which was the same percentage as Kazakhstan in 2016. In general, the percentage of agricultural employment is slightly declining, with the most rapid decline experiencing in Kazakhstan from 30 per cent in 2008 to 18 per cent in 2017 (World Bank 2017b).

3.2.4. Tourism

Tourism has significant importance to the economies of the Caspian littoral states, contributing to their GDPs. In Azerbaijan, the travel and tourism sector contributed 4.5 per cent to the GDP, providing jobs to 1.5 per cent of the total workforce in 2017 (Azerbaijan 2018). Investments of between 2 and 5.4 per cent were made in each country's travel and tourism sector in 2016. The sector is expected to grow in the next decade, creating tens of thousands of jobs in the countries (World Travel and Tourism Council [WTTC] 2017).

In 2015, the southern coast of the Caspian Sea in Iran, was visited by over 33 million tourists, including the most popular provinces of Mazandaran (8 million), Gilan (1.9 million) and Golestan (209,000).

In Kazakhstan, there has been positive development in the tourism sector, thanks to state support measures and properly developed state policy for the 2015–2018 period.

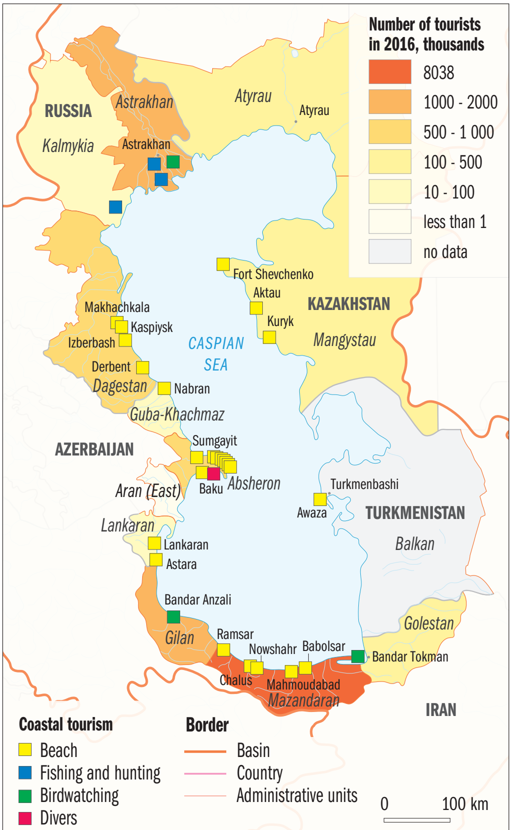
In accordance with the approved "Concept of Tourism Industry Development of the Republic of Kazakhstan until 2023", the Mangystau Region is the centre of the "Caspian Gates" tourist cluster in western Kazakhstan and has the capacity to develop cultural, ethnographic, camping, environmental and sport tourism.

In efforts to further develop the region's tourism, an action plan for tourism development was drafted and approved, which includes activities to improve tourism infrastructure (roadside service sites, visitor centres, road repairs, water, gas and electricity supply facilities), digitize tourist facilities, and promote the region's tourism potential through training (Official Internet Resource of Akimat of Mangystau Region 2018).

At present, the tourism industry generally attracts domestic holidaymakers and does not attract large numbers of international tourists. Most tourists arriving in Kazakhstan come from former Soviet countries. The main challenges facing the industry are poor infrastructure and varying standards of service between regions. The sector has the potential to develop, which can be achieved if strategic partnerships and investments are made (Andrades and Dimanche 2017).

Astrakhan Oblast is the most visited region near the Caspian section of the Russian Federation. In 2016, 72.6 per cent of the total number of collective accommodation facilities and 60.7 per cent of the total number of people staying in them were located in this region, followed by the Republic of Dagestan (21.3 and 32 per cent respectively) and the Republic of Kalmykia (6.3 and 7.4 per cent respectively).

In the Russian Federation's Caspian section, 145 tourist organizations were registered in 2016. Most of these were located in Astrakhan Oblast (125 organizations), with just 12 in the Republic of Dagestan and eight in Kalmykia). In total,



Sources: National statistical offices; Chuchilova, 2016; DagTourism, 2017; Iran Daily, 2015; Iran Visitor; Mixfacts, 2016; MK-Astrakhan, 2016; Sorokin, 2016; TASS, 2017 and 2018; Vesti-Kalmykia, 2016.
Map by Manana Kurtubadze, GRID-Arendal, April 2018.

Figure 3.4: Tourism around the Caspian Sea

these organizations sold 32,400 tour packages in 2016 (23,800 in Astrakhan, 7,800 in Dagestan and 800 in the Republic of Kalmykia).

Fishing and hunting are the main tourism purposes in Astrakhan Oblast, though these activities are contributing to the depletion of natural resources. State policies have therefore been developed to diversify the sector, through aiming to develop other types of tourism, including educational, ecological, therapeutic, health-improving and gastronomic tourism. In the Volga-Caspian basin (Astrakhan Oblast) tourism in recent years has been narrowly developed around fishing and as a result is directly dependent on fish stocks (Astrakhanstat 2018b).

In the Republic of Dagestan, state policy aims to develop recreational marine and mountain tourism (including sports, health and educational tourism). Fishing and hunting tourism are also in development and a tourist and recreational complex – Agrakhan-Kaspiy – is being established to facilitate this (Russian Federation, Republic of Dagestan 2013).

In the Republic of Kalmykia, tourism development is not a priority, though the region is establishing an educational and ethnographic tourism infrastructure (Russian Federation, Republic of Kalmykia 2013)

The Government of Turkmenistan supports and financially participates in major programmes to develop the tourism industry in the Caspian region, with a special emphasis on beach tourism and, in the future, ecotourism.

The region is attractive for investment not only in terms of its raw materials and production capacity, but also its potential for general tourism and health resort and spa tourism development. A present, tourism is a strategic priority for Turkmenistan in developing its national economy. Since gaining independence, the coast of the Caspian Sea has become a national resort and tourist area. In July 2007, the President of Turkmenistan, Gurbanguly Berdimuhamedov, signed a decree on the creation of the Avaza NTZ in order to develop tourism, promote investment, create jobs and improve the quality of tourist services in the country.

Avaza NTZ has a special place in the country's strategic plans for the coming decades and will be developed with advanced architecture engineering. The value of the facilities being built in this zone currently amount to more than US$1.5 billion. At present, the zone has 33 world-class hotels and a leisure and entertainment industry is being developed, including water parks, yacht and sports clubs, restaurants, camping sites, amusement parks and shopping centres. A seven-kilometre canal cuts through the resort, with well-equipped recreation areas planned for either side.

To date, a new airport has been commissioned in the city of Turkmenbashi and new roads, a power station, a desalination plant, sewage treatment plants and water supply networks are being built. In 2018 the Turkmenbashi International Sea Port was commissioned, and new ships, including cruise liners, were introduced. The tourist zone will increase to 5,000 hectares (Avaza 2018), with investments funding the construction of luxury health resorts and hotels. Construction of other facilities and infrastructure is continuing in the area. The Balkan Region has significant recreational resources and unique attractions for tourists, such as Mollakara, Karshi, Kara Kala and Nohur in Magtymguly (DN Tours n.d.).

In Turkmenistan, Avaza NTZ is designed to both preserve and improve the state of the environment. As an example, more than 500 hectares of land in Avaza have been dedicated for use as plantations. Plans are also in place to add a new park to the green strip that stretches across the tourist zone for many kilometres.[2]

3.3. Indirect drivers

3.3.1. Climate change

The Intergovernmental Panel on Climate Change (IPCC) has confirmed that climate change is impacting natural and human systems around the world, which has been proven through measured increases in the atmosphere's greenhouse gas concentrations as well as global mean temperatures. Atmosphere and ocean temperatures have also increased, with ocean temperature increases accounting for approximately 90 per cent of energy accumulated between 1971 and 2010. Around 60 per cent of this energy is stored in the upper layer (0–700 metres) of seas, while 40 per cent is stored 700 metres, causing sea levels to rise. The world's cryosphere is also decreasing, which is further contributing to sea level rise and a lower albedo.[3] Global sea levels are rising faster than they have in the past two millenniums (Intergovernmental Panel on Climate Change [IPCC] 2013), yet another sign that global warming is accelerating and causing ripple effects that will influence future global warming.

According to the IPCC, there is a tendency for warming in the countries of North and Central Asia that border the Caspian Sea, which in the northern part is combined with an increase in abundant rainfall in the winter. In summer, warming is observed in the central regions along with a decrease in the amount of precipitation. Warming in these areas is higher than the global average, and, according to modelling predictions, extreme precipitation is likely to occur more often. It should be noted that modelling the changes in these regions is challenging, due to a lack of observation data and difficulties for models to consider the influence of mountain landscapes when calculating climatic parameters. It is assumed that the duration, intensity and frequency of thermal waves are likely to increase in these areas and there is a high probability that temperatures in the Caspian region will continue to rise during this century (IPCC 2013).

The biggest driver of climate change is positive radiative forcing[4] caused by the burning of fossil fuels, which releases greenhouse gases into the atmosphere, followed by land-use change. Carbon dioxide (CO_2) emissions will influence the carbon cycle by increasing the amount of CO_2 that can be absorbed in the atmosphere. These emissions will also further contribute to ocean acidification, as oceans absorb around 30 per cent of released CO_2 (IPCC 2013). Recent data show that CO_2 is continuing to increase in the atmosphere, after reaching unprecedented levels in 2016. This is mainly due to anthropogenic influences on carbon and other biogeochemical cycles, which are affecting the global climate (IPCC 2013). These drivers will have significant and various consequences at the regional level.

In Azerbaijan, there have been significant changes in annual temperatures, precipitation and wind patterns. The country is suffering from the adverse effects of climate change, such as floods, droughts and rising temperatures (National Hydrometeorological Department).

In Kazakhstan, the 2007–2016 ten-year average for air temperature was +6.5°C, exceeding the norm for the 1961–1990 period by +1.01°C. This was the second biggest positive anomaly after the record-warm decade of 1997–2006. The 2012–2016 five-year average for annual air temperature was +6.66°C, the highest it has been since 1941. Between 1976 and 2016, the ten-year average increase in annual air temperature across Kazakhstan was 0.34°C. There is also a significant increasing trend in the number of days with temperatures above 35°C, which in the western part of Kazakhstan in Atyrau and Mangystau Regions, is 4–8 days every 10 years. Throughout the country, the total duration of heat waves is increasing too by 6–10 days every 10 years and the number of frost days is decreasing by 3–8 days every 10 years (Kazhydromet 2016).

According to CASPCOM, the average air temperature on the Russian coast of the Caspian Sea has increased in the last 30 years (1987–2016) compared with the average temperature for 1961–1990, rising from 9.9°C to 10.7°C in Astrakhan, from 12.2°C to 12.5°C in Makhachkala and from 12.7°C to 13.5°C in Derbent. It should be noted that regardless of the increase in average air temperature in the last 50 years, or its decrease in the last 10 tens, the overall average rate of air temperature increases is decreasing, and was negative for the 2012–2016 period (CASPCOM 2017). This indicates that climate warming in the Caspian region has been slowing down in recent years.

Within the framework of preparing the First National Communication on Climate Change issued by Turkmenistan, annual and seasonal data from 30 meteorological stations located in different physical and geographical areas throughout the country were analysed to study its temperature and atmospheric precipitation patterns. The analysis showed that autumn and winter months had become colder by 0.2–0.6°C, while spring and summer months had become warmer by 0.3–0.9°C (Atamuradova 2012).

In the Caspian Sea, increases in the water temperature and air temperature over the water are of great importance. Any increase in water temperature is especially significant, as it decreases the area of winter ice cover in the Northern Caspian, weakens vertical water circulation in the deep sea, increases evaporation and activates chemical and biological processes. According to CASPCOM data (CASPCOM 2017), the average water temperature in the Makhachkala area for the 1986–2015 period was 12.9°C, which was 0.4°C higher

than the average for the 1961–1990 period. In general, the water temperature in the Makhachkala area of the Caspian Sea has been rising 0.06°C per year for the last 30 years. Time series data reveal anomalies in the water temperature that differ to those for air temperature: during 1997–2007, only positive water temperature anomalies were observed, while in the years before and after this period, positive anomalies alternated with negative anomalies (CASPCOM 2017).

According to the CASPCOM assessment (2017), which not only covers water temperature changes, but also the variability of surface water run-off into the sea, in the last quarter of the twentieth century, the Caspian Sea was impacted by global warming, with the air temperature over the water increasing by 0.7–0.8°C and the surface water layer by 0.4–0.5°C. At first, the warming occurred alongside a rapid rise in sea level, following increased flow from the Volga and Ural Rivers into the Caspian Sea, despite a decreased flow from the Kura River. At the turn of the century, the levels of run-off decreased, causing sea levels to slowly decline. Since 2006, the Caspian Sea level has been declining rapidly and global warming has slowed down, with run-off normalizing and sea level stabilizing in 2016–2017.

3.3.2. Impact and contribution to climate change

The Caspian Sea's water column, with the exception of its freshwater inflows in the Northern Caspian, has relatively uniform salinity. Since the salinity is fairly evenly distributed, impacts on water mixing, the level of biogenic elements present in the photic zone and the water's bioproductivity are largely the result of climate change. Climatic factors that stimulate deep water mixing in the Caspian Sea are diverse. Regional atmospheric circulation creates vortices, causes declines and rises in water levels and also increases the density of the water's surface layer, resulting in summer evaporation, winter cooling and ice cover formation. Salinity fluctuations in the water's surface layer also influence deep mixing, due to changes in the volume of river inflows and atmospheric precipitation.

The Northern Caspian is the smallest section of the Caspian Sea in terms of both volume (0.5 per cent) and area (33.8 per cent), with an average depth of 4.4 metres, making it more susceptible to any changes in the atmosphere above its waters. Fluctuations in run-off from the Volga River also affect the Northern Caspian, where the flow of heat and moisture into the atmosphere is most intense, which helps the area to ventilate the entire sea. The Southern Caspian is the sea's largest area, comprising 65.6 per cent of its volume and 39.5 per cent of its area, with an average depth of 345 metres. The Southern Caspian differs greatly from the Northern Caspian, not only in terms of its hydrometeorological conditions, but also in its response to climate change.

The impact of climate conditions on the sea's biota is not limited to the effect of temperature on the physiology, biochemistry and behaviour of specific organisms. Rather, climate impacts the functioning of the sea's entire ecosystem. The sensitivity of the Caspian Sea's ecosystem to climate (both the sea and its basins) is determined by several factors, such as isolation (drainless water body), morphology and consistency of the water column, among others.

Due to its isolation, the Caspian Sea has only two sources of water supply: river run-off and precipitation. The volume of water from river run-off is several times greater than the amount of precipitation, which means that catchment areas are particularly sensitive to moistening. The Volga River provides a significantly larger volume of run-off than the combined flows of the remaining rivers, and therefore greatly influences the Caspian Sea's water level fluctuations. As an isolated water body, the Caspian Sea has the potential to serve as an indicator of the humidity of the East European Plain, as well as other large-scale climate changes.

Anthropogenic climate change will impact the socioeconomic future of all the Caspian littoral states. The effects of climate change, such as the increasing frequency and intensity of extreme weather events, have shown that both human-made systems and natural ecosystems are vulnerable. The degree of people's vulnerability largely depends on social factors, such as marginalization (IPCC 2013; IPCC 2014). The social costs of climate change are high and are closely related to impacts on ecosystems and the economy. The emission of greenhouse gases into the atmosphere today is a process of cost shifting, where the price of emissions will manifest through known and unknown possible future impacts of climate change on people, ecosystems and economies.

As greenhouse gas emitters, the Caspian littoral states are all contributing to climate change (GRID-Arendal 2011). Turkmenistan emits almost the same volume of greenhouse gases as the Russian Federation per capita. Azerbaijan emits the least amount of CO_2 overall and per capita (Azerbaijan, State Statistical Committee of the Republic of Azerbaijan 2017), while Iran emits the second largest volume of greenhouse gases overall and per capita (The Guardian 2018).

Thanks to an understanding of climate's influence on the Caspian Sea, it is possible to analyse the consequences of such influence for the 1961–2015 period. Analysis revealed that increases in the temperature of the water's surface layer contributed to a weaker winter convection as a result of cooling, and a stronger summer convection as a result of evaporation. Summer convections in the Caspian Sea did not play a particularly important role in stimulating deep water mixing. In fact, the warming had a negative influence on the mixing and in recharging the upper layer of the water with biogenic elements.

The period of climate warming in the Caspian region can be divided into two time frames: increased river run-off, which increased the water's level of nutrients, and decreased river run-off. In the 1980s and the first half of the 1990s, the decrease in the level of biogenic elements in the water's deep layers was supplemented by nutrients in river inflows. During this period, temperature increases encouraged more active biochemical processes to occur, resulting in higher biological productivity in the Caspian Sea. At the start of the second half of the 1990s, the level of biogenic elements in the deep layers decreased, as did the amount of nutrients in the sea's river inflows. The continuing rise in water temperature caused a nutritional deficiency in the sea, which led to an increase in various short-lived species and was most likely responsible for the outbreak of the ctenophore *Mnemiopsis leidyi*[5] that occurred at the turn of the century.

The alternation of dry and cold years with wet and warm years every 10–15 years is needed to maintain high productivity in the Caspian

Sea. While this was once the Caspian Sea's natural rhythm, it has now been affected by global warming, resulting in dry, warm years during the 1996–2015 period, with the 2006–2015 period providing particularly unfavourable conditions. The impact of climate change on the Caspian Sea's ecological situation is unknown, since biochemical processes resulting from changes during 2006–2015, along with bacterial marine products and short-lived species, were found to have contributed to the self-purification of the seawater from pollution (CASPCOM 2017).

3.3.3. Changes in sea level

As a closed water body, considerable fluctuations in water level are common in the Caspian Sea. Observations of the water level began in the first half of the nineteenth century, with coastal observation data from 1900 onwards included in CASPCOM's General Catalogue of the Caspian Sea Level. Satellite-based sea level observations from 1992 to present day are available and accessible online.

Although fluctuations are normal in the Caspian Sea level, they can have considerable impact, with faster changes resulting in severer consequences. In the twentieth century, the most rapid decline in sea level occurred from 1931 to 1940, decreasing by 1.7 metres, with the fastest rise taking place from 1978 to 1995, when it increased by 2.5 metres. From 1996, the sea level decreased, most noticeably by almost a metre during the 2006–2015 period, before stabilizing in 2016–2017 (Figure 3.5).

In the time period considered, fluctuations in the Caspian Sea level were largely due to changes in its water balance, which have been calculated for each year, starting from the mid-nineteenth century. Average per year, approximately 1,000 mm of water (approximately 400 km^3) evaporates from the surface of the Caspian Sea (including Duzly-Bogaz-Gol), though it is compensated by river run-off (about 750 mm or 300 km^3 of water) and atmospheric precipitation (about 250 mm or 100 km^3). The water balance is positive in the Northern Caspian, where the Volga and Ural Rivers flow into the sea, and is negative in the Middle and Southern Caspian due to meagre run-off. River run-off is largely responsible for water balance variations. Four fifths of river run-off into the Caspian Sea originates from the Volga River, meaning that sea level fluctuations are mainly determined by the river's water content. These fluctuations are therefore indicative of the transfer of moisture from the Atlantic Ocean to the Volga River basin.

Figure 3.5: Fluctuations of the Caspian Sea level 1900–2017

Note: Acco rding to the CASPCOM data, «0» on the graph corresponds to a mark below 28.0 metres of the Baltic Sea level.
Source: Lebedev (2014).

4. Pressures

4.1. Fishing

In the Caspian littoral states, the fishing industry is very important for many rural communities living in coastal areas around the Caspian Sea or in the deltas of rivers flowing into it. However, the relatively low level of economic development in rural areas and inadequate legal regulation are important factors that are maintaining pressure on fragile resources (United Nations Environment Programme (UNEP) and GRID-Arendal 2014). Fish stocks are affected by natural conditions such as the hydrological regime of rivers and fluctuations in sea level, as well as pollution, invasive species and human economic activities – dam construction and various fishing strategies.

The consequences of sea level fluctuations, which are largely associated with changes in the hydrological regime of rivers, became apparent during the period 1971–1991, when large changes in fish numbers from period to period were observed in the Kizlyar Bay area of Dagestan in the Russian Federation, due to sea level fluctuations in spawning areas (Abdusamadov et al. 2015). It has been determined (Ivanov 2000) that annual stock replenishment depends on the timing and volume of the spring high water in the Volga River: the greater the river run-off, the higher the juvenile survival rate and spawning productivity. In 2015, the spring high water reached a critical minimum. This led to negligible stock replenishment of semi-migratory fish species.

Hydroengineering had a significant effect on the hydrological regime of rivers, in some cases blocking fish migration routes. All this resulted in a sharp reduction in catches of both semi-migratory and migratory fish species. Fish stocks in the Terek River are almost completely depleted due to the impact of construction on fish reproduction, feeding and migration (Abdusamadov et al. 2015).

Fishing of aquatic biological resources in the Volga-Caspian fishing grounds is mainly based on semi-migratory species (Caspian roach, bream, catfish, pike, pike perch, carp, rudd, crucian carp, white bream, perch, blue bream, sabre carp, roach, Volga pikeperch, asp, ruffe, tench, white-eye bream and herring).

Overfishing has been a persistent problem for many years, leading to the depletion of several fish species. Unregulated fishing by amateur fishers is contributing to the reduction of fish stocks. At the same time, overfishing of sturgeon, in particular, is not new, and had already resulted in a decline in fish stocks and catches as far back as 1914 (Ruban et al. 2015).

Total production is a characteristic indicator of the state of fish resources. For example, total production in Kazakhstan decreased by more than half between 1989 and 2007 (Kazakhstan, Ministry of National Economy of the Republic of Kazakhstan Statistics Committee 2009–2018). It is possible that, in addition to the sharp decline in fish stocks in the Caspian Sea, problems associated with a large number of illegal vessels engaged in fishing also contributed to this decrease. The Ural-Caspian region has nonetheless maintained stable fish catches over the past decade due to an increase in the bony fish catch (Strukova et al. 2016).

Total production by fisheries in Azerbaijan is less than 15,000 tons (Azerbaijan 2018), while the fish catch in Turkmenistan was 1,693 tons in 2017 (Turkmenstat 2018). It should also be noted that informal employment is common in most of the Caspian littoral states (World Bank 2017b).

Aquaculture

The question of whether aquaculture is useful for ecosystem management and social development in the Caspian littoral states is the subject of much discussion, and the significance of this sector varies in different parts of the Caspian region.

Aquaculture was not common in Azerbaijan before the end of the twentieth century, but it is becoming increasingly important today (Salmonov et al. 2013). The Blue Marine Foundation is implementing a project to help protect some fish ecosystems in Azerbaijan through promoting aquaculture and tourism as the best alternatives that do not cause pollution or over-exploitation of biological resources (Blue Marine Foundation n.d.). According to official statistics, aquaculture production in Azerbaijan almost doubled in 2015 compared to 2014, amounting to 603 tons, rising to 645 tons in 2016 (Azerbaijan, State Statistical Committee of the Republic of Azerbaijan 2017).

Generally speaking, all littoral states (with the exception of Iran) experienced a decline in aquaculture production following the collapse of the Soviet Union. Only the Russian Federation has recently restored production to previous levels. Azerbaijan, Turkmenistan and Kazakhstan have very little production in this sector, but there are opportunities for growth.

Total fish production in Iran has been steadily increasing since 1990, as has the contribution of aquaculture to the fisheries sector as a whole. In 2015, production in the aquaculture sector accounted for 35 per cent of total fisheries production (World Bank 2017b).

Fisheries policy in Iran is largely focused on transitioning from fishing to aquaculture. An important reason for this is that, although the total fish catch has increased, by some estimates it has reached the biological limit of production (FAO 2016). This certainly applies to most types of fishing activity in the Caspian, where it is already being felt in everyday life, including by Iranian fishers, with a decrease in the number of fish caught (The Guardian 2015). Nevertheless, in the governmental five-year fisheries plan, the total annual fish catch is expected to increase from 950,000 in 2014 to 1.5 million tons in 2020 (FAO 2016). It is important to note that Iran is developing aquaculture significantly in its inland waters and at fish farms (Strukova et al. 2016).

The encouragement of new aquaculture production in Iran by issuing affordable licences in various parts of the country, investing in aquaculture research and increasing the availability of funds for co-financing aims to increase existing and stimulate new production.

To reduce the pressure on natural resources and create jobs in Gilan Province, a specific type of aquaculture – pen aquaculture – was proposed for the production of sturgeon and bony fish species (Zekrgoo and Lafmejani 2017). Iran and FAO are participating in a two-year project entitled "Genetic improvement of rainbow trout in the Islamic Republic of Iran". The project aims to improve food security for the people of the

Mazandaran Province and broaden their opportunities to earn a living by increasing the availability of farmed rainbow trout (FAO 2016).

Aquaculture production in Kazakhstan amounted to a modest 1.7 per cent of total fisheries production in 2015, and this trend towards limited production persists (Kazakhstan, Ministry of National Economy of the Republic of Kazakhstan Statistics Committee 2009–2018). For example, it was only in 2014 that the first limited liability company, Kazakh Oseter Scientific and Production Company, was set up in Mangystau. The company produced 6 tons of sturgeon fish in 2016 and 9 tons in 2017. Efforts to promote aquaculture are continuing. FAO has noted that the main reasons for the low level of investment in aquaculture are inadequate incentives for the development of the regulatory framework and insufficient funds allocated to the development of fisheries and technology (FAO 2010). This situation should be viewed in the context of general problems with developing the fisheries sector in Kazakhstan: regulatory issues, high taxes and an overall lack of investment. The potential offered by aquaculture is significant, and could help to protect endangered species and promote economic development through the production of high-value goods like caviar (Strukova et al. 2016).

In the Russian Federation, fish-farming companies of all forms of ownership under the responsibility of the Federal Agency for Fishery (Rosrybolovstvo) Directorate for the Volga-Caspian Region released approximately 1,624,836,000 juvenile specimens, including 39.05 million sturgeon fish specimens, 1,585,378,000 ordinary fish specimens and 0.018 million herbivorous fish specimens. In 2014, sturgeon production by Rosrybolovstvo enterprises reached its highest level since 2009. In 2015, 31.65 million juvenile sturgeon were released into their natural habitat in Astrakhan Oblast.

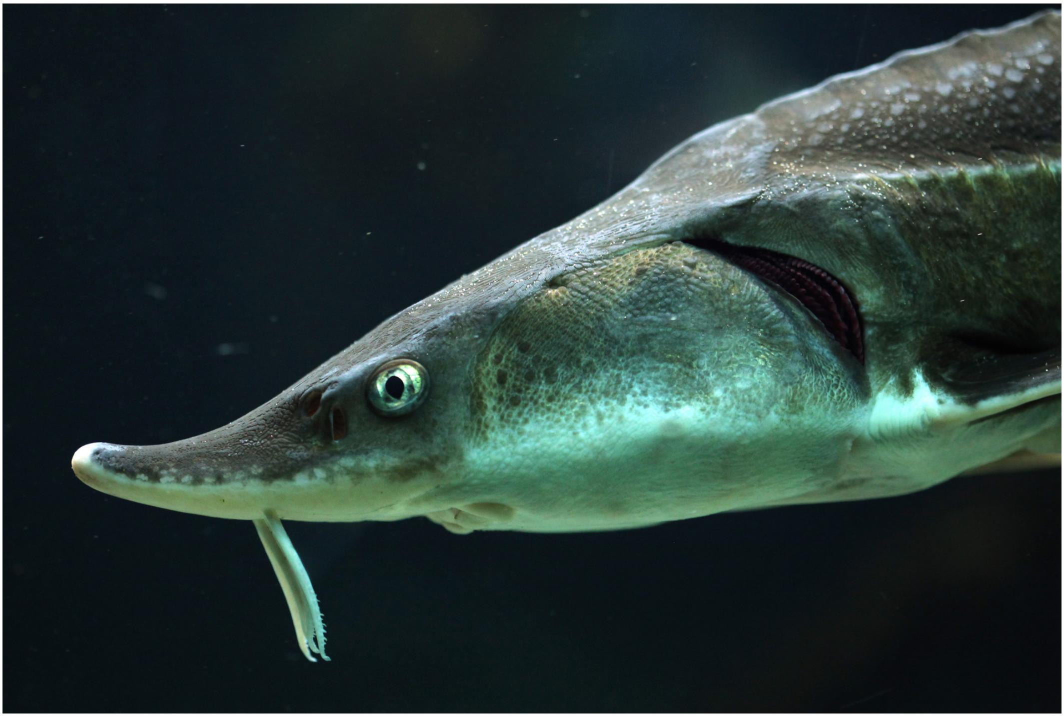
Astrakhan Oblast is one of the largest commercial producers of sturgeon fish and caviar in the Russian Federation. Three fish farms – two state and one private – breed sturgeon in the waters of the Caspian Sea and the Volga delta here. More than 90 per cent of all sturgeon, beluga, stellate sturgeon and sterlet juveniles released in Astrakhan Oblast are reared by the fish farms operated by federal state enterprise Sevkasprybvod, which also coordinates the activities of fish-farming enterprises in Astrakhan Oblast.

It should also be noted that using farmed fish to replenish the sturgeon population is highly effective. At present, the share of farmed fish in catches is 99 per cent for beluga, 65 per cent for sturgeon and 45 per cent for stellate sturgeon.

State fishing enterprises in Turkmenistan also catch river fish. The average catch per day for each region is 2.5–3.5 tons, which is sufficient to cover demand (Turkmenstat 2018). In addition, the company Hazar Balyk currently operates a fish farm with a capacity of 100 tons of fish per year, 2 tons of black caviar, 170 tons of smoked fish and 10 million tins of various types of commercial fish (Hazar Balyk 2018).

To promote growth in the fishing industry, the Government is investing in the development of fish processing as well as efforts to increase the catch. A fish-processing complex with a processing capacity of 100 tons of fish per year was successfully commissioned in 2012.

Aquaculture is not risk-free, and the importance of simultaneously restoring natural habitats should not be ignored. It is also essential to remember that different types of aquaculture can have an adverse impact on fishing. The fact that catches decline in areas close to fish farms, as a result of pollution and other impacts on local ecosystems, is well known to fishers (Martinez-Porchas and Martinez-Cordova 2012). There are several potential environmental impacts which should be considered. The establishment of fish farms can destroy natural ecosystems, cause soil salinization or acidification, contaminate water sources that were once fit for human consumption, lead to eutrophication and nitrification of ecosystems that receive wastewater, introduce exotic species that may biologically pollute water bodies, contaminate soil and water with medicines, modify landscape and hydrological conditions that may have unknown consequences for ecosystems, and act as a trap for eggs, larvae, juveniles and adult individuals of various organisms. There are also concerns about high concentrations of toxins



and heavy metals, genetic contamination and contamination with unwanted species of phytoplankton and zooplankton (Martinez-Porchas and Martinez-Cordova 2012). Consequently, ensuring that aquaculture is beneficial to the local population and to the environment will be a difficult task, requiring consideration of all potential impacts.

Sturgeon species are considered to be at greater risk of extinction than any other group of species (Gessner et al. 2010). They are endangered by "... overfishing, habitat degradation, pollution and hydroelectric power station dams that prevent them from reaching breeding sites, as well as by an absence of effective international legal regulation and by organized criminals seeking quick profits" (Apostle 2017). About 90 per cent of sturgeon fishing in the post-Soviet space was conducted in the Volga, the river that is also home to the most important spawning grounds. This commercial fishing and the development of hydropower are important reasons behind the dramatic population decline in recent decades. It has been suggested that sturgeon aquaculture could provide a solution to the problems of falling fish stocks and illegal fishing (Ruban et al. 2015).

Another reason why particular attention has been paid to sturgeon in the aquaculture sector is the specific genetic make-up of the species, which may offer an advantage for preserving genetic diversity even when breeding under artificial conditions (Apostle 2017).

Compared with natural conditions, the pond method reduces unavoidable losses of larvae and juveniles by 10-15 per cent and accelerates the maturation of caviar-producing fish from 7–8 years to 5 years. By strictly complying with scientific and technical regulations and applying the latest developments and advanced technologies in the field of aquaculture, Hazar Balyk was able to achieve significant results in breeding sturgeon at its production complex within two years (Bobkin 2017).

It is believed that commercial aquaculture makes a positive contribution to sturgeon conservation by providing economic incentives, since it is the only legal way to produce sturgeon caviar in large quantities, meet market demand and provide an alternative to illegal caviar. The development of aquaculture to protect sturgeon stocks in the Caspian could reduce the attractiveness of illegal fishing by satisfying the market and lowering prices.

4.2. Mineral extraction

Like the sea itself, the territories which border the Caspian possess significant reserves of a wide variety of economically useful resources, the most popular of which are currently oil and gas.

The oil and gas sector devotes particular attention to sound management practices, including operational standards and safety measures. Nevertheless, in view of the investment in existing and future oil and gas projects, the increase in the transportation of oil resources and associated petroleum products remains a concern due to the potential environmental risks.

Natural factors also increase the risk posed by oil and gas production and transportation in the Caspian Sea. These factors can include strong winds, icy conditions in the Northern Caspian, changes in sea level, extreme waves, coastal flooding and earthquakes (Zhiltsov et al. 2016). Additional challenges include difficult weather conditions, high-pressure reservoirs, problems with borehole instability, unstable bottom sediments and the risks of drilling in shallow waters (SoE 2011). There are also significant risks and problems associated with human activities, such as accidents on tankers or oil platforms, damage to offshore pipelines, failure to comply with rules and regulations on equipment construction, repair or manufacture and the potential for mistakes by operational and maintenance personnel (Zhiltsov et al. 2016).

Uncontrolled oil and gas wells (open gushers), where oil, gas and gas condensate burst up to the surface, at sea or on land, for long periods of time (from several days to months) cause particularly significant damage. This is the most serious incident that can occur during exploration drilling for oil (Figure 4.1).

The Caspian Sea has already been contaminated by the oil and gas industry and activities such as drilling, maintenance of drilling rigs, oil transportation, and oil and gas blowouts during drilling operations continue to cause further degradation. In addition to accidental spills, processing, transportation and other sectors also increase the pressure on the environment by polluting the water and air.

A comparison of oil and gas transportation methods shows pipelines to be the most economically profitable, despite the significant risks associated with their construction and operation. The potential for pipeline construction to harm land and water resources and result in the loss of historical sites and monuments, reserves and protected areas must be taken into account (Zhiltsov et al. 2016).

Abandoned wells represent another potential threat to the environment. During implementation of the Strategic Plan of the Ministry of Industry and Trade of the Republic of Kazakhstan, 1,900 wells were surveyed within the Kazakhstan sector of the Caspian Sea in the 1990s. All of the wells were inventoried and a cadastre was compiled. As a result of the survey, 110 wells in a critical state were identified, including 89 in Atyrau Region and 21 in Mangystau Region. An action plan to close down these wells was drawn up.

Figure 4.1: Oil spill accidents since 2000

In accordance with this plan, state bodies and oil companies routinely monitor the status of the wells and are undertaking work to close down and preserve flooded wells in the coastal zone (Republic of Kazakhstan 2014–2016).

No abnormal deviations in dissolved oxygen content or biogenic indicators have been recorded in the Turkmenistan sector of the Caspian Sea over the last five years. During this period, the heavy metal ion and detergent concentrations did not exceed the maximum acceptable concentrations (MACs): the oil product concentration was 1.0 MAC, and the phenol concentration was 1.5 MAC on average.

Particular attention is paid to drilling technology, the operation of offshore oil and gas wells and the disposal of industrial waste.

In 2017, the best available technologies were introduced and the construction of new sewage treatment plants was completed at the Turkmenbashi Complex of Oil Refineries. As a result, the quality of treated wastewater meets requirements and the concentration of pollutants in the effluent does not exceed MACs. Construction of the new treatment facilities helped to cut emissions by 3,128.3 tons per year (Turkmenstat 2018).

The new facility has also enabled a zero-discharge water reuse system to be introduced. This has decreased the volume of effluent discharged into Soymonov Bay by almost three times, helping to conserve water resources and prevent wastewater contaminated with oil refinery waste from polluting the bay. This will have a beneficial effect on the state of Soymonov Bay and will significantly improve the ecological situation in the region (CaspEcoControl).

Hydrocarbon development and extraction in the Turkmenistan sector of the Caspian Sea is carried out in full compliance with established interna-

tional rules. All production waste (drilling mud, drill cuttings, etc.) from drilling sites is transported to shore by service companies for further processing at specially constructed facilities.

To improve state monitoring of seawater quality, CaspEcoControl purchased new, modern instruments for determining dissolved oxygen content in seawater, pH levels, and concentrations of oil products, ammonium nitrate, nitrites, phenols and other pollutants.

4.3. Agriculture

Agriculture is one of the most important sources of pollution worldwide, and this is also the case in the Caspian littoral states. Problems associated with harmful pesticides, fertilizer use and poorly treated livestock waste are widespread, and the latter two may have contributed to eutrophication in the Caspian Sea as early as 2005 and 2006. Water quality is especially vulnerable to agricultural waste discharged into rivers running into the Caspian Sea (GRID-Arendal 2011).

Environmentally harmful pesticides are generally cheap and readily available to both small-scale enterprises and large-scale farms, which use them to ensure high yields from their agricultural land. Chlorinated pesticides such as dichloro-diphenyl-trichloroethane (DDT) and hexachlorocyclohexane (HCH) have been used along the Caspian coast (GRID-Arendal 2011).

Another widespread and well-known problem related to agriculture is increased nitrate loading as agricultural production intensifies. Nitrate loading in the Tajan watershed in Iran originates primarily from agricultural land where nitrates are widely used in paddy fields and orchards (Rajaei et al. 2017). In addition, the use of organophosphate pesticides in agricultural practices in the Southern Caspian basin also poses a threat to humans and wildlife (Nasrabadi et al. 2011)

4.4. External inputs: discharge and run-off

Pollutants enter the Caspian Sea from various sources, including river run-off, precipitation, sewage, discharge from ships and oil and gas facilities, and gas and liquid releases from the seabed. For geographic and historical reasons, pollution sources are unevenly distributed along the coastline and in the sea. River run-off predominantly affects the Northern Caspian (Figure 4.2), with most of the pollutants discharged into the sea along with river water in the area. The amount of precipitation falling on the southern coast is five times greater than that which falls on the northern coast, so atmospheric pollutants primarily affect the southern coast. Wastewater discharge is mainly concentrated on the western and southern coasts, where there are large urban settlements and well-developed industrial and agricultural sectors. Gaseous and liquid releases from the seabed (streams, springs and mud volcanoes) are associated with geologically active regions, which are heavily concentrated around the Absheron Peninsula. As shown by observations from space, discharge from ships is mainly localized along navigable routes connecting large seaports. Pollution from oil and gas facilities depends on the condition of the facility – modern facilities with a zero-discharge policy do not pollute the marine environment when operating normally, but discharges are possible in the event of an accident, something which often occurs at older facilities.

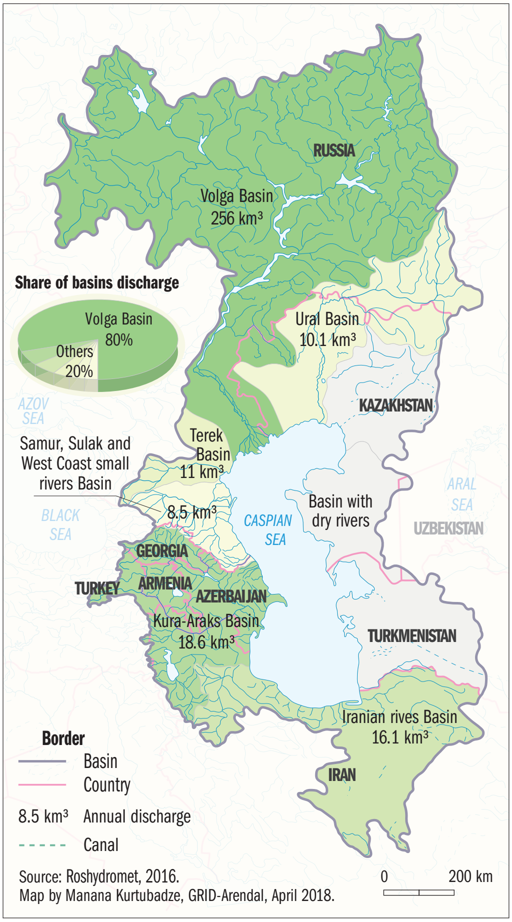


Figure 4.2: River basin discharge into the Caspian Sea

River run-off, sewage and atmospheric transport are land-based sources of Caspian Sea pollution.

Pollution of the Caspian Sea from land-based sources in Azerbaijan

Pollution of the Caspian Sea from the territory of Azerbaijan comes mainly from the discharge of polluted wastewater. The Kura River, which is heavily polluted by domestic and industrial wastewater from Armenia and Georgia, plays a significant role here.

To prevent the discharge of untreated sewage into the sea, Azerbaijan is undertaking a huge amount of investment, carrying out large-scale projects, rebuilding and modernizing major sewage treatment plants and constructing modern new treatment plants and sewage systems. Recently built or modernized wastewater treatment facilities alone have a capacity of up to one million cubic metres of water per day. The main sources of polluted water discharged into Baku Bay have been eliminated. In addition, to prevent the sea from being polluted by small local sources that are not connected to the central sewer system, modular treatment plants have been installed along the Caspian coast on the Absheron Peninsula

Pollution of the Caspian Sea from land-based sources in Kazakhstan

Water quality in the north-eastern sector of the sea is affected by run-off from the Ural River and the Volga River. During the period of 2012 to 2017 the waters of the Ural River on the territory of Atyrau Region were rated as "normatively clean" and "clean". On the territory of Western Kazakhstan Region in 2012-2014 the Ural River was rated as "clean" and "moderately polluted". It was noted that nitrites, total iron, chromium (6+) and phenols exceeded permissible values (Kazhydromet 2012-2017). In Kazakhstan, the Akimat of Mangystau Region developed and adopted Resolution No. 249, "A regional plan for preventing and cleaning up oil spills in the Kazakhstan sector of the Caspian Sea in Mangystau Region" on 9 August 2016. Systematic work is now carried out in accordance with this integrated plan (Official Internet Resource of Akimat of Mangystau Region 2018).

Pollution of the Caspian Sea from land-based sources in the Russian Federation

Surface run-off of pollutants

According to statistical data, polluted wastewater discharge into the Caspian Sea basin (referring

Table 4.1: Average annual flow at the upper and sea edges of the Volga delta

Pollution	Head of delta		Marine fringe of delta, 1995–2004		
	1977–1993	1995–2004	Total	Western part	Eastern part
Total Petroleum Hydrocarbons, thousand tonnes	71.65	54.8	57.1	37.2	19.9
Detergents, thousand tonnes	5.29	6.96	7.95	4035	3.6
Phenols, thousand tonnes	0.7	0.98	1.07	0.68	0.39
Ferrrum (Fe), thousand tonnes	–	–	51.05	31055	19.5
Zinc (Zn), thousand tonnes	4.97	9.42	9.45	6.01	3.44
Cuprum, (Cu), thousand tonnes	2.19	1.89	1.66	1.13	0.53
Nickel (Ni), thousand tonnes	–	–	1.49	0.94	0.55
Lead (Pb), tonnes	–	–	439	276	163
Cobalt (Co), tonnes	–	–	311	195	115
Manganese (Mn), tonnes	–	–	273	172	101
Chromium (Cr), tonnes	–	–	186	117	69
Cadmium (Cd), tonnes	–	–	122	77	45
Hydrargyrum (Hg), tonnes	–	–	15.4	9.7	5.7
DDT, kg	3710*	186	124	56	68
Dichlorodiphenylethylene (DDE), kg	1320*	27	29.5	23.6	5.9
Alfa-hexachlorocyclohexane, kg		Not detected	Not detected	Not detected	5
Gamma-hexachlorocyclohexane, kg	1026*	115	87	27	60

*1983–1986

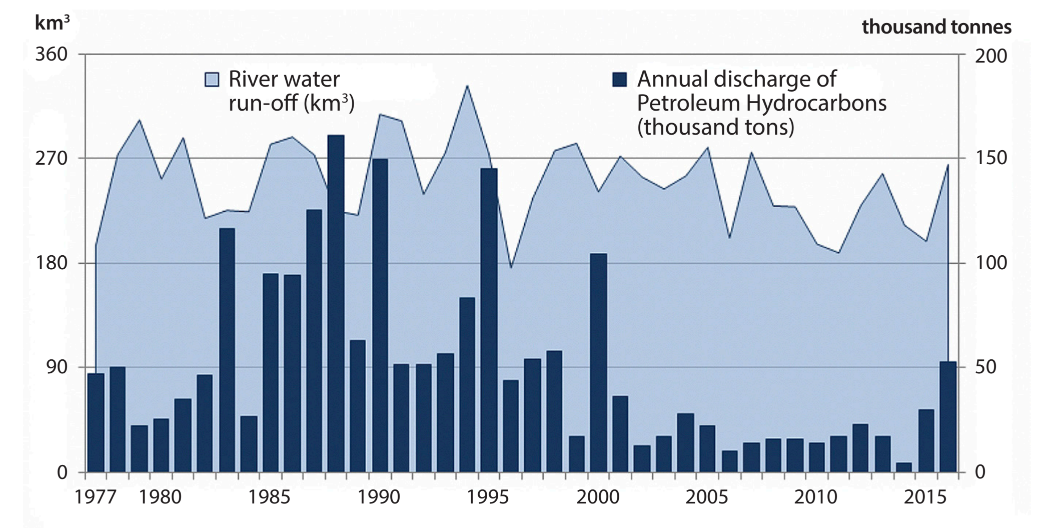


Figure 4.3: Fluctuations in Volga River water run-off (km^3) and discharge of oil products (thousand tons), 1977–2016

Source: Alexeevsky et al. 1997.

here and subsequently to the part of the basin which is located within the Russian Federation) accounts for almost half (approximately 45 per cent) of all wastewater discharge into seas in the Russian Federation. Since 1993, when statistical reports were first produced, the amount of discharge has halved, from 12.1 to 6.1 km^3.

As discharge of polluted wastewater into the Caspian Sea basin decreased, the flow of pollutants directly into the sea with river water also decreased. An example of this is the decline in the discharge of oil products from the Volga River, which averaged 91,300 tons per year in 1981–1990, 66,600 tons per year in 1991–2000 and 18,600 tons per year in 2001–2010, fluctuating around 18,200 tons per year for the following five years.

A significant reduction in the discharge of oil products (as well as organochlorine pesticides) into the Caspian Sea with water from the Volga was highlighted in a 2007 report published by the Federal Service for Hydrometeorology and Environmental Monitoring (Roshydromet): Trends and Dynamics of Environmental Pollution in the Russian Federation at the Turn of the Twenty-First Century (Table 4.1). Pollutant run-off has stabilized during the second decade of this century.

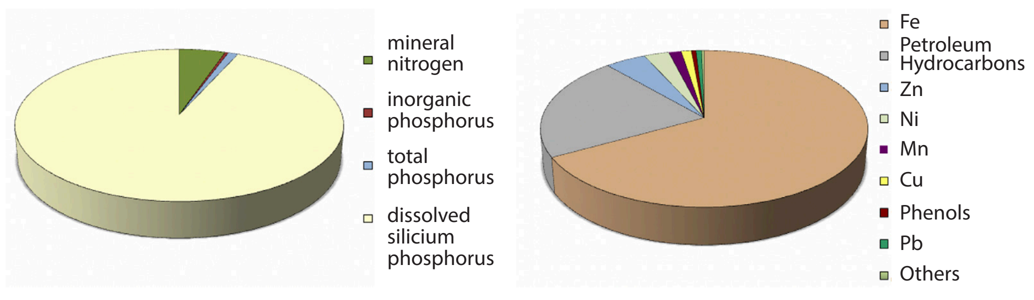


Figure 4.4: Total chemical run-off from the Volga and Terek rivers (thousand tons per year), 2012–2016

If the effect of the long-term trend resulting from the reduction in polluted wastewater discharge is subtracted from the time series of pollutant run-off, then a directly proportional relationship between pollutant run-off and water run-off can be clearly seen in the remaining fluctuations (smoothed rows or series of annual increments). 2016 serves as an example of this: after a series of low-water years, the water run-off increased by 65 km³ compared to the previous year, and the volume of oil products discharged rose by 33,000 tons (Figure 4.3).

Roshydromet's annual reviews of onshore surface water quality include data on pollutant run-off into the Caspian Sea with the waters of the Volga and Terek rivers (Monakhov 2014a; Monakhov 2014b; Monakhov 2015). During the period 2011–2015, total chemical run-off from these rivers averaged 4.1 million tons of organic substances per year, 72,200 tons of mineral nitrogen, 5,200 tons of mineral phosphorus, 2,000 tons of nickel, 1,100 tons of manganese, 900 tons of copper, 500 tons of lead, 70 tons of aluminium and molybdenum, 20 tons of cobalt, 9.7 tons of cadmium, 2.3 tons of mercury, 16,800 tons of oil products, 400 tons of phenols, 0.5 tons of DDT and 0.7 tons of HCH (Figure 4.4, Table 4.2).

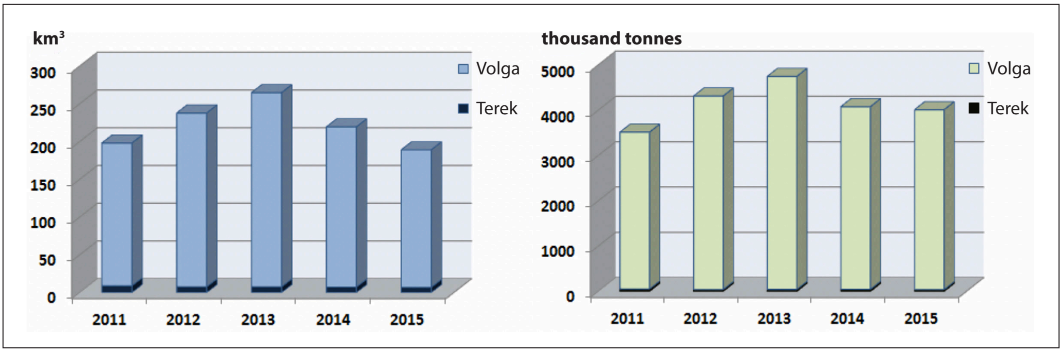


Figure 4.5: Volume of water run-off (km³) and amount of organic substances discharged (thousand tons), 2011–2015

Table 4.2: Total chemical run-off from the Volga and Terek rivers into the Caspian Sea, 2011–2015

	2011	2012	2013	2014	2015	Average
River run-off, km^3	198	238	265	220	189	222
Organic matters, thousand tonnes	3519	4316	4749	4082	4015	4136
Ammonium nitrate, thousand tonnes	11,9	6,5	30,6	2,2	3,1	10,9
Nitrite, thousand tonnes	5,6	3,8	14,3	0,54	2,0	5,2
Nitrates, thousand tonnes	46,4	76,4	72,5	48,8	36,2	56,1
Mineral nitrogen, thousand tonnes	63,9	86,7	117,6	51,5	41,3	72.2
Mineral phosphorous, thousand tonnes	4.0	7.5	7.6	5.1	2.0	5.2
Phosphorous, total, thousand tonnes	11.4	22.4	22.7	14.9	5.7	15.4
Silicon, thousand tonnes	1029	2470	962	1048	769	1256
Ferrum, thousand tonnes	52.1	75.0	71.3	32.3	30.3	52.2
Cuprum, tonnes	864	1133	1020	842	796	931
Zink, tonnes	3086	2777	3239	5611	3468	3636
Nickel (Ni), tonnes	2090	3380	1430	2540	1580	2204
Lead (Pb), tonnes	231	395	658	1060	371	543
Manganese (Mn), tonnes	973	1280	2060	697	283	1059
Chromium (Cr), tonnes	71.8	148	136	90	82.8	106
Molybdenum, tonnes	33.1	36.3	119	-	90.8	69.8
Cobalt (Co), tonnes	11.3	23.0	11.3	33.5	37.5	23.3
Cadmium (Cd), tonnes	9.6	0.43	-	-	19	9.7
Hydrargyrum (Hg), tonnes	2.3	0.23	3.6	3.3	-	2.4
Aluminium, tonnes	-	-	64.0	82.6	-	73.3
Phenols, thousand tonnes	0.32	0.41	0.48	0.35	0.34	0.38
Total Petroleum Hydrocarbons, thousand tonnes	15.7	22.1	15.8	7.1	24.4	16.8
DDT, tonnes	0.24	0.30	0.26	0.23	0.33	0.27
Dichlorodiphenylethylene (DDE), tonnes	0.36	0.56	0.51	0.30	0.51	0.45
Alfa-hexachlorocyclohexane, tonnes	0.28	0.32	0.44	0.38	0.29	0.34
Gamma-hexachlorocyclohexane, tonnes	0.23	0.14	0.18	0.23	0.35	0.23

Source: Monakhov 2014a; Monakhov 2014b; Monakhov 2015.

The majority of pollutant run-off into the Caspian Sea comes from the Volga. The contribution of the Terek River to pollutant run-off is limited to a few per cent of the total, with the exception of mineral nitrogen, for which its contribution averages 15 per cent. The concentration of pollutants in the Volga is slightly different to that in other rivers flowing into the Caspian Sea. The Volga is thus the main supplier of pollutants to the waters of the sea adjacent to the Russian Federation, and this is due to its high water content.

Sewage discharge

In 2015, 15.3 km^3 of sewage was discharged into the Caspian Sea basin (Russian Federation, Federal State Statistics Service 2011; Russian Federation, Federal State Statistics Service 2013; Russian Federation, Federal State Statistics Service 2015). This was 15 per cent less than in 2011. Contaminated wastewater accounted for 6.3 km^3 of the total. From 2012 to 2016, the volume of polluted sewage fell from 7.0 to 6.1 km^3 (Figure 4.6).

In the Russian Caspian region, the amount of sewage discharged into water bodies (including the Caspian Sea and the rivers flowing into it) averaged 0.82 km^3/year for the period 2012–2016, 0.15 km^3 (or 18 per cent) of which was contaminated wastewater.

Almost 80 per cent of wastewater generated annually in the Russian Caspian region in 2012–2016 was discharged into water bodies in the Republic of Dagestan; 17.8 per cent into water bodies in Astrakhan Oblast; and 2.7 per cent into water bodies in the Republic of Kalmykia.

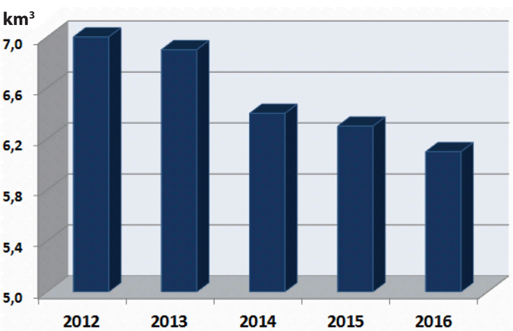


Figure 4.6: Discharge of polluted sewage into the Caspian Sea basin, 2012–2016

Source: Russian Federation, Federal State Statistics Service 2017b.

During the period 2012–2016, an average of 0.03 km^3 per year of polluted water was discharged into water bodies without being treated. Slightly more than half of this water was discharged into water bodies in the Republic of Kalmykia, 40 per cent into water bodies in the Republic of Dagestan,

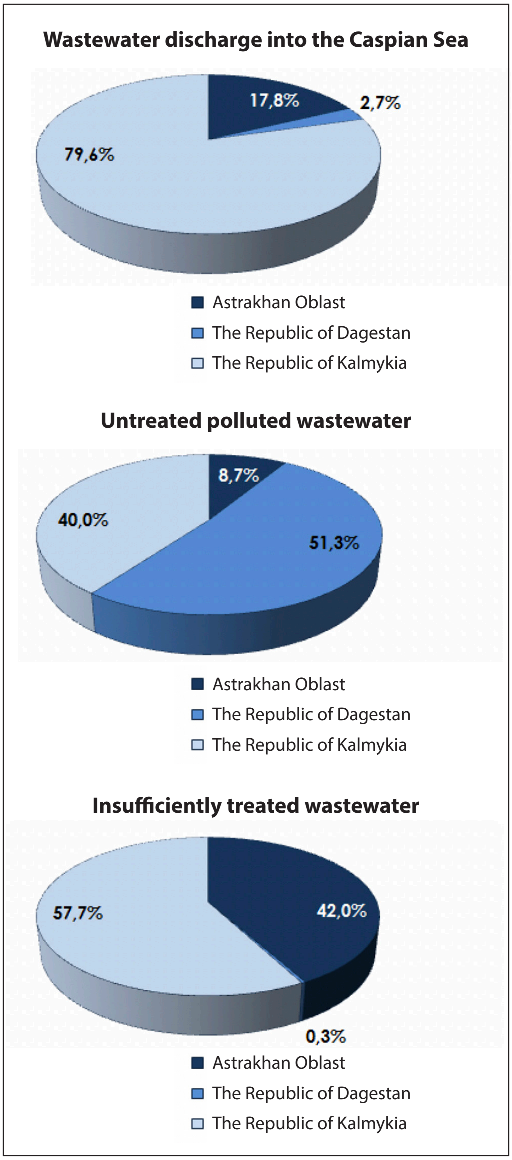


Figure 4.7: Average annual wastewater discharge, 2012–2016

Including untreated and insufficiently treated polluted wastewater, into the Caspian Sea and the rivers flowing into it from the territory of Astrakhan Oblast, the Republic of Dagestan and the Republic of Kalmykia.

Source: Russian Federation, Ministry of Natural Resources 2017.

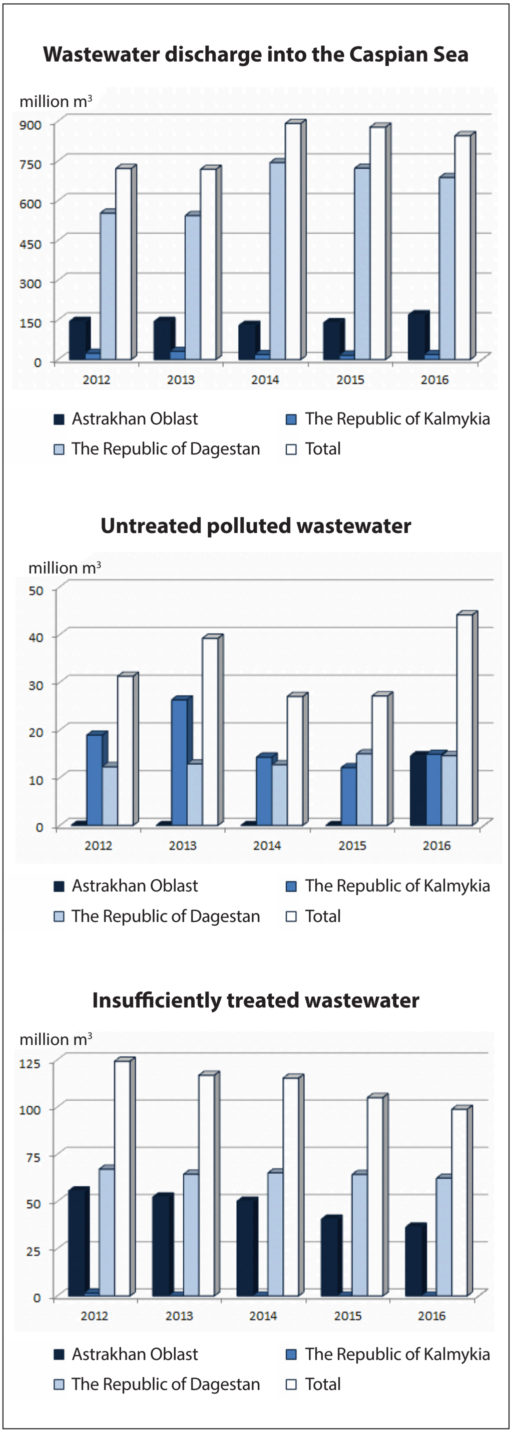


Figure 4.8: Discharge of wastewater into the Caspian Sea and rivers flowing into it, 2012–2016

From the territory of Astrakhan Oblast, the Republic of Dagestan and the Republic of Kalmykia.
Source: Russian Federation, Ministry of Natural Resources 2017.

and slightly less than 10 per cent into water bodies in Astrakhan Oblast.

An average of 0.11 km³ of polluted wastewater per year was insufficiently treated before being discharged into water bodies over the same period. Almost 60 per cent of this was discharged into water bodies in the Republic of Dagestan, over 40 per cent into water bodies in Astrakhan Oblast, and less than 1 per cent into water bodies in the Republic of Kalmykia (Figures 4.7, 4.8).

Pollution of precipitation

By observing the pollution of precipitation from the integrated background monitoring station on the Caspian coast (in the Damchik area of the Astrakhan Biosphere Reserve), it is possible to estimate the flow of pollutants from the atmosphere to the sea surface (Table 4.3).

Assuming that 100 mm of precipitation falls annually on the water area adjacent to the Russian Federation (which is close to the actual figure), and that this water area covers an area equal to the area of the bottom of the Russian Federation sector (63,400 km²), then the amount of precipitation falling on this water area annually will be 6.3 km³. Data on the concentration of pollutants in precipitation is available and so calculating precipitation flow from the atmosphere to the sea surface is straightforward. Comparison of pollutant volumes entering the sea with river run-off and with precipitation have shown that for a number of substances (for example, mercury), similar volumes of pollutants enter the sea from the atmosphere and from river run-off, and the amount of DDT entering the sea

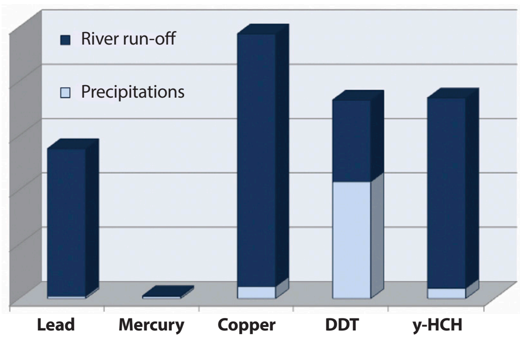


Figure 4.9: Pollutants entering the sea with atmospheric precipitation and with river run-off (in comparable units)

Table 4.3: Average concentration of pollutants in atmospheric precipitation at the integrated background monitoring station

Year	Pb µg/l tons/km³	Hg µg/l tons/km³	Benzopyrene ng/l kg/km³	DDT ng/l kg/km³	HCCH γ-isomer ng/l kg/km³	Cu µg/l tons/km³
1987–2016*	0.05–91.0	0.02–376.0	0.05–22.72	1.5–994	0.3–1,397	NA
2012	2.18	2.39	0.46	27.1	BDL**	12.0
2013	2.06	0.38	0.69	134.4	BDL**	13.0
2014	1.55	0.84	0.69	23.2	12.60	7.0
2015	0.92	1.62	0.58	67.2	3.68	1.9
2016	0.48	1.31	1.23	87.7	1.90	1.5
average	*1.44*	*1.31*	*0.73*	*67.91*	*6.06*	*7.1*

* limits of variability during observation period 1987–2016
** below detection limit
Sources: Monakhov 2014a; Monakhov 2014b; Monakhov 2015.

from the atmosphere is even higher than that which flows in with the river (Figure 4.9).

The volume of precipitation falling on the Caspian Sea is about five times lower than the volume of water flowing into it from rivers, and the salinity level of the precipitation is approximately 10 times lower than the salinity of the river waters. Precipitation therefore plays a minor role in the salt balance of the Caspian Sea, but the significance of some of the salts entering the sea (for example, nitrates and phosphates) is not limited to their role in the salt balance; they are much more important as nutrients.

The volume of mineral nitrogen entering the sea with precipitation in the water area adjacent to the Russian Federation (7,900 tons per year) is very similar to the volume which is discharged into the sea from the Terek River (Figure 4.10). Precipitation falling on the Caspian Sea therefore plays an important role in supplying nutrients to its ecosystem (a role which is at least comparable to that played by river run-off).

In addition to determining ionic composition, the network of Roshydromet stations also measures the zinc concentration in precipitation samples (Glavnaya Geofizicheskaya Observatoriya imeni A.I. Voyeykov 2011–2015). Analysis of the available data shows that atmospheric precipitation brings 7,200 tons of zinc into the sea, a comparable amount to that which comes from the Volga River (Figure 4.10).

Overall, run-off from the Volga River is the leading contributor to sea pollution from land-based sources in the Russian Federation. In absolute terms, the volume of pollutants entering the sea with river run-off at the beginning of this century was significantly lower when compared with the previous century.

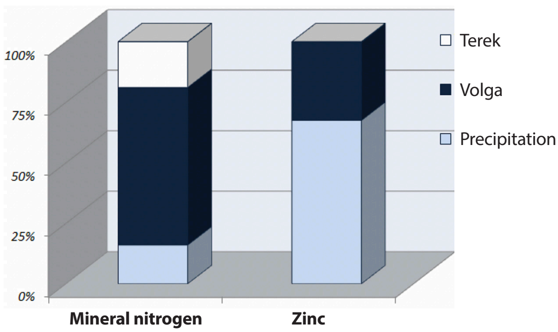


Figure 4.10: Intake of mineral nitrogen and zinc from precipitation and from Volga and Terek River run-off (%)

Turkmenistan is focused on the need to clean up hotspots like Soymonov Bay, which has been heavily polluted in the past by the refinery plant located on the shoreline. Wells have been drilled and equipped with pumping and separating equipment to extract polluted groundwater at the plant site, creating an effective system for removing oil pollutants from soil and groundwater. CaspEcoControl monitors water quality in Soymonov Bay. Based on the results of monitoring carried out from 2010 to 2017, the average oil product content in 2017 was 2.2 mg per litre. New treatment facilities have been built at the refinery plant, which has significantly improved the ecological situation in the region (National Contribution).

4.5. Atmospheric emissions

4.5.1. Greenhouse gas emissions

The Caspian region is a major contributor to atmospheric emissions. Greenhouse gas emissions have been increasing in the Caspian littoral states since 2000, though there was a dip during the global economic recession and decline in oil prices. Energy, including oil and gas extraction, industry, agriculture and waste are the main sectors contributing to greenhouse gas emissions. The Caspian littoral states continue to submit regular reports on their greenhouse gas inventories, potential climate change scenarios and the progress they have made to the United Nations Framework Convention on Climate Change (UNFCCC).

Oil and gas, transportation, industry and agriculture account for a significant share of the greenhouse gases emitted in Azerbaijan. Despite the fact that the country's GDP increased fivefold between 2005 and 2016, greenhouse gas emissions rose from 49.5 million tons in 2005 to 50.9 million tons in 2016 (Azerbaijan, State Statistical Committee of the Republic of Azerbaijan 2017). The energy sector is the largest source of greenhouse gases, accounting for around 75 per cent of emissions in Azerbaijan. The agricultural industry is one of the main producers of methane and nitrous oxide. Greenhouse gas emissions in this industry increased from 6.5 million tons in 2005 to 7.1 million tons in 2016. In 2012, Azerbaijan switched from liquid fuel to natural gas, which is used in industry and public utilities, as well as in the energy sector. The use of environmentally friendly and safe compressed natural gas, including for public transport, further contributes to reducing greenhouse gas emissions (Azerbaijan, State Statistical Committee of the Republic of Azerbaijan 2017).

Iran has not submitted a report to the UNFCCC since its initial contribution in 2003. In 2000, CO_2 emissions totalled approximately 375 million tons, of which 90 per cent came from the energy sector, 8 per cent from the industrial sector and 2 per cent from forestry (Iran, Department of Environment 2003). As in the rest of the Caspian littoral states, the oil and gas industry is a staple of the Iranian economy. However, the most recent atmospheric emissions data for Iran is from 2000.

Greenhouse gas emissions also increased in Kazakhstan, from 162 million tons of CO_2 equivalent in 2000 to 271 million tons in 2011. There are, however, some regional variations. Following strategic efforts by the Government of Kazakhstan in Mangystau Region, which borders the Caspian Sea, greenhouse gas emissions are declining in this region. For instance, total emissions from industry, the main emitter, fell from 72,500 tons in 2015 to 65,800 tons in 2016 (Kazakhstan, Ministry of National Economy of the Republic of Kazakhstan Statistics Committee 2009–2018).

To reduce atmospheric emissions in Mangystau Region, all large and small energy facilities, including municipal and private boiler plants, have been fully converted to gas. There has been an increase in the number of vehicles running on gas fuel. As of 1 January 2018, 88,513 (53.3 per cent) of the 166,005 registered vehicles in the region were equipped with liquefied petroleum gas (LPG) systems and there were 211 LPG filling stations in the region (Kazakhstan, Ministry of National Economy of the Republic of Kazakhstan Statistics Committee 2009–2018).

The Russian Federation ranks fourth in the world for greenhouse gas emissions. At the federal level, excluding changes in land use and forestry, emissions fell by 29.6 per cent between 1990 and 2015.

4.5.2. Pollutant emissions

To comply with European Union legislation, Azerbaijan has adopted a number of laws, state programmes and regulatory acts in recent years. As the country's emissions are closely associated with the energy sector, the priorities are to improve energy efficiency, increase energy savings and make more use of alternative energy sources. The country is looking to alternative energy sources and the development of low-carbon measures in the commercial and residential sectors to reduce carbon emissions by 35 per cent by 2030 compared to the base year (1990). The transition from fuel oil to gas in the energy sector is already complete.

In 2016, annual emissions by industrial enterprises in Atyrau Region totalled 167,100,000 tons, 80–85 per cent of which were emissions from the oil and gas sector. Gas flaring is the primary source of these emissions. In 2016, 189 million m^3 of associated petroleum gas were flared (Kazakhstan, Ministry of National Economy of the Republic of Kazakhstan Statistics Committee 2009–2018).

During the period 2012–2016, average annual pollutant emissions in the Caspian region of the Russian Federation amounted to 489,000 tons, of which the Republic of Dagestan accounted for 47.6 per cent, Astrakhan Oblast for 44.8 per cent, and the Republic of Kalmykia for 7.6 per cent (Russian Federation, Federal Service for the Oversight of Customer Protection and Welfare 2012–2016). In both the Republic of Dagestan and the Republic of Kalmykia, the main source of emissions is motor transport, which accounts for 94 per cent and 89 per cent of emissions in Dagestan and Kalmykia, respectively. Emissions from stationary sources are the most significant factor in Astrakhan Oblast, contributing 57.4 per cent of emissions. The main source of emissions here is the Astrakhan Gas Processing Plant (Russian Federation, Federal Service for the Oversight of Customer Protection and Welfare 2012–2016).

Turkmenistan submitted its third National Report in 2015 (Turkmenistan, Ministry of Nature Protection of Turkmenistan 2015). Greenhouse gas emissions have risen sharply in Turkmenistan since 1998, primarily due to the rapid development of industry. As in other littoral states, the majority of greenhouse gas emissions come from the energy sector, followed by agriculture and industry. It should be noted that the growth trend observed since 1994 has been somewhat reduced, and that there has been a fall in emis-

sions since 2008 due to the introduction of modern technologies in the oil and gas industry.

The following main production enterprises are located in the coastal zone of the Turkmenistan sector of the Caspian Sea: Turkmenbashi Complex of Oil Refineries, Turkmenbashi Central Heat and Power Plant, Garobogaz Sulfat in the town of Garabogaz, Turkmenbashi Non-metallic Construction Materials Plant, Kenar Oil Storage and Offloading Terminal, Balkanbalyk, a state-owned company in the city of Turkmenbashi, Hazar Chemical Plant in Hazar, Turkmenbashi International Seaport and Galkynyshknebit, an oil and gas production management company in Hazar. Transport is also contributing to air pollution. Greenhouse gas emissions from these sources have increased due to an expansion in the scale of activity (the commissioning of new equipment which adds new sources of pollution).

Turkmenistan has installed and is making use of new compressor stations to recover previously flared gas to increase oil production. Any residual associated gas is now funnelled through pipelines to consumers instead of being released into the atmosphere (United Nations Development Programme [UNDP] Turkmenistan 2010). The country has also prioritized the replacement of old power stations with newer and more efficient facilities. These have the potential to lower greenhouse gas emissions by 67.5 million tons of CO_2 equivalent over the period 2010–2030 (UNDP Turkmenistan 2010).

According to the State Statistical Committee, 3,353 enterprises and organizations, 11,248 vehicles and 62 means of water transport were examined in 2017. Of these, 1,173 enterprises and organizations, 1,626 vehicles and 16 means of water transport were found to have exceeded standards for pollutant discharge into water bodies and atmospheric emissions (Turkmenstat 2018).

4.6. Solid waste

The generation of industrial and municipal waste is closely linked to overall regional economic development. The Caspian littoral states produce huge amounts of industrial waste, some of which is associated with the oil and gas sector.

It should be borne in mind that if the coastal area is polluted with waste, this could become a source of sea pollution if the area floods due to strong waves or surges. The accumulation of litter in riverbeds, which is then washed out into the sea during flooding, constitutes another potential source of pollution. Information on solid waste management in coastal areas is therefore important for assessing the anthropogenic load on the Caspian Sea.

Landfill sites are a commonly used approach to solid waste management, but these offer limited opportunities for recycling valuable secondary materials. Landfill sites are often over-exploited, in poor technical condition and fail to comply with sanitary and epidemiological requirements; waste is not separated or recycled. Uncontrolled or unauthorized waste disposal is also a problem in the region, leading to the pollution of local land and marine ecosystems.

The volume of waste generated varies across the region. While a reduction in the volume of waste generated has been observed in some countries, others are seeing an increase due to higher levels of consumption and increased urbanization as more people move to the cities. In Azerbaijan, for example, there has been an increase in the volume of plastic, polymer materials and hazardous waste such as electronic and electrical waste.

An incinerator and sorting plant has been serving the residents of Baku since 2012, turning household waste into energy (Decree of the President of the Republic of Azerbaijan 2012). With the help of the World Bank, Azerbaijan funded the rehabilitation of the Balakhani landfill site, as well as the closure and remediation of 154 ha of illegal dumps. A hazardous waste landfill site was built near Sumgayit to manage hazardous waste in accordance with international norms and standards. Appropriate measures have been taken to clean up the oil-polluted areas on the Absheron Peninsula, as well as in other parts of Azerbaijan.

The Absheron Lakes Clean-up and Rehabilitation Project is being implemented as part of the State Programme for the Socioeconomic Development of the City of Baku and its Settlements. Part of Lake Boyukshor, the largest lake on the Absheron Peninsula, has evolved from being an environmentally hazardous area to becoming a recreational area in a short period of time. During the first phase of the project, 2.8 million m^3 of highly contaminated sediment were treated. Protective measures that removed all household and construction waste from the lake and its shores were implemented (National Contribution).

Kazakhstan is one of the world's largest producers of hazardous waste. Almost 100 per cent of the waste generated in the country is hazardous (Nugumanova et al. 2017). Some parts of the Caspian shore still suffer from industrial pollution accumulated as a result of oil and gas extraction. The consequences of such pollution are dispersed across more than 350,000 thousand ha of Mangystau Region, and the situation in Atyrau Region is similar (Republic of Kazakhstan 2014–2016).

There are about 28 landfill sites for municipal solid waste in the districts bordering the Caspian Sea in Kazakhstan, only eight of which have licences or operational permits. About 87 per cent of the population here has access to appropriate services. For example, as of 1 January 2018, 89.9 per cent of people in Mangystau Region were living in settlements with landfill sites that met environmental requirements (Republic of Kazakhstan 2014–2016). The Solid Waste Management Programme was launched in Atyrau District in 2014 (Republic of Kazakhstan 2014–2016), with a focus on managing landfill sites and waste-to-energy projects. The programme aims to build 10 new landfill sites.

Some work on recycling household waste has been done in Mangystau Region. For instance, an experimental sorting line with a capacity of 50,000 tons of domestic waste – almost a third of the total waste generated – was launched in Aktau in 2018. To support these efforts, the municipality of Aktau has installed special collection containers, including containers for mercury-contaminated waste. The first solid domestic waste processing plant in Mangystau Region began operations in 2014. In 2017, 13.8 per cent of municipal solid waste was sorted and disposed of in Mangystau Region, and efforts to improve the waste management programme are ongoing (Republic of Kazakhstan 2014–2016).

Over the past few years, the Government of Kazakhstan and the private sector have agreed on the need to rehabilitate land affected by industrial pollution from oil and gas production, and practical steps have been undertaken to improve the situation in some areas. As a result, about 20 ha of contaminated land in Atyrau have been restored using biological methods. The goal of this work is to prevent, reduce and control pollution of the marine environment, and to comply with the "zero-discharge" policy.

Regional waste management (including municipal solid waste management) plans currently offer the most comprehensive source of information on waste management in the Caspian region of the Russian Federation. These plans were developed and approved by the executive authorities in the Russian Federation regions bordering the Caspian Sea in 2016, in accordance with the Resolution issued by the Government of the Russian Federation on 16 March 2016: "On approval of requirements for the composition and content of regional waste management, including municipal solid waste management, plans" (Russian Federation 2016).

The Caspian region of the Russian Federation generates 1.7 million tons of industrial and municipal waste annually, including waste from the metallurgical, oil and gas, chemical, pharmaceutical, construction, textile, processing and other industries. This waste includes 30.2 tons of class 1 hazardous waste; 7,800 tons of class 2 hazardous waste; 39,900 tons of class 3 hazardous waste; 1.3 million tons of class 4 hazardous waste; and 320,200 tons of class 5 hazardous waste[6] (Hazard Classes, GOST 12.1.007-76, 1976). The volume of municipal solid waste, which makes up the majority of production and consumer waste, produced in the Caspian region of the Russian Federation totals 1.3 million tons per year, of which 465,100 tons (33.8 per cent) is produced in coastal municipalities, with urban settlements accounting for 283,100 tons and rural areas for 182,000 tons.

The Republic of Dagestan produces the most waste – 1,068,300 tons (including 784,500 tons of municipal solid waste) – followed by Astrakhan Oblast with 523,000 tons (including 490,900 tons of municipal solid waste), and the Republic of Kalmykia with 107,300 tons (including 102,300 tons of municipal solid waste).

The coastal municipalities of the Republic of Dagestan generate 382,700 tons of municipal solid waste annually; in Astrakhan Oblast this figure is 76,300 tons and in the Republic of Kalmykia – 6,700 tons.

Only a small proportion of the production and consumer waste generated annually in the Caspian regions of the Russian Federation is neutralized and recycled: 75,400 tons (4.4 per cent of the total) and 44,800 tons (2.6 per cent of the total), respectively. Astrakhan Oblast neutralizes and recycles the most waste, accounting for 100 per cent of neutralized waste and 57.6 per cent of recycled waste. The Republic of Kalmykia does not neutralize or recycle any of its waste (hazardous waste falling in classes 1–3 is sent to other regions of the Russian Federation for neutralization).

The main environmental problem relating to waste management in the Russian Federation is the use of landfill sites that do not meet the required standards or sites that are not intended for waste disposal. One of the reasons for this is the lack of specialist waste disposal facilities. Astrakhan Oblast has seven such facilities, including two in coastal areas; the Republic of Kalmykia and Republic of Dagestan each have one specialist landfill facility, one of which is located in a coastal area.

The concern of the Caspian littoral states regarding the problem of waste accumulation is reflected in the urgent measures that are being taken to address it.

In the Russian Federation, there are plans to build one new specialist waste disposal facility in Astrakhan Oblast and another in the Republic of Kalmykia in the near future, while four new landfill sites are planned for the Republic of Dagestan, all of which will be in coastal areas. Twenty-two waste sorting facilities are set to be built in Astrakhan Oblast and the Republic of Dagestan, split evenly across both regions. Eight of these will be in coastal areas (also equally spread across the two regions). There are also plans to create waste handling facilities in all administrative districts of the Republic of Kalmykia (including one near the coast).

4.7. Marine litter

The Protocol for the Protection of the Caspian Sea against Pollution from Land-Based Sources and Activities (Moscow Protocol 2012) seeks to "…prevent, control, reduce and to the maximum extent possible eliminate pollution of the marine environment from land-based sources and activities in order to achieve and maintain an environmentally sound marine environment of the Caspian Sea."

The protocol covers categories of substances identified on the basis of their hazardous or otherwise harmful characteristics, including marine litter, which is defined as "any persistent, manufactured or processed solid material which is discarded, disposed of or abandoned."

In accordance with the Moscow Protocol, priorities for action should be established by assessing the relative importance of impacts on marine and coastal ecosystems and resources, and on public health.

The sources of marine litter in the Caspian Sea are inadequate management of municipal waste, coastal tourism, improper disposal of hazardous waste, fishing and shipping. It should also be noted that fluctuations in sea level are an important source of marine litter, most of which comes from land-based sources.

Since the data available on marine debris are scarce, it is likely that the magnitude of the problem is even greater than visual observation would suggest, and that sources such as illegal dumping from ships could be making a significant contribution to marine pollution (Caspian Environment Programme [CEP] 2009). Abandoned, lost or discarded fishing gear is also a significant source of pollution worldwide. Plastic accounts for the largest share of marine debris and is associated with land-based sources of pollution and the dumping of waste into the sea.

The amount of marine litter produced by aquaculture has not been estimated at the global level, but studies conducted in various locations show that such litter may be having a significant impact on ecosystems. Litter from aquaculture can take the form of lost cages, tiers, pillars and other floating and stationary objects. Microplastics may also be found in the sea due to the deterioration of plastic pipes used in marine aquaculture.

In recent years, the international scientific community has paid greater attention to the impact of plastics on the marine environment, in particular the possible socioeconomic costs associated with disrupting ecosystem services and the potential risks to human health resulting from the introduction of microplastics into the fish food chain. These are important factors to consider when managing current and future aquaculture or other fishery enterprises in or near the Caspian Sea (Christensen 2017).

At present, there is no reliable information on the presence or amount of litter discharged into the coastal or marine environment of the Caspian Sea. This is an issue which requires particular attention, especially as regional measures may be required to address it.

4.8. Tourism and recreation

The Caspian Sea accounts for a small share of global tourism. Most tourists in these countries are domestic or regional tourists. The Caspian littoral states are not considered to be major global tourism destinations for a number of reasons (see Tourism section). However, seasonal tourist flows to the Caspian Sea coastline are an important factor in the discussion of environmental impact.

The growth of amateur fishing as a recreational activity is occurring in an uncontrolled fashion, with very little in the way of restrictions. No special studies have been carried out to determine the impact of amateur fishing on aquatic biological resources, and no work has been done to develop optimal regulations for this type of fishing, resulting in additional pressure on the region's aquatic biological resources.

The tourism industry can have both positive and negative social and environmental impacts, depending on a number of factors, such as how it is managed, how it develops and whether planning takes account of local conditions. To ensure that

tourism is sustainable, it is vital that it develops and grows within the limits of the ecosystems on which it depends. The loss or degradation of arable land, the generation of household waste and the discharge of wastewater are just some of the possible adverse effects. Tourism is a source of marine litter in the Caspian Sea. In Iran, seasonal tourists, who mostly come from Tehran to spend their vacation on the Caspian shore, are the source of large amounts of waste and marine litter (CEP 2009).

Where the quality and sustainability of the natural environment are crucial to the survival of the industry, tourism can, in some cases, contribute to conservation efforts. Beaches that are polluted with plastic can discourage tourists from visiting, and since tourism is an important source of income for local residents, they have an incentive to keep beaches clean so that they continue to attract tourists. This is the case, for example, in the Caspian coastal zone of Iran (CEP 2009).

From a social perspective, a sharp increase in the population, even if only in the short term, can lead to a shortage of resources and a decrease in the purchasing power of local residents. However, tourism can help to create employment and business opportunities, upgrade infrastructure and mobilize investment to achieve environmental or social goals (Stanciu et al. 2016). To ensure that tourism is sustainable, the potential environmental and social impacts must be taken into account. An alternative to high-performance tourism is sustainable ecotourism, which can provide both socially and environmentally sustainable livelihoods.

5. State

5.1. Changes in bioresources

There have been significant changes in the state of the biological resources in the Caspian Sea over the past 10–15 years, during which zooplankton numbers and biomass have fallen five- or six-fold in the Middle Caspian and approximately tenfold in the Southern Caspian. The biomass and number of Mnemiopsis leidyi comb jellies on the western shelf of the Central and Southern Caspian increase significantly from summer to autumn. Thus, the Mnemiopsis leidyi, which was brought to the Caspian Sea with ballast water in the late 1990s, spread rapidly, causing direct and extensive damage to the biodiversity of the sea. It consumed large amounts of zooplankton, which is a food source for sprat, and this led to a decrease in the food source available to Acipenseriformes, predatory Clupeidae, and others along the food chain (Azerbaijan Scientific-Research Fisheries Institute).

Most of the benthic animals on the western coast of the Caspian Sea are molluscs, crustaceans and worms. Plankton larvae, such as Mitilyaster, Abra, Balanus, and crab have fallen victim to the Mnemiopsis leidyi in the Southern Caspian to the extent that, in recent years, Abra and crab numbers have declined significantly and the species are rarely encountered in the benthos, if at all. No spots created by a high benthic biomass as a result of the mass development of Abra, Cerastoderma or Nereis are found on the western coast of the Southern Caspian, compared with data from previous years (National Contribution).

The superior numbers of Abra and crab, which created an abundant benthos in the Southern Caspian in previous years, compared with Nereis and Balanus, have not been recorded in recent years. However, the high numbers of worms and molluscs in the benthic fauna have created a decent food source for fish at all trophic levels in the western region of the Southern Caspian (Azerbaijan Scientific-Research Fisheries Institute). This is illustrated in Tables 5.2 to 5.6, below.

Table 5.1: Biomass of Mnemiopsis (g/m^3) in the Azerbaijan sector of the Middle and Southern Caspian

Sea area	2011	2012	2013	2014	2015	2016
Middle Caspian	1.8	3.3	2.5	5.8	8.2	7.6
Southern Caspian	6.83	5.98	4.13	9.34	11.9	6.7

Source: Azerbaijan Scientific-Research Fisheries Institute.

Table 5.2: Biomass of the Southern Caspian zoobenthos (g/m^2)

Organism	2010	2011	2012	2013	2014	2015	2016
Vermes	3.25	5.16	2.11	1.47	3.98	5.34	1.02
Crustacea	2.07	4.85	12.01	7.69	9.26	8.05	8.75
Mollusca	1.85	1.37	5.1	8.23	14.02	11.26	6.29
Total	7.174	11.38	20.22	17.39	27.26	24.65	16.06

Source: Azerbaijan Scientific-Research Fisheries Institute.

Table 5.3: Biomass of the Middle Caspian zoobenthos (g/m^2)

Organism	2010	2011	2012	2013	2014	2015	2016
Vermes	5.5	7.93	10.8	2.81	3.48	6.53	4.13
Crustacea	10.1	13.47	17.93	10.12	12.06	9.02	8.12
Mollusca	4.0	8.11	12.05	11.36	5.13	20.48	7.16
Total	19.6	29.51	40.78	24.29	20.67	36.03	19.41

Source: Azerbaijan Scientific-Research Fisheries Institute.

Table 5.4: Zooplankton numbers (specimens/m^3) and biomass (mg/m^3) in the Azerbaijan sector of the Caspian Sea

Year	Middle Caspian		Southern Caspian	
	Number (specimens/m^3)	Biomass (mg/m^3)	Number (specimens/m^3)	Biomass (mg/m^3)
2011	10,323.2	275.4	3,326.7	88.1
2012	10,620.8	301.8	4,005.7	104.3
2013	12,747.5	312.9	4,109.0	102.8
2014	11,620.5	308.6	4,225.7	110.5
2015	12,116.4	352.4	3,835.2	96.9
2016	11,903.3	347.8	3,753.6	106.3

Source: Azerbaijan Scientific-Research Fisheries Institute.

Given the distribution of fish habitats, there is a need to distinguish between breeding grounds, feeding grounds and wintering grounds. The western coast of the Middle Caspian (Azerbaijan sector) plays a decisive role in the formation of the ichthyofauna of the entire sea. Here, at depths of 10–50 m, are silty-sandy, sandy-silty and silty-shell soils, which are considered to contain the highest populations of benthic feed organisms. It is therefore in this area that the juveniles of migratory and semi-migratory fish concentrate for feeding. In addition, male fish from migratory and semi-migratory species gather ready for breeding in this area of the Middle Caspian, close to the mouths of the Terek, Samur and smaller rivers. The region becomes particularly important during the spring-summer period, and to a lesser extent, in autumn. Herrings and sprats come to the Yalama-Shabran zone of the Middle Caspian coast for breeding. This area belongs to the mixing zone, at a depth of 10–50 m. During spring, young sturgeon also flock here to feed. Areas along the western coast of the Middle and Southern Caspian are home to sturgeon wintering and feeding grounds in shallow marine pastures which are 10–40 m in depth. The entire western coast of the Middle and Southern Caspian can therefore be considered a zone of sensitive fish habitats.

The aquatic biological resources industry in the Volga-Caspian fisheries region of the Russian Federation is based primarily on semi-migratory fish species. It has been established (Ivanov 2000) that annual stock replenishment depends on the

Table 5.5: Zooplankton numbers (specimens/m³) and biomass (mg/m³) in the Azerbaijan sector of the Middle Caspian Sea

Indicator	2011	2012	2013	2014	2015	2016
Overall mean number	10,323.2	10,620.8	12,747.5	11,620.5	12,116.4	11,903.3
Overall mean biomass	275.4	301.8	312.9	308.6	352.4	347.8

Source: Azerbaijan Scientific-Research Fisheries Institute.

Table 5.6: Zooplankton numbers (specimens/m³) and biomass (mg/m³) in the Azerbaijan sector of the Southern Caspian Sea

Indicator	2011	2012	2013	2014	2015	2016
Overall mean number	3,326.7	4,005.7	4,109.0	4,225.7	3,835.2	3,753.6
Overall mean biomass	88.1	104.3	102.8	110.5	96.9	106.3

Source: Azerbaijan Scientific-Research Fisheries Institute.

timing and volume of the spring high water in the Volga River: the greater the river run-off, the higher the juvenile survival rate and spawning productivity. In 2015, the spring high water reached a critical minimum, and stock replenishment of semi-migratory species was therefore estimated as low.

Unregulated fishing by amateur fishers also is also reducing commercial stocks of semi-migratory species. Amateur fishers catch 19 species of fish, mostly Caspian roach, bream, catfish, pike, pike perch, carp, rudd, crucian carp, white bream, perch, blue bream, sabre carp, roach, Volga pikeperch, asp, ruffe, tench, white-eyed bream and herring.

A steady decline in commercial stocks of valuable fish species in the northern part of the Caspian Sea was observed during the period 2010–2016. Commercial stocks of semi-migratory Caspian roach and tench fell, while stocks of other freshwater fish species tended to increase.

Sturgeon are transboundary species which feed in the waters of all Caspian littoral states. No Caspian-wide acoustic trawl surveys have been conducted over the last decade to estimate total sturgeon numbers and biomass.

Russian sturgeon. The highest catches of Russian sturgeon (14,100–14,600 tons) were recorded in 1980–1981. From 2005 to 2016, depending on the need for breeding, catches of Russian sturgeon ranged from 195 tons (2005) to 4.62 tons (2016). Commercial stocks amounted to 5,350 tons in 2015, 2.5 times lower than in 2010. They continued to maintain a downward trend in 2016, totalling no more than 3,880 tons.

Persian sturgeon. The absolute population size in 2015 was 0.696 million specimens, representing a decline by a factor of 4.7 compared with 2010. Commercial biom ass fell from 920 to 280 tons. The 2016 catch amounted to 0.03 tons. Total stocks of Persian sturgeon in 2016 amounted to 0.582–0.43 million specimens with a biomass of 1,610–1,040 tons.

Stellate sturgeon. The largest catches of stellate sturgeon in the Caspian Sea basin (over 5,000 tons) were recorded in the first years after the ban on sea fishing was introduced, with a subsequent decrease in the late 1980s to 2,990 tons, and to 200 tons in the 1990s. In 2010–2014, catches for breeding and research purposes varied within a range of 0.14-1.65 tons. The absolute number was estimated at 0.94 million specimens in 2015, with a commercial biomass of 2,460 tons, representing declines by factors of 2.4 and 2, respectively, when compared with 2010. The stellate sturgeon catch in 2016 was no higher than 42 kg.

Sterlet. Over the last five years of observation, the number of sterlet has fallen from 0.166 million to 0.104 million specimens, and the commercial biomass has decreased from 34.3 to 29.2 tons.

Beluga. There was a steady decrease in the absolute number of beluga (from 0.466 million to 0.228 million) and commercial stocks of the fish (from 8,080 to 4,060 tons) between 2010 and 2015.

Fishing for Caspian marine species is undergoing a revival on the basis of reserve species: common sprat and all species of sea herring (Caspian marine shad, saposhnikovi shad and Alosa caspia, Atherina and mullet). The priority is to exploit aquatic biological resources near the Dagestan coast.

In the Russian Federation, the raw material base of the most abundant commercial semi-migratory and river fish species (Caspian roach, bream, carp and pike) is experiencing significant stress. The species bear the brunt of the pressure from fishing, with 82.6 per cent (49,200 tons) of the allowable catch and recommended catch utilized. At the same time, stocks of such species as catfish, pike and "other" fish are satisfactory.

Currently, commercial resources of marine fish species with sufficient reserves (migratory sea herring, common sprat, Atherina, mullet) continue to be shaped primarily by natural population decline.

According to the results of an aerial survey conducted in 2012, the Caspian seal population was estimated to be 270,000–330,000. The correction of aerial photographs of broodstock from 2012 using ship route registration in 2015 confirms that the total Caspian seal population in the Caspian Sea has stabilized. Preliminary calculations showed that the seal population was projected to remain at up to 266,000 and commercial sealing levels in the Russian Federation region could be set at 6,000.

In February 2015, the main Caspian seal whelping grounds were located on ice fields with an ice thickness of 10–15 cm, in both the Russian Federation and Kazakhstan sectors of the Northern Caspian. The distribution pattern of producing females was the same as in 2014, when the whelping grounds were located along the ice edge from east to west. In the western part of the Northern Caspian, the Caspian seal population varied considerably from season to season in 2015, from a minimum of 19,310 in summer to a maximum of 68,040 in spring and autumn. Photographs showed that the seals used 700 autumn grounds on sandbanks, twice as many as in autumn 2014.

The main biological indicators for broodstock and seal pups in autumn 2015 were within the normal range for this period. Compared with 2014, the average density (0.74 seals/km^2) in the Northern Caspian increased by 14 per cent in spring. The fattening average concentrations of Caspian seals in the sea increased by 42 per cent in summer and by 232 per cent in autumn (Kuznetsov et al. 2016).

The inter-annual trend in the taxonomic composition and quantitative indicators of the macrozoobenthos in the north-eastern part of the Caspian Sea is characterized by minor fluctuations. The taxonomic composition in the study area comprised 53 taxa in summer 2017 compared with 59 in 2016, and 31 taxa in autumn 2017 and autumn 2016. Numbers were slightly higher in summer 2017 than in summer 2016, but the biomass was slightly lower than in 2016. Worms made up a dominant proportion of hydrobionts in summer 2017 and 2016, while worms and molluscs dominated the biomass. In autumn 2017, the numbers and biomass were slightly higher than in autumn 2016. Worms dominated in numbers, and shellfish in biomass. The population trend has been highly variable in recent years, as illustrated in Table 5.7 below.

As in previous study years (2007–2014), the community structure in 2015 was characterized by the persistent dominance of worms (in terms of numbers) and molluscs (in terms of biomass). The composition of dominant species in the leading groups experienced a small degree of change.

Table 5.7: Trends in the main characteristics of the macrozoobenthos in the Kazakhstan part of the Caspian Sea

Year of study		Number of species	Number	Biomass
2011		27	3,719	7.31
2012		41	7,810	19.22
2013	August September	46 25	5,030 4,877	8.25 9.83
2014	July–August September	42 28	5,906 5,936	11.17 16.46
2015	July September	32 25	6,123 4,543	13.35 9.64
2016	July–August September	59 31	6,313 4,764	17.64 9.10
2017	May July September	24 53 31	7,800 9,232 6,993	8.36 16.39 12.23

Source: National Contribution.

The qualitative and quantitative indicators of the macrozoobenthos in recent study years are therefore within the limits of fluctuations in long-term values.

5.2. Quality of seawater and incoming fresh water

Systematic monitoring of the state of the environment in the Caspian Sea basin, including monitoring of the quality of seawater and bottom sediment, is carried out by the national hydrometeorology services. In addition, companies and enterprises whose work may negatively impact the environment, such as those engaged in oil production, oil refining, the chemical industry, etc., are regularly monitored in the Caspian littoral states.

The National Hydrometeorology Department of the Azerbaijan Ministry of Ecology and National Resources is responsible for monitoring and forecasting hydrometeorological processes in the western section of the Caspian Sea.

Hydrometeorological monitoring of the Caspian Sea is carried out by the National Hydrometeorology Department's Marine Hydrometeorology Centre. The centre operates a monitoring network consisting of 14 observation posts located on the sea shore, islands and platforms. In addition, ship expeditions supply the centre with hydrometeorological data collected at sea. The centre conducts hydrometeorological data monitoring, collection, analysis, and collation, and compiles annual maritime reports. In recent years, the marine monitoring network has been upgraded with modern equipment, including data automation tools. Daily, monthly and annual data is collated in the annual maritime reports (National Hydrometeorology Department).

As noted above, 25 large and small rivers flow into the Caspian Sea through Azerbaijan. Many of them receive communal, agricultural and industrial wastewater. The increase in domestic wastewater discharge from developing coastal cities and settlements is a significant cause behind the decline in seawater quality.

The Caspian Complex Environmental Monitoring Department of the Ministry of Ecology and Natural Resources is the authorized agency for ecological monitoring of the quantitative and qualitative indicators of anthropogenic impact on the environment in the Azerbaijan sector of the Caspian Sea and its adjacent coastline. State monitoring of water sources and pollution of water sources is carried out by the Department in coastal areas and offshore.

Pollution and other environmental indicators in the southern sector of the Caspian Sea are monitored by the Meteorological Department of the Ministry of Roads and Urban Development of the Government of Iran (IRIMO).

The Atyrau and Mangystau regional branches of Kazhydromet carry out regular monitoring of the state of marine waters in the Kazakhstan sector of the Caspian Sea. The Atyrau Region monitoring network consists of 46 sampling points: at the Maritime shipping canal, at the Tengiz oilfield, in the Ural River delta-front, in the Middle and Northern Caspian (near the Kurmangazy, Darkhan and Kalamkas oilfields, near flooded wells and on Kulaly Island), and along the long-term cross section – Shalygi and Kulaly Islands – and two additional cross sections (National Contribution).

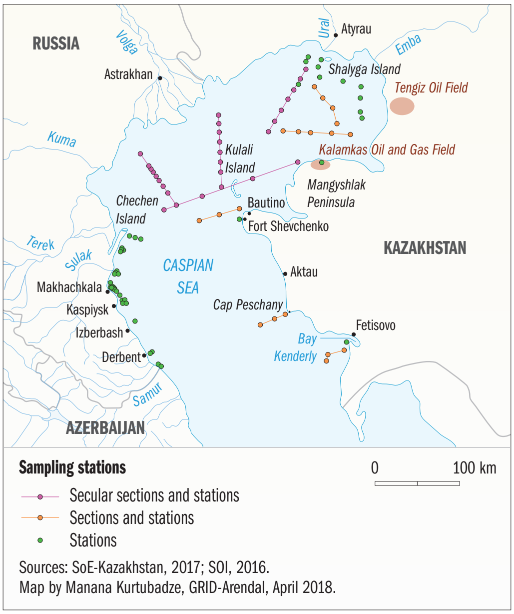


Figure 5.1: Marine water observation network in Russia and Kazakhstan

Kazhydromet publishes information on the state of seawater in the State of the Environment of the Kazakhstan Part of the Caspian Sea Fact Sheet (Kazhydromet Fact Sheets 2011-2016) and in a similar publication dedicated to the Aktau Seaport special economic zone. Samples of seawater and bottom sediment are taken at coastal stations, along long-term cross sections and near oilfields on the shelf of the Northern (Atyrau Region) and Middle (Mangystau Region) Caspian.

The suspended solid content, pH, dissolved oxygen and biological oxygen demand (BOD5) levels, and concentrations of petroleum hydrocarbons, phenols, total chlorine, phosphates, ammonium, nitrite and nitrate nitrogen and metals (copper, manganese, zinc, nickel, lead, total iron, and chromium6+) of the seawater samples are determined. For bottom sediment samples, the total volume of petroleum hydrocarbons and concentration of heavy metals (copper, nickel, chromium6 +, manganese, zinc, lead and cadmium) are analysed.

Water sampling is carried out monthly at the Aktau Seaport special economic zone (four monitoring points). The Kazhydromet branch for Atyrau Region analyses water samples from all monitoring points on the basis of 45 indicators, while the analysis by the Mangystau Region branch covers 28 indicators. Water sample analysis is carried out by the Kazhydromet Integrated Laboratories for the Atyrau and Mangystau Regions.

During oil and gas exploration in the Kazakhstan sector of the Caspian Sea, organizations managed by KazMunayGas conduct background environmental studies, environmental impact assessment and subsequent monitoring at every stage of operations. The following indicators are monitored: oil products, phenols, nitrites, nitrates, ammonium nitrogen, iron, phosphates, salinity, BOD5, dissolved oxygen, temperature, calcium, magnesium, carbonates, hydrogen carbonates, anionic surfactants, cationic surfactants and pH (National Contribution).

The quality of seawater in the Northern Caspian was assessed as "clean", and seawater at coastal stations, near the Karazhanbas and Arman oilfields in the Middle Caspian, was assessed as "moderately polluted". In the Karazhanbas area, and along the Kenderli–Divichi, Peschanniy–Derbent and Mangyshlak–Chechen cross sections, seawater quality was assessed as "clean" (Monakhov 2014a; Monakhov 2014b; Monakhov 2015).

Data from the monitoring carried out by Roshydromet as part of a special extended programme at more than 100 stations were used to assess pollution and seawater quality in the northern and north-western part of the Caspian

Table 5.8: Main chemical composition and marine pollution indicators in areas close to oilfields

Indicator	Horizon	Concentration in 2017		Background concentration	
		Filanovsky Field	Korchagin Field	Historical*	Contemporary**
Oxygen, mg/dm^3	Surface	7.33…11.84	7.5…11.9	4.30…9.90	6.70…12.0
	Bottom	7.28…11.96	7.4…12.0	3.10…9.90	2.40…12.1
BOD5, mg/dm^3	Surface	1.43…3.84	1.02…2.17	0.40…3.80	0.70…3.90
	Bottom	1.26…3.85	1.08…2.08	0.50…4.70	0.40…3.90
pH, pH unit	Surface	7.98…8.44	8.23…8.42	7.58…8.67	8.03…8.67
	Bottom	7.99…8.45	8.20…8.40	7.34…8.66	7.75…8.69
Ammonia nitrogen, µg/dm^3	Surface	12.2…86.2	0.6…39.1	0…438	0…201
	Bottom	10.6…84.4	0.5…41.8	0…72	0…174
Total nitrogen, µg/dm^3	Surface	359…714	263…583	148…1355	254…1759
	Bottom	369…769	244…557	224…1333	244…1538
Mineral phosphorus, µg/dm^3	Surface	1.07…2.70	1.50…7.50	0…73.0	0.60…28
	Bottom	1.12…2.80	1.80…8.70	0…15.0	0.60…26
Total phosphorus, µg/dm^3	Surface	18.5…39.9	16.0…31.1	15.0…210	0…110
	Bottom	19.6…39.7	13.6…37.2	18.0…400	8.20...85
Dissolved silicon, µg/dm^3	Surface	376…1060	255…656	10.0…1617	96.0…4736
	Bottom	397…1025	304…763	23.0…2500	15.0…3544
Oil products, mg/dm^3	Surface	0.04…0.13	0…0.12	0…0.43	0…0.22
	Bottom	0.01…0.13	0.03…0.12	0…0.37	0…0.61
Surfactants, mg/dm^3	Surface	0.018…0.094	0.042…0.090	0…0.056	0…0.173
	Bottom	0.018…0.095	0.037…0.086	0…0.041	0...0.270
Total PAH, µg/dm^3	Surface	0...0.0023	0…0.018	0…0.69	–
	Bottom	0...0.0022	0…0.024	0…0.51	–
Zinc, µg/dm^3	Surface	7.49…16.4	6.09…12.6	0…19.0	1.70…113
	Bottom	7.47…18.4	5.36…13.1	0…27.0	2.30...95.0
Nickel, µg/dm^3	Surface	1.52…4.98	1.47…6.08	0…8.80	3.90…94.0
	Bottom	2.93…6.75	1.81…6.75	0…6.60	3.40…90.0
Copper, µg/dm^3	Surface	1.67…4.33	1.62…4.95	0.10…11.0	0.30…65.0
	Bottom	1.81…4.92	1.86…4.61	0…14.0	0.30…25.0

Table 5.8 *continued*

Indicator	Horizon	Concentration in 2017		Background concentration	
		Filanovsky Field	Korchagin Field	Historical*	Contemporary**
Lead, μg/dm³	Surface	2.23…6.28	0.81…7.69	0.30…27.0	0…16.0
	Bottom	2.73…6.60	0.92…7.94	0.50…23.0	0…22.0
Cadmium, μg/dm³	Surface	0.17…1.07	0.19…1.28	0.01…1.80	0…6.80
	Bottom	0.16…1.06	0.08…0.88	0…1.90	0…5.10
Barium, μg/dm³	Surface	10.3…23.1	10.0…22.4	5.00…24.0	–
	Bottom	9.2…19.5	10.0…23.5	4.70…29.0	–

* LUKOIL-Nizhnevolzhskneft n.d.
** Roshydromet data (Monakhov 2014a; Monakhov 2014b; Monakhov 2015)
Source: Kuzin 2018.

Sea (Monakhov 2014a; Monakhov 2014b; Monakhov 2015).

It should be noted that in the open sea, these observations were carried out following a 20-year gap. Data from monitoring conducted by LUKOIL-Nizhnevolzhskneft from 1998 to 2009 (before the Korchagin oilfield, the first oilfield in the Russian part of the Caspian Sea, was commissioned) were used to assess marine pollution during this gap.

Taken together, these data describe the historical (LUKOIL-Nizhnevolzhskneft n.d.) and contemporary (Monakhov 2014a; Monakhov 2014b; Monakhov 2015) regional background pollution of the open sea, and allow the impact of oil and gas production facilities on seawater quality to be assessed. It should be borne in mind that the historical background describes the state and pollution of the marine environment before the oilfields were commissioned, and the contemporary background describes the state and pollution of the marine environment after commissioning, but beyond the scope of the potential impact of production facilities on the marine environment.

A comparison of the variability limits found in the main indicators of chemical composition and marine pollution in the areas around oil and gas facilities in 2017 with the historical and modern background data demonstrated that the values of most indicators remain within the background range. Compared to the historical background, the concentration of surfactants in the water has increased, but not above the contemporary regional background level. This indicates that there has been a general increase in the surfactant load in the Northern Caspian.

The increase in the concentration of oil products in the water close to oilfield production facilities, which was identified in 2016–2017, was also within the limits of the background level and was observed in other parts of the Northern Caspian. Given the changes in hydrological conditions (high flood in 2016, prolonged flooding in 2017), the most likely cause is an increase in the discharge of oil products with run-off from the Volga River.

A comparison of the variability of the main indicators of chemical composition and marine pollution close to oil and gas facilities indicated an increase in pollutant concentrations. The increase in the concentration of oil products in the water close to oilfield production facilities, which was identified in 2016–2017, was also observed in other parts of the Northern Caspian. According to Roshydromet data, the discharge of oil products in the Volga River reached 50,000 tons per year in 2016, a level three times higher than the average for 2001–2015. Currently, seawater in the coastal areas of the Russian Federation sector of the Caspian Sea are assessed as "moderately polluted" and "polluted", and in the open sea as "moderately polluted" and "clean"

(Russian Federation, State Oceanography Institute 2012–2016).

The Caspian Environmental Control Service (HazarEcoControl) of the Turkmenistan Ministry of Agriculture and Environmental Protection monitors water quality in the north-eastern sector of the Caspian Sea. Water in the eastern sector contains certain concentrations of petroleum hydrocarbons, phenols and heavy metal ions. Seasonal reductions in dissolved oxygen content, which can vary from 4.6 to 7.6 mg per litre, are possible here.

The country has focused particularly on the need to clean up hotspots like Soymonov Bay, which was heavily polluted by the refinery plant on the coast. The hydrocarbon concentration has fallen to 2.2 mg per litre over the last 10 years (National Contribution).

5.3. Air quality

Air quality is an important indicator of anthropogenic pressure on the environment. In addition to having a direct impact on human health and land-based ecosystems, atmospheric pollutants can be deposited on the surface of water bodies and affect water quality.

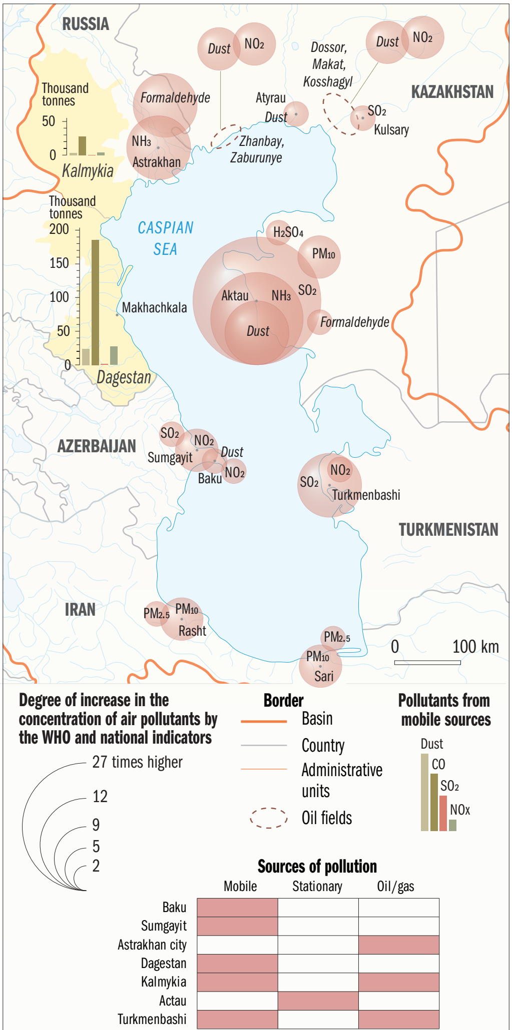
All of the Caspian littoral states note with a high degree of confidence that transport and industrial emissions are the main sources of air pollution (National Contributions). Their main concerns with regard to air quality are related to industrial areas and urban centres.

Air pollution can be classified according to two main groups: particulate and gaseous. Some forms are visible and some invisible. Both groups have a major impact on human health and the environment. Some atmospheric pollutants contribute to climate change (Nugumanova et al. 2017). There are four main sources of air pollution:

- mobile sources: cars, buses, aeroplanes, trucks, trains, etc.
- stationary sources: power plants, oil refineries, industrial facilities, factories, etc.
- area sources: agricultural areas, cities, wood-burning fireplaces, etc.
- natural sources: windblown dust, forest fires, volcanoes, etc.

One of the most pressing problems in the region is the increasing contribution to air pollution from mobile sources. In Baku, mobile sources account for 84 per cent of air pollution (Azerbaijan, State Statistical Committee of the Republic of Azerbaijan 2017).

Regular monitoring of dust (PM10 and PM2.5), sulphur dioxide, ozone, carbon monoxide, nitrogen dioxide and nitrogen monoxide is currently conducted in Azerbaijan. On the coast, air quality is



Sources: National statistical offices; Anoshkina et al., 2015; Mustafaev et al., 2016; "Report", 2017; Rosprirodnadzor; SoE-Astrakhan, 2017; SoE-Kazakhstan, 2017; SoE-Seaport Aktau, 2017; SoE-Turkmenistan, 2008; WHO Air pollution online map, figures for 2016; WHO-guidelines.
Map by Manana Kurtubadze, GRID-Arendal, April 2018.

Figure 5.4: Pollutant emissions

monitored in Baku, Sumgayit and Lankaran, which are the major urban areas with a high population or significant industrial activity. Air quality has improved since 1995 (Azerbaijan, State Statistical Committee of the Republic of Azerbaijan 2017).

There is no unified system for monitoring air quality in the region. Monitoring is fragmented and the data collected by the countries are, in most cases, disparate. Air monitoring activities and the frequency of monitoring vary across the region, making it difficult to assess air quality in the coastal zone of the Caspian Sea.

In Mangystau Region (Kazakhstan), air pollution monitoring is conducted at seven stationary posts that are part of the state system in Aktau, Zhanaozen and Beineu. According to the data recorded, atmospheric pollution levels in Zhanaozen and Beineu were low and did not exceed permissible values. According to data from the fixed monitoring network, the atmospheric pollution level in Aktau was high. The air in the city was polluted with PM-10 suspended particulate matter. Compared with the previous period, atmospheric pollution levels in Aktau increased from low to high, while in Beineu, they fell from high to low. Atmospheric pollution levels in Zhanaozen remained unchanged (Kazhydromet 2016).

Kazhydromet conducts occasional monitoring in Koshkar-Ata and Bautino. Here, the concentrations of suspended particulate matter (PM-10), sulphur dioxide, carbon monoxide, nitrogen dioxide, nitric oxide, soluble sulphates, ammonia and total hydrocarbons were measured. According to the data recorded, concentrations were within permissible ranges.

The maximum concentrations of suspended particulate matter, sulphur dioxide, carbon monoxide, nitrogen dioxide, ammonia, sulphuric acid and total hydrocarbons in the Dunga and Zhetybai oilfields did not exceed maximum permissible concentrations (Kazhydromet 2016).

There are 39 monitoring posts in Atyrau Region, including 20 posts on the territory of the North Caspian Operating Company (NCOC), 12 posts at the Tengiz oilfield operated by Tengizchevroil, four posts at the Atyrau Refinery, five posts in Atyrau and one post in Kulsary. Monitoring at NCOC posts was limited to carbon monoxide, nitrogen oxide, nitrogen dioxide, hydrogen sulphide and sulphur dioxide; at Tengizchevroil posts it was limited to hydrogen sulphide, sulphur dioxide, hydrocarbons (methane), carbon monoxide, nitrogen oxide and nitrogen dioxide; and at Atyrau Refinery to carbon monoxide, nitrogen oxide, nitrogen dioxide, hydrogen sulphide, sulphur dioxide and total hydrocarbons.

Kazhydromet conducted occasional monitoring in the settlements of Kulsary, Zhana Karaton and Ganyushkino, as well as at the Zhanbay, Zaburunye, Dossor and Makat oilfields, measuring concentrations of suspended particulate matter (PM-10), sulphur dioxide, carbon monoxide, nitrogen dioxide, nitrous oxide, soluble sulphates, phenol, formaldehyde, methane, ammonia and total hydrocarbons. According to the data recorded, concentrations were within permissible ranges.

Atmospheric pollution levels recorded in Atyrau and Kulsary in 2016 had not changed compared with the previous period (Kazhydromet 2016). However, 357 cases of high and 75 cases of extremely high atmospheric pollution in Atyrau were noted.

According to the results of occasional on-site monitoring and monitoring conducted at the oilfields in 2017, pollutant concentrations were within permissible regions.

In the Caspian region of the Russian Federation, atmospheric pollution is monitored in urban centres, as well as at the integrated background monitoring station located in the Damchik area of the Astrakhan Biosphere Reserve on the Caspian Sea coast (Federal Service for Hydrometeorology and Environmental Monitoring of Russia [Roshydromet] 2017).

According to the Russian Federal Service for the Oversight of Consumer Protection and Welfare (Rospotrebnadzor), the number of air samples that do not meet standards in Makhachkala is lower than the average for the Republic of Dagestan. There was also a reduction in the

number of such samples in the city and across the republic as a whole between 2012 and 2016. Both Rospotrebnadzor and Roshydromet have also confirmed that air quality in Astrakhan improved over the same period. In the Republic of Kalmykia, no air samples in which pollutant concentrations exceeded the maximum permissible concentration were taken in 2012–2015. However, the concentration of pollutants in cities on the Russian Caspian coast is much higher than in coastal areas far from urban settlements (Russian Federation, Federal Service for the Oversight of Customer Protection and Welfare 2012–2016).

According to data from integrated background monitoring stations located on the Caspian coast, average atmospheric concentrations for the period 2012–2016 were as follows: lead – 4.0 ng per cubic metre, cadmium – 1.4 ng per cubic metre, sulphur dioxide – 0.5 μg per cubic metre, nitrogen dioxide – 1.6 μg per cubic metre, sulphate – 6.6 μg per cubic metre, hydrogen sulphide – 0.14 μg per cubic metre, suspended particulate matter – 45.1 μg per cubic metre, and benzo(a)pyrene and benzoperylene – 0.004 ng per cubic metre. Atmospheric pollution on the Caspian coast in the Russian Federation is local in nature and is concentrated over the cities and the Astrakhan Gas Processing Plant. Air quality did, however, improve between 2012 and 2016 (Roshydromet 2016).

In Turkmenistan, the primary challenge is from stationary sources. Between 75 and 95 per cent of total emissions come from the oil and gas, chemical, manufacturing, construction, textiles and cotton processing industries (Turkmenistan, Ministry of Nature Protection of Turkmenistan 2010).

5.4. Sediment quality

The quality of bottom sediments is determined by the complex processes involved in the deposition of pollutants and the dynamics and chemical and mechanical composition of bottom sediments,. The distribution of pollutants in the bottom sediments of the Caspian Sea is therefore uneven.

In 2016, Jamshidi and Bastami (2016) studied concentrations of metals, including arsenic, cadmium, copper, chromium, cobalt, vanadium, nickel, lead and zinc, in sediments from the Anzali Wetland in relation to sediment properties. Statistical analysis revealed that aluminium and iron are effective factors in the distribution of metals on the sediments. The results implied that aluminium and iron are probably responsible for transporting heavy metals into the Anzali Wetland sediments, which have a 21 per cent probability of toxicity.

Jamshidi and Bastami (2016) also found that concentrations of nickel, arsenic, chromium and copper were higher than the permissible levels stipulated in the Sediment Quality Guidelines (United States Environmental Protection Agency [EPA] 2019).This could lead to some organisms being poisoned, and the Anzali Wetland is facing the possibility of significant damage to the environment as a result of metal pollution.

The uneven distribution of pollutants in the bottom sediments of the Caspian Sea is evidenced by pollution data for the bottom sediments of the Northern and Middle Caspian, published in the Kazhydromet State of the Environment of the Kazakhstan Part of the Caspian Sea Fact Sheet (Kazhydromet 2011; Kazhydromet 2012; Kazhydromet 2013; Kazhydromet 2014; Kazhydromet 2015; Kazhydromet 2016) and a similar publication dedicated to the Aktau Seaport special economic zone, obtained by analysing sediment samples taken at coastal stations, along long-term cross sections and near oilfields on the shelf of the Northern (Atyrau Region) and Middle (Mangystau Region) Caspian.

Table 5.9: Pollutant concentration ranges in bottom sediments of the Caspian Sea (µg/g)

Sampling site/ Indicator	TPHs	Copper	Chromium6+	Nickel	Manganese	Zinc	Lead	Cadmium
Ural-Caspian Canal	232–237	0.5–0.7	0.1–0.2	1.37–1.46	5.1–5.2	2.1–2.2	0	0
Tengiz oilfield	224–247	0.6–1.0	0.1–10.9	1.37–1.48	4.2–5.5	2.0–2.5	0	0
Ural River coastal waters	210–275	0.8–1.2	0.2–0.8	1.25–1.43	2.56–6.40	2.1–2.8	0	0
Shalygi-Kulaly long-term cross section	211–345	1.0–1.2	0.1–0.6	1.39–1.99	2.4–4.2	2.4–3.0	0	0
Additional cross sections A and B	215–268	1.1–1.3	0.8–1.0	1.25–2.00	3.6–4.2	2.0–3.0	0	0
Middle Caspian stations	140–160	0	0.01–0.0	0.03–0.05	1.11–1.20	0.09–0.14	0.001–0.002	-
Near oil and gas fields on the shelf	190–220	0	0.01–0.0	0.047–0.28	0.18–0.21	0.08–0.09	0	-
Long-term cross sections in the Middle Caspian	226–312	1.0–1.3	0.8–1.0	1.25–2.00	3.55–4.25	2.0–3.0	0	-

Source: Kazhydromet 2017a.

Total petroleum hydrocarbons and concentrations of heavy metals (copper, nickel, chromium6+, manganese, zinc, lead and cadmium) in the bottom sediment samples were analysed. The outcomes for samples taken from different areas of water are shown in Table 5.9. As the table demonstrates, changes in pollutant concentrations are quite wide-ranging and bear little

Table 5.10: Organic pollutant content of bottom sediments of the north-western part of the Caspian Sea, 2012–2014.

Pollutant	September–October 2012	November–December 2012	September–October 2013	August–December 2014
Total PAH, μg/kg	2.4–242	17.3–699	<0.03–309	<0.03–531
Total PCBs, μg/kg	<0.03–6.70	0.35–10.8	<0.03–2.12	0.10–2.50
Hexachlorobenzene, μg/kg	<0.03–0.2	<0.03–0.25	<0.03–0.3	<0.03–0.40
Total DDT, μg/kg	<0.03–1.15	<0.03–4.72	0.11–1.74	<0.03–6.50
Total HCH, μg/kg	<0.05	<0.05	<0.05–0.21	<0.05–1.80
Phthalates, μg/kg	380–3,920		130–17,210	70–2,320

Source: Reviews of the state and pollution of the marine environment of the north-western part of the Caspian Sea in 2012–2014 (Monakhov 2014a; Monakhov 2014b; Monakhov 2015).

Table 5.11: Main indicators of sea bottom sediment contaminants around oil and gas fields (Filanovsky oilfield and Korchagin oilfield in 2017, compared with historical and contemporary background concentrations).

Indicator	Concentration in 2017		Background concentration	
	Filanovsky Field	Korchagin Field	Historical*	Contemporary**
Oil products, mg/kg	1.37…12.7	0.4…11.1	0…57.0	0…68.0
Surfactants, mg/kg	10.8…31.7	8.4…25.3	0…120	0.50...66.0
Total PAH, μg/kg	0…1.68	0…26.5	0…506	0…313
Zinc, mg/kg	8.4…20.4	4.0…125	0…226	1.10…166
Nickel, mg/kg	5.70…19.2	5.6…41.0	0…48.0	3.30…54.0
Copper, mg/kg	2.40…5.50	2.80…13.0	0…70.0	3.70…55.0
Lead, mg/kg	1.50…5.30	1.0…6.30	0.60…32.0	0…35.0
Cadmium, mg/kg	0.11…0.28	0.10…0.23	0.02...0.65	0…8.00
Barium, mg/kg	56…497	58…471	0…3,100	–

* LUKOIL data for 1998–2009 (LUKOIL-Nizhnevolzhskneft n.d.)
** Roshydromet data (Monakhov 2014a; Monakhov 2014b; Monakhov 2015)
Source: Kuzin 2018.

relation to the sampling sites, thereby confirming the above.

Pollution of marine sediments in the north-western part of the Caspian Sea adjacent to the Russian Federation is determined by lithodynamic processes, through which the suspended sediments are transferred from the mouth of the Volga, Terek and Sulak rivers to the deep basin of the Middle Caspian. Suspended particles, together with the pollutants they absorb when river and marine waters mix, are transported.

To assess the contamination of bottom sediments, the results of monitoring that Roshydromet carried out in the north-western part of the Caspian

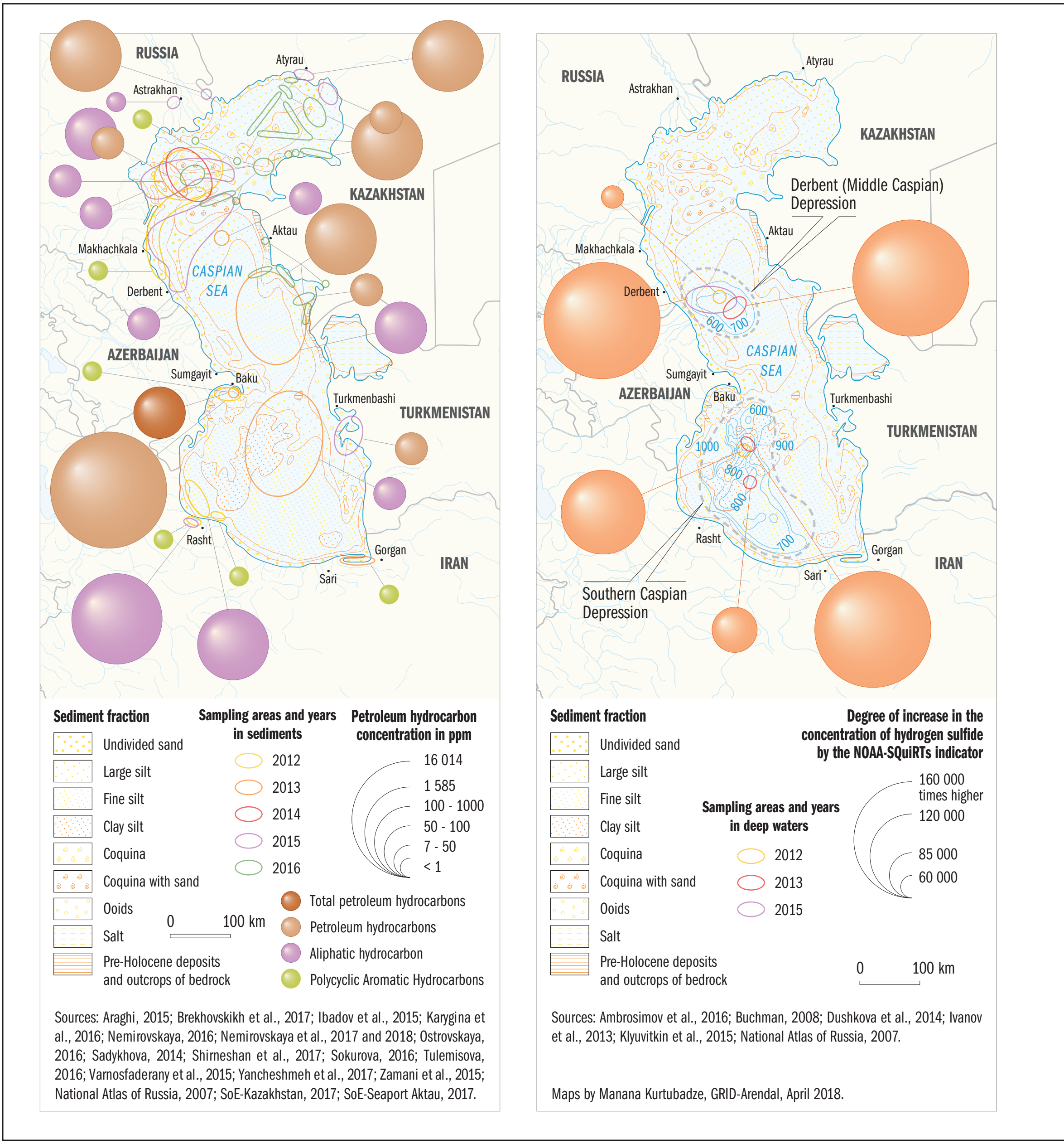
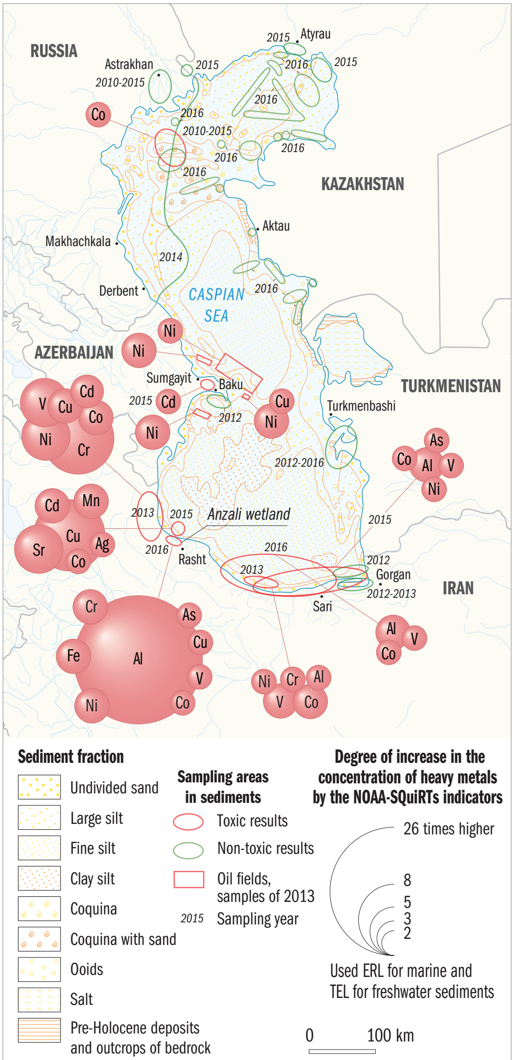


Figure 5.5: Sea bottom sediment pollution in the Caspian Sea, 2010–2016

Sea in 2012–2014 as part of a special expanded programme at more than 100 stations were used. Data show that the concentration of organic pollution in the north-western part of the Caspian Sea is negligible (Monakhov 2014a; 2014b; 2015).

Analysis shows that the majority of the main indicators of sea bottom sediment contaminants around oil and gas facilities in 2017 were within normal background concentration ranges.



Sources: Bastami et al., 2014, 2015 and 2017; Brekhovskikh et al., 2017; Buchman, 2008; Guliyev et al., 2014; Jamshidi et al., 2016 and 2017; Khalilova et al., 2016; Makhlun, 2017; Pakzad et al., 2016; Salahova et al., 2015; Sokurova, 2016; Tulemisova et al., 2016; Vosoogh et al., 2017; Zaferani et al., 2015; National Atlas of Russia, 2007; SoE-Kazakhstan, 2017; SoE-Seaport Aktau, 2017.

5.5. Biodiversity

The Caspian Sea's biodiversity serves as an indicator of its overall environmental quality and the impacts of anthropogenic pressures.

Russian sturgeon. Since the beginning of the 1990s, there has been a decrease in the number and biomass of commercial Russian sturgeon reserves, although stocks are replenished annually through artificial reproduction.

The *Persian sturgeon* mainly occupies the feeding area of the Middle and Southern Caspian, making spawning migrations from there. In the Volga River and its tributaries, there is not an extensive population. During the high-intensity fishing period, the size of the catch does not exceed 2 to 5 per cent of all sturgeon caught.

Stellate sturgeon. In recent years, the surveyed water area of the Caspian Sea has experienced a steady decline in the stellate sturgeon population.

Sterlet is the only species of sturgeon whose stock has not been declining as rapidly as beluga, sturgeon and stellate sturgeon. Many large groupings dispersed throughout the Volga (from the Volgograd Hydroelectric Plant dam to the desalinated waters of the Northern Caspian) and geographically shorter spawning migrations, allowing maximum use to be made of all existing spawning grounds, have helped to preserve sterlet reserves.

Beloribitsa is listed in the Red Book of Astrakhan Oblast. Currently, the only way to preserve and restore beloribitsa stocks is through artificial reproduction.

The *Caspian seal* (Pusa caspica) is the only marine mammal and endemic Caspian species listed as Endangered in the IUCN Red List of Threatened Species 2008. At the beginning of the twentieth century, the Caspian seal population numbered about one million.

Despite hunting for Caspian seals having been prohibited by law in Azerbaijan since 1952, hunting is the main reason for the decline in their numbers, alongside the loss of rangelands, the loss of inhabitants and, most significantly, the decline in food resources (Goodman and Dmitrieva 2016). Climate change, rising sea levels and industrial pollution are thought to contribute to the increasing pressure. For example, global warming is reducing the number of breeding sites on ice (National Contribution).

The Caspian Sea is at the crossroads of the migration routes of millions of migratory birds, and the Northern Caspian is a concentrated region in terms of the migration and breeding of waterfowl and waterbird species, including loons, grebes, Pelecaniformes, Anseriformes, rails, Ciconiiformes, waders and gulls, as well as passerine birds, diurnal birds of prey and some other groups.

Special attention should be paid to the state of the spring-summer population of colonial nesting birds on Maliy Zhemchuzhny Island, a specially protected area. According to figures from the LUKOIL-Nizhnevolzhskneft project in 2013, there were 14,600 bird pairs, including: 12,000 breeding pairs of Pallas's gull (species included in the Russian Federation Red Book), 1,500 pairs of European herring gull and 1,100 pairs of Caspian tern. A single instance of another species found in the Russian Federation Red Book – the Rosy pelican, was noted there. The project found that oil production had no impact on the bird population.

Autumn migrations in the Caspian region are more extensive and, as already noted, occur in coastal areas, i.e. in the waters adjacent to LUKOIL-Nizhnevolzhskneft's licensed areas. As in spring, the migration involves various groups of birds: waterfowl (Anseriformes, Pelecaniformes, grebes), waterbirds (Ciconiiformes, waders, gulls), passerine birds, diurnal birds of prey and so on.

Huge numbers of waterfowl winter in the North-Western Caspian, in three wintering areas: the south-western part of the Volga delta-front, Kizlyar Bay and waters around the islands of Tyuleniy, Kulaly, Morskoy and Rabochiy. The largest wintering of waterfowl takes place in the south-western part of the delta-front. The following species are dominant: whooper swan, mute swan, tufted duck, common pochard, common merganser, smew, common goldeneye and mallard, and in warm winters – greylag goose, common teal and common coot.

The following eight species of birds were registered during counts in 2014: European herring gull (Caspian gull subspecies), Pallas's gull (listed in the Russian Federation and Astrakhan Oblast Red Books), Caspian tern (listed in the Russian Federation and Astrakhan Oblast Red Books), sandwich tern, great cormorant, Dalmatian pelican (listed in the Russian Federation and Astrakhan Oblast Red Books), sanderling and Eurasian skylark (LUKOIL 2015).

The South-Eastern Caspian is another location for the mass flight and wintering of birds: in the coastal areas of Turkmenistan there are more than 300 species from various groups. In January 2018, about 190,000 waterfowl and water birds were counted. Coot (Fulica atra), tufted duck (Aythya fuligula), greater scaup (Aythya marila), red-crested duck (Netta rufina) and common pochard (Aythya ferina) were found in the biggest numbers.

Table 5.12: Protected areas in Azerbaijan (thousand km²).

Specially protected natural areas	2011	2012	2013	2014	2015	2016	2017	2018
National parks	310.5	322.3	322.3	322.3	322.3	322.3	322.3	421.3
(% of total protected areas)	35.3	36.1	36.1	36.1	36.1	36.1	36.1	47.2
State nature reserves	209.0	209.0	209.0	209.0	209.0	209.0	209.0	120.7
(% of total protected areas)	23.7	23.4	23.4	23.4	23.4	23.4	23.4	13.5
State nature sanctuaries	361.1	361.1	361.1	361.1	361.1	361.1	361.1	350.7
(% of total protected areas)	41.0	40.5	40.5	40.5	40.5	40.5	40.5	39.3
Total area	880.7	892.5	892.5	892.5	892.5	892.5	892.5	892.5
(% of the country)	10.17	10.3	10.3	10.3	10.3	10.3	10.3	10.31

5.5.1. Protected areas

Over the last decade, countries have worked hard to protect the most valuable areas both on land and at sea.

In Azerbaijan, such efforts have increased total protected areas to 892,546.49 ha. The country has 10 national parks,[7] 10 state nature reserves and 24 state nature sanctuaries. In general, specially protected natural areas cover 10.3 per cent of the country's territory, with national parks accounting for 3.7 per cent (National Contribution). In 2018, the first marine national park was created in Azerbaijan on the basis of the Gizil-Agach State Reserve and the Gizil-Agach State Nature Sanctuary.

Monitoring and research carried out by the Institute of Zoology of the Ministry of Education and Science of the Republic of Kazakhstan confirmed the numbers of rare and endangered wild animal species in Mangystau Region (Table 5.13).

There are five specially protected areas of national importance in Mangystau Region, covering a total of 1,761,922 ha. A further seven specially protected areas covering a total of 1,046,746 ha were established in the region between 2012 and 2015 to help conserve and restore natural ecosystems and biodiversity, and to maintain ecological balance. These 12 specially protected areas of all types cover a total of 2,808,668 ha, or 17.02 per cent of the region.

Table 5.13: Rare and endangered wild animal species in Mangystau Region (thousands).

Animal species	2015	2016	2017
Saiga antelope	NA	1.9	2.0
Mountain sheep	Up to 1.1	Up to 1.3	1.5
Black-tailed gazelle	0.8	1.0	1.3

Source: Republic of Kazakhstan (2014-2016).

There are three specially protected areas in Atyrau Region:

- A state nature reserve in the Northern Caspian covering an area of 662,600 ha
- Novinsky State Natural (Zoological) Sanctuary covering an area of 45,000 ha on the Caspian coast
- Akzhaiyk State Nature Reserve, covering an area of 111,500 ha in the Makhambet District

Akzhaiyk State Nature Reserve was established in the Ural River delta. The delta and adjacent Caspian Sea coast that falls within the boundaries of the reserve feature extraordinary biodiversity:

292 species of birds have been recorded, including 110 species that come to nest, 76 species that come for the winter and 106 species that are observed during migration. There are 48 species of mammals, 227 species of higher plants, 65 species of fish and over 3,000 invertebrate species. Thirty-six bird species, two mammal species, three plant species and five fish species inhabiting the Ural River delta are listed in the Kazakhstan Red Book.

The network of specially protected areas in the coastal areas of the Caspian regions in the Russian Federation is essentially established. It covers most of the diverse landscapes and habitats of protected species and includes Astrakhan Biosphere Reserve and Dagestan Nature Reserve, both designated as federal specially protected areas, as well as the Agrakhansky and Samursky state nature sanctuaries, the Volga Delta Wetlands, an area of international significance, the Northern Caspian Protected Area (north of the line connecting the mouth of the Sulak River and Tyub-Karagan Cape), Maliy Zhemchuzhny Island, and national parks, nature sanctuaries and natural features of regional significance.

There are also a number of key ornithological territories (KOTR) in the region, including some of international significance, which do not hold the official legal status of specially protected area. All of these land and water areas ensure that many vulnerable habitats and outstanding natural environments around the Caspian Sea are protected.

There are 49 specially protected areas of regional significance in Astrakhan Oblast, covering a total of 428,600 ha. These include two natural parks, Volga-Akhtuba Interfluve and Baskunchak; four state nature sanctuaries, Vyazovskaya Oak Forest, Ilmenno-Bugrovoy, Stepnoy and Peski Berli; eight state biological nature sanctuaries, Teplushki, Ikryaninsky, Mininsky, Krestoviy, Zhirotopka, Bukhovsky, Kabaniy and Yenotayevsky; and 35 natural features of regional significance.

Studies conducted in the Astrakhan Biosphere Reserve have demonstrated that the phenological phases of the development of the Caspian lotus population in 2016 are within the limits of long-term average values.

According to counts in the Damchik area in May 2016, the number of nesting mute swans fell by 5.4 per cent compared with 2015. It is possible that a good flood created more favourable feeding conditions for them at other water bodies in the Ilmenno-Bugrovoy area (Astrakhan 2015 and 2016).

Specially protected areas cover more than 600,000 ha in the Republic of Dagestan: nature reserves cover 0.4 per cent of the republic's territory and federal and regional nature sanctuaries cover a further 10.4 per cent.

The Dagestan Nature Reserve (19,100 ha) includes three federal nature sanctuaries (Samursky, Tlyaratinsky and Agrakhansky, covering a total of 152,700 ha).

The Ministry of Natural Resources and the Environment of the Republic of Dagestan has responsibility for 12 state nature sanctuaries covering a total area of 467,500 ha (4,680 km^2), including Verkhniy Gunib Nature Park in Gunibsky District (1,422 ha); Itzari Nature Park in Dakhadaevsky District (5,413 ha); 26 natural features of regional significance and three natural features of local significance (Republic of Dagestan 2016).

Currently, specially protected natural areas in the Republic of Kalmykia, including federal protected areas, cover 1,048,457.10 ha, or about 14 per cent of the republic's territory. The existing system of specially protected areas in the Republic of Kalmykia consists of one nature reserve, three federal nature sanctuaries, nine regional nature sanctuaries and 10 natural features.

The Kuma-Manych Depression is home to an ornithological area covering 27,600 ha, within a protected area of 39,720 ha and including Lake Manych-Gudilo. The Tatal-Barunsky Regional Nature Sanctuary and Tyulpanovaya Steppe were designated in 2016 (Republic of Kalmykia 2016).

Turkmenistan has nine nature reserves, 16 nature sanctuaries and 17 natural features, which are under the jurisdiction of the Ministry of Agriculture and Environmental Protection. More than two thirds of the country's total biodiversity is concentrated within these specially protected natural areas, which play a major role in preserv-

ing the natural biological state. Protected areas (excluding zoological and botanical gardens, and health, recreational, historical and cultural lands under the jurisdiction of other ministries and departments) currently cover 2,152,360 ha, or more than 4 per cent of the entire country. Nature reserves cover 925,157 hectares, or more than 43 per cent of the protected areas. Nature sanctuaries occupy about 50 per cent of the territory (1,070,506 hectares), protected areas account for more than 5 per cent (114,660 hectares), natural features for 0.09 per cent (2020 hectares) and ecological corridors for about 2 per cent (40,017 hectares) of the entire protected area.

According to currently available data, 777 vertebrate species live in Turkmenistan, including 105 mammal species, 436 bird species (70 settled, 181 migrating-nesting, 71 migrating, 75 flying-wintering and 39 visiting), 100 amphibian and reptile species and subspecies, 135 fish species and subspecies and one cyclostome species, and 12,000 invertebrate species, including about 8,000 insect species (Rustamov 2009; Rustamov 2018).

To create effective standards for the management, protection and use of specially protected natural areas, a new Law of Turkmenistan, dated 31 March 2012, “On Specially Protected Natural Areas” was issued. The law has greatly expanded the categories of protected area, making it possible to create state biosphere reserves and national natural parks. State botanical gardens and zoological parks were the first to acquire legally protected status on environmental grounds. These gardens and parks seek to preserve the plant world under natural conditions in collections and at experimental plots, and to protect animals in captivity. The law provides for the preparation and adoption of a programme to develop a system of specially protected natural areas.

According to the new law “On Nature Protection”, adopted on 1 March 2014 (Kepbanov 2016), wetlands of international importance, key ornithological territories, outstanding natural water bodies (or the areas in which they are located) are also a type or category of protected area.

A draft Programme for the Development of the System of Protected Areas in Turkmenistan covering the period up to 2030 was developed in 2014 (UNDP Turkmenistan 2010). Under the programme, protected areas will be expanded to cover 3,525,856 ha, which is more than 7 per cent of the country's territory, including assigning a status to new sites: UNESCO World Heritage sites, national parks, biosphere reserves, key ornithological territories, wetlands to be protected in accordance with the Ramsar Convention and ecological corridors.

In 2017, under the Convention on Biological Diversity, the following Ecologically or Biologically Significant Marine Areas (EBSAs) were identified and designated to improve the protection and sustainable use of marine protected areas in the Turkmenistan sector of the Caspian Sea: the Turkmenbashi Gulf, the Turkmen Gulf and the Kara-Bogaz-Gol Strait. In addition, the transboundary Miankala-Esenguly region was designated in cooperation with Iranian colleagues

In accordance with the Convention on Wetlands (Ramsar Convention), the Turkmenbashi Gulf in the Hazar State Nature Reserve is recognized as being of international significance. It covers an area of 267,124 ha. The gulf is traditionally used by many wetland birds for wintering and nesting and 72 per cent of the reserve is designated as a key ornithological territory of Turkmenistan.

There is a separate inter-State agreement on the protection of African-Eurasian migratory waterbirds under the Convention on the Conservation of Migratory Species of Wild Animals (UNEP/AEWA Secretariat 1979). The agreement covers 235 species of birds, whose existence depends on the availability of wetlands during a certain period of their life cycle. Turkmenistan is taking measures to promote the conservation of wetland birds as part of international cooperation efforts in accordance with the action plan.

5.5.2. Species

Taxa whose representatives are able to withstand significant fluctuations in seawater salinity demonstrate the greatest species diversity, while a high degree of endemism and relict biota (at least 40 per cent of species found in the Caspian Sea are endemic) reflect the long-term isolation of the Caspian.

Table 5.14: Fish species included in the Azerbaijan Red Book (Redlist Committee of Azerbaijan 2013).

Scientific (Latin) name	Name in English
Acipenser nudiventris (Lovetsky, 1828)	Ship sturgeon
Salmo trutta caspius (Kessler, 1870)	Caspian brown trout
Salmo trutta fario (Linneus, 1758)	River trout
Rutilus atropatenus (Derjavin, 1937)	Shirvan roach
Luciobarbus capito (Güldenstaedt, 1773)	Bulatmai barbel
Luciobarbus brachycephalus caspius (Berg, 1914)	Aral barbel
Abramis sapa bergi (Belyaeff, 1929)	Southern Caspian white-eye bream
Pelecus cultratus (Linnaeus, 1758)	Sabrefish
Sander marinus (Cuvier, 1828)	Estuarine perch

Source: Azerbaijan Scientific-Research Fisheries Institute

The Azerbaijan Red Book (Redlist Committee of Azerbaijan 2013) includes nine species of fish, six of which live in the Caspian Sea: ship sturgeon, Caspian brown trout, Aral barbel, Southern Caspian white-eye bream, sabrefish and estaurine perch. These species were rare even in the 1970s and 1980s, and since the 1990s they have been pushed to the verge of extinction. In recent years, uncontrolled illegal fishing has significantly reduced the commercial stocks of such fish as sturgeon, Caspian brown trout, beloribitsa, capoeta, alburnus mento, common barbel and vimba bream. These fish species, especially the sturgeon and brown trout, are threatened with extinction due to a significant decrease in the production of juveniles at fish farms.

In the Russian Federation, 299 species (subspecies of populations) of animals and plants are listed in the Republic of Dagestan Red Book (Redlist Committee of the Republic of Dagestan 2009). A ban on catching beluga, sturgeon and stellate sturgeon is in place, which is extended to other types of fish during spawning. Sport and amateur fishing are prohibited in all artificial reservoirs and channels of the Terek River system. Eight fish species listed on the IUCN Red List, eight in the Russian Federation Red Book and six in the Republic of Dagestan Red Book have been observed at Kizlyar Bay. Eighty-one fish species have been recorded in the Agrakhansky State Nature Sanctuary, nine of which are included on the IUCN Red List, 10 in the Russian Federation Red Book, and eight in the Republic of Dagestan Red Book. Sixty-two species have been recorded in the Samur State Nature Sanctuary, seven of which are included on the IUCN Red List, seven in the Russian Federation Red Book and six in the Republic of Dagestan Red Book (Redlist Committee of the Republic of Dagestan 2009).

In 2016, state environmental inspectors identified the habitats of wildlife species listed in the Astrakhan Oblast Red Book, completing the relevant cards in accordance with the Government of Astrakhan Oblast Decree of November 2013, "On the Astrakhan Oblast Red Book".

A 2013 assessment of nesting success and expert estimate of Dalmatian pelicans listed in the Russian Federation Red Book, carried out at the Astrakhan Biosphere Reserve ornithological site, demonstrated that their numbers were stable. The colony of rosy pelican (Pelecanus onocrotalus) in the reserve is sufficiently numerous, though subject to annual fluctuation. An increase in the numbers of nesting black-winged stilt (Himantopus himantopus) and Pallas's gull (Larus ichthyaetus) was recorded at the ornithological site.

During counts conducted in 2014, six bird species listed in the Russian Federation and Astrakhan Oblast Red Books were recorded: European herring gull (subspecies Caspian gull), Pallas's gull (listed in the Russian Federation and Astrakhan Oblast Red Books), Caspian tern (listed in the Russian Federation and Astrakhan Oblast Red Books), sandwich tern, great cormorant, Dalmatian pelican (listed in the Russian Federation and Astrakhan Oblast Red Books) (Redlist Committee of Astrakhan 2014).

The Republic of Kalmykia is the habitat of many animal and plant species included in the Russian Federation Red Book, including more than 50 rare and endangered vertebrate species found in the republic. Most of these are bird species. For example, the Republic of Kalmykia is home to the largest colony of nesting rosy pelicans.

In 2014, the Chornye Zemli (Black Lands) Nature Reserve monitored the state of populations of plants listed in the Russian Federation Red Book. Bellevalia sarmatica is found annually in all barely disturbed habitats along the shores of Lake Manych-Gudilo in the Chornye Zemli Nature Reserve protected area (Redlist Committee of the Republic of Kalmykia 2014).

The third edition of the Turkmenistan Red Book (Redlist Committee of Turkmenistan, 2011) includes:

- 115 species of plants and fungi (three fungi, five lichen, two moss, eight fern and 97 flowering plant species)
- 149 invertebrate and vertebrate species/subspecies (43 insect, one arachnid, one mollusc, one cyclostome, 14 fish, 20 reptile, 40 bird and 29 mammal species)

The Turkmenistan Red Book (2011) includes 14 fish species, of which five are endemic to the Caspian Sea: *Acipenser nudiventris* (Lovetsky, 1823), *Alosa kessleri volgensis* (Berg, 1913), *Schizothorax pelzami* (Kessler, 1870), *Salmo trutta caspius* (Kessler, 1870) and *Stenodus leucichthys leucichthys* (Guldenstadt, 1772).

Table 5.15: Cyclostomes and fish listed in the Red Book of Turkmenistan (Redlist Committee of Turkmenistan 2011).

Family (Latin)	Family (English)
Petromyzontiformes	**Lamprey**
Caspiomyzon wagneri (Kessler, 1870)	Caspian lamprey
Acipenseridae	**Sturgeon**
Acipenser nudiventris (Lovetsky, 1823)	Ship sturgeon
Pseudoscaphirhychus hermanni (Kessler, 1877)	Dwarf sturgeon
Pseudoscaphirhychus kaufmanni (Bogdanov, 1874)	Amu Darya sturgeon
Clupeidae	**Clupeidae**
Alosa kessleri volgensis (Berg.1913)	Caspian anadromous shad
Cyprinidae	**Minnows and carp**
Alburnoides bipunctatus eichwaldi (Filippi, 1863)	Kura chub
Aspiolucius esocinus (Kessler, 1874)	Pike asp
Barbus lacerta cyri (Filippi, 1865)	Kura barbel
Leuciscus cephalus orientalis (Nordmann, 1840)	European chub
Rutilus rutilus uzboicus (Berg, 1932)	Rutilus rutilus uzboicus
Schizothorax pelzami (Kessler, 1870)	Transcaspian marinka
Balitoridae	**Hillstream loach**
Schistura sargadensis turcmenicus (Berg, 1933)	Schistura sargadensis turcmenicus
Troglocobitis staroslini (Parin, 1983)	Starostin's loach
Salmonidae	**Salmonidae**
Salmo trutta caspius (Kessler, 1870)	Caspian brown trout
Stenodus leucichthys leucichthys (Guldenstadt, 1772)	Beloribitsa

Source: Azerbaijan Scientific-Research Fisheries Institute

5.5.3. Invasive species

In the Caspian Sea (Southern, Middle and the south-western part of the Northern Caspian), Mnemiopsis affects all levels of the ecosystem in one way or another, completely restructuring it. The numbers and diversity of zooplankton (the main food source for Mnemiopsis leidyi) are declining significantly.

In 2015, Mnemiopsis biomass and numbers on the western coast of the Southern and Central Caspian were higher than they had been throughout the 15-year period between 2001 and 2016. This is having an adverse impact on the formation of food resources for fish which feed on zooplankton and zoobenthos.

Recent studies have established that the basis of the Mnemiopsis habitat in the Caspian Sea was formed in the Southern Caspian, where it occurs all year round, unlike in other areas. As the weather gets warmer in spring, the Mnemiopsis population increases due to the growth of individuals and the commencement of reproduction. The population spreads first to the southern part of the Middle Caspian in April and May, then to the northern part of the Middle Caspian in June and July, reaching the Northern Caspian in late July or early August.

Monitoring conducted by Azerbaijan over a period of 13 years (2001–2013) identified the principles behind its distribution along the western coast of the Southern and Middle Caspian. About 60 per cent of Mnemiopsis is concentrated south of where the Kura River flows into the sea. In general, higher concentrations of Mnemiopsis are observed in the water column closer to the surface. At depth, 50 per cent of Mnemiopsis are concentrated at 10 m and 87 per cent at up to 75 m. Juvenile Mnemiopsis, in the 0–5 and 6–10 mm ranges, make up 95 per cent of the population in the Middle Caspian and 91 per cent in the Southern Caspian. The maximum Mnemiopsis size in the Middle Caspian is 36–40 mm and in the Southern Caspian – 51–55 mm (Zarbaliyeva et al. 2016).

Recent studies have produced important outcomes, such as the use of molecular genetic techniques to study invasive corridors and invasion

impact and in invasion control, the use of information technology and modelling of invasive species population trends, the course of the invasive process in the Black and Caspian Seas, data on the accumulation of chemical elements by the invasive species and their impact on water quality.

These studies demonstrated that, as the population of the ctenophore Beroe (Beroe abyssicola) grows, the number of Mnemiopsis may decrease, and the influence of Beroe on other elements of the food chain will be negligible. Special measures to combat the accidental introduction of Beroe into the Caspian Sea are not, therefore, recommended.

The Scientific Council of the Russian Federation Interdepartmental Ichthyological Commission (March 2015) issued a summary of the outcomes of the scientific study on the impact of Mnemiopsis on fish stocks ("On the impact of alien species on the state of sturgeon stocks in the Caspian Sea") and confirmed its conclusions.

6. Impact

This chapter examines the impact of various factors on the environment, namely, on health, the economy as a whole and certain sectors of the economy.

6.1. Impact on human health

Climate has a significant impact on human health and well-being. As the climate changes, this impact could be direct (injury or death due to heatstroke or natural disaster) or indirect, through the spread of diseases (mosquitoes, waterborne pathogens, water and air quality, availability and quality of food). Human health depends on the state of the environment, socioeconomic conditions and the effectiveness of organizational, managerial, technological and adaptation measures to reduce the impact of climate change.

Public health is inextricably linked to the state of the environment, and environmental pollution is leading to increased costs for both states and individuals. The Caspian region is one of the top three regions predicted to experience GDP losses as a result of air pollution, due to a combination of high pollutant concentrations, an ageing population and relatively high health-care costs (World Health Organization [WHO] 2018).

6.2. Impact on the economy

Overfishing in the Caspian region, as well as the illegal fishing, lead to a change in the structure of fish stocks and have a negative economic impact on the fishing industry. The Caspian littoral states are actively fighting illegal fishing.

Azerbaijan amended its previous fisheries law in 2017 to ensure the sustainable development of aquaculture in rural areas while creating an alternative source of income and improving the well-being and health of the coastal population (National Contribution).

Sea level fluctuations have been a constant feature throughout the history of the Caspian Sea. Of course, when the level increased, grasslands were flooded or reduced in some places, and when the level fell, spawning grounds were degraded and so on. River regulation has also had a negative impact in that there was a sharp decline in the run-off of nutrients and mineral salts, especially phosphates, without which the primary production of the sea and, in tandem, the food base cannot be significantly increased.

Over the past decade, Eastern Turkmenistan has become one of the country's industrial centres. Oil and gas facilities are located in the cities of Balkanabat, Hazar, Turkmenbashi, Garabogaz (formerly known as Bekdash) and Gumdag. A rise in sea level could flood the oil and gas pipelines that have been laid to and along the coast, and if they were to be destroyed, this would contaminate the soil in the coastal areas of Hazar and Ekerem. A potential rise in the sea level around the Hazar (formerly Cheleken) Peninsula in the middle of the Turkmenistan coastline would have the most serious impact. If the sea level were to increase by 5 m, part of the current Hazar Peninsula could be flooded turning the peninsula into an island separated from the mainland by a sea channel 2 km in width. A rise in the water level will negatively impact industry and infrastructure, including populated areas as well as the unique coastal biomes of Turkmenistan (Atamuradova 2012).

6.3. Fisheries

The unity of the Caspian ecosystem is manifested in the presence of a common, connected system of currents, as well as a single network of migration routes used by the most valuable commercial fish species that covers the entire Caspian. Moreover, the life cycle of migratory and semi-migratory fish relies on the connection between the Caspian Sea ecosystem and the coastal and river ecosystems of its basin. The Caspian Sea is characterized by a high degree of endemism, as well as significant fluctuations in the sea level and other features of the natural environment. These aspects have created and sustain the most important features of biological diversity in the Caspian Sea: high bioproductivity of individual areas and unique biological resources. As a result of evolutionary processes, integrated, sufficiently stable ecosystems have formed in the basin. The separate links of these ecosystems can only exist through close interaction. Anthropogenic distortion of such systems or the removal of particular elements from them inevitably leads to negative changes, simplifications and even the collapse of a unique natural structure, reducing its economic value and entailing the loss of other qualities that are important to people living in coastal areas.

Sea level changes profoundly transform the coastal zone, leading to changes in the conditions for numerous species of nesting birds, the fattening of many fish species, salinity, groundwater levels in adjacent areas, etc. Sea level fluctuations radically change the environmental conditions for the development of biocenoses in river estuaries and the production properties of the sea itself, especially in its shallow northern part.

Several possible environmental impacts on the fisheries sector should be considered. The establishment of aquaculture farms could destroy natural ecosystems, cause soil salinization or acidification, pollute water sources that were previously suitable for human consumption, result in eutrophication and nitrification of sewage receiving ecosystems, introduce exotic species that may biologically contaminate water bodies, contaminate soil and water with medicines, transform landscape and hydrological sites with unknown consequences for ecosystems, and limit the movement of the eggs, larvae, juveniles and adults of various organisms.

There are also concerns about environmental contamination by toxins and heavy metals, as well as genetic contamination and contamination by unwanted species of phytoplankton and zooplankton (Martinez-Porchas and Martinez-Cordova 2012). Consequently, ensuring that aquaculture is beneficial to the local population and to the environment will be a challenge that requires consideration of all possible impacts.

In Azerbaijan, the number of fishing licences issued in the period from 2011 to 2016 increased compared to the period from 2005 to 2010, despite the Government's belief that the shift from catching sprats and other endangered fish species to the establishment of sustainable aquaculture had taken place. To ensure the sustainable development of aquaculture in rural areas, create new sources of income and improve the well-being and health of coastal and local populations, the Government also amended the old fisheries law in 2014, introducing new provisions on aquaculture (Azerbaijan Scientific-Research Fisheries Institute).

In Iran, gross revenue from fishing in the Caspian Sea is falling, due in part to the decline in bioresources (Strukova et al. 2016).

The Kazakhstan fisheries sector relies on the Caspian Sea to a greater degree; 40 per cent of fish caught in Kazakhstan came from the Ural-Caspian basin in 2010, while the rest came from Balkhash-Alakol and Zaysan-Irtysh (FAO 2010). It is still a small sector, contributing approximately 0.8 per cent of the GDP of Kazakhstan in 2010 and supporting around 17,000 official jobs.

According to the IUCN, five species of sturgeon are currently listed as critically endangered in the Caspian (Acipenser gueldenstaedtii, Acipenser nudiventris, Acipenser persicus, Acipenser stellatus and Huso huso (Gessner et al. 2010).

Little information is available on the role that illegal, unreported and unregulated (IUU) fishing plays in Turkmenistan. However, what is known suggests that poaching is minimal because the country has four high-speed patrol boats monitoring its 1,200 km coastline, most of which surrounds Turkmenbashi (Muradov 2011).

Declining fish stocks, coupled with a lack of retraining and new employment opportunities, have resulted in some shifting of the workforce from legal fishing to poaching (Strukova et al. 2016).

6.4. Shipping

The Caspian Sea is positioned between two large trading areas, with the Asian market to the east and the European to the west. Geographical location and oil and gas resources are both influencing the current growth in shipping in the Caspian Sea.

As noted above (see Mineral extraction section), the oil and gas sector devotes significant attention to sound management practices, including operational standards and safety measures. However, increased oil production and transportation as a result of investment in current and future oil and gas projects continues to be of particular concern with respect to potential environmental risks.

An assessment of the impact of maritime transport on the Caspian Sea environment has yet to be completed. The impact can currently be measured by indirect indicators, such as volume of goods transported or port capacity. The Port of Baku has a capacity of 5.9 million tons per year (Port of Baku 2018). Azerbaijan has been a member of the International Maritime Organization (IMO) since 1995 and has acceded to all major conventions adopted under its auspices. In addition, on the basis of an inspection by the European Maritime Safety Agency, Azerbaijan has been included on the "White List" of countries where the training and licensing of ship crews complies with the requirements of international conventions.

The Azerbaijan Action Plan for the Sustainable Development of the Maritime Transport Sector is set to improve the safety and efficiency of the sustainable transport system, and help to prevent marine pollution, promote energy efficiency and protect natural resources (National Contribution).

Kazakhstan has been a member of IMO since 1994 and has acceded to the main conventions adopted under its auspices. In 2013, Kazakhstan moved from the "Grey List" to the "White List" of the Paris Memorandum of Understanding on Port State Control, and has since confidently retained its White List spot (in 2015, the country was ranked at number 30 of 43 in the White List).

The Ministry of Investment and Development of Kazakhstan recently announced that it is working with relevant organizations in other countries to establish a unified system for state control of ships in Caspian Sea ports. The system will be similar to the one used in the Black and Mediterranean Seas. This initiative is aimed at improving safety and reducing the number of accidents by concentrating efforts on monitoring older vessels which do not

meet current standards (Decree of the President of the Republic of Kazakhstan 2010).

Turkmenistan has formed its fleet over the last 20 years. The country has purchased four general-purpose dry cargo ships, six oil tankers and many auxiliary vessels for various purposes, and intends to develop its shipping sector further. All of the old ships were recycled (National Contribution).

Turkmenistan has been a member of the IMO since 1993 and has acceded to the main conventions adopted under the aegis of the organization. In February 2015, following ratification by the Mejlis of Turkmenistan, the Protocol of 1997 on Amendment of the International Convention for the Prevention of Pollution from Ships of 1973, amended by the Protocol of 1978, came into force with Annex IV, Prevention of Pollution by Sewage from Ships.

The design of the new tankers takes into account all of the special requirements and environmental restrictions imposed by global oil companies. There has been a significant improvement in the technical and economic specifications of the tankers compared with the old vessels of the same dead weight: automated controls are in place, oil products cannot be discharged into the sea even in the event of an accident, and safe crew working conditions have been developed for all modes of operation. As a result, vessels of this type can operate in special ecological zones. This is extremely important in helping to safeguard the biodiversity of the fragile ecosystem in the Caspian Sea (Turkmenistan, 2013).

6.5. Ports and harbour infrastructure

Most of the Caspian ports are being reconstructed due to the expansion of shipping activities.

The Port of Baku in Azerbaijan has long been an important port in the region. Kazakhstan and Turkmenistan are both currently engaged in expanding their shipping industries and the as-

sociated ports. Iran and the Russian Federation are also focusing increasingly on the potential offered by the sea.

It is expected that the Port of Alat, which has been designed as a Green Port (Port of Baku 2018), will reduce unwanted discharge into the Caspian Sea. The discharge will be collected and treated at the port terminal. Upgrading the old Baku port facility to a Green Port and world-class logistics centre using the latest innovative environmental technologies may also have a positive impact on the environment and biological resources in the Caspian Sea (National Contribution).

Sangachal Oil Terminal, Hovsan Port and Zykh Port, all international ports, are currently officially registered in the State Port Register of Azerbaijan in accordance with the 2014 Ports Act. Hovsan Port can accommodate ships of varying purposes and tonnage. Sangachal is an oil port. All of the ports provide ship-generated waste reception and cargo residue disposal services and all are navigable year-round. Ports located in Azerbaijan can receive vessels with a draught of more than 5.5 m. The maximum permissible draught in Hovsan Port is 6.5 m.

Cargo turnover at ports in Azerbaijan is currently lower than their carrying capacity. Zykh Port has a potential capacity of 1.15 million tons of cargo, 15,000 containers (20-foot) and 12,000 passengers, while Sangachal Oil Terminal can handle up to 20 million tons of oil and oil products per year. Hovsan Port has a potential capacity of 8.603 million tons of cargo of varying types and 134,000 containers.

There are three operational seaports in Kazakhstan: Aktau International Sea Trade Port, Bautino Cargo District, a branch of the Aktau International Sea Trade Port, and Kuryk Port, all providing services for ships of various tonnages.

In accordance with Presidential Decree No. 725, dated 13 January 2014, Kazakhstan adopted the

State Programme to Develop and Integrate the Transport System Infrastructure of the Republic of Kazakhstan by 2020. The programme envisages an increase in the share of goods transported across the Caspian Sea by Kazakhstan from 58 per cent in 2012 to 70 per cent in 2020, as foreign companies still account for a significant proportion of cargo transported by sea. Over the period from 2016 to 2020, the programme also provides for an increase in the number of Kazakh ships from three to five, an increase in the level of coastal infrastructure provision from 45 to 50 per cent, a reduction in the rate of accidents per 100 ships (seagoing and river vessels) from 1.4 to 1.2 per cent, the construction of a ship repair and shipbuilding plant by 2020, and so on. There are also plans to increase the capacity of Aktau International Sea Trade Port by 2020, from 16.8 to 20.5 million tons. This would require carrying out dredging and construction of three dry cargo terminals, and automatization of loading and unloading. Ferry crossings across the Kigach River in the Kurmangazinsky District of Atyrau Region will be modernized (Republic of Kazakhstan, 2014-2016).

In a bid to expand cooperation with the Caspian littoral states, the Government of the Russian Federation recently approved a strategy to build new seaports in the Caspian Sea (Government of the Russian Federation 2017).

There are three seaports on the Caspian Sea coast in the Russian Federation: two in the Volga delta – Astrakhan and Olya – and one on the western coast of the Middle Caspian – Makhachkala.

The largest port by area is the Port of Olya (324 ha), though the Port of Astrakhan has a larger body of water (55 km^2). Astrakhan also has the largest number of berths (26), only slightly ahead of Makhachkala with 20 berths. The Port of Olya has four berths.

The Port of Astrakhan has the largest throughput capacity, at 9.93 million tons per year, followed by Makhachkala at 7.26 million tons per year and Olya in last place at 1.58 million tons per year. The total capacity of Russian Federation ports is 18.8 million tons per year. The Port of Olya can only accept dry cargo, while the other ports can also handle containers and liquid cargo. All ports are equipped with covered and uncovered warehouses.

All ports are navigable year-round, although ports located in the Volga delta can freeze over during winter, leading to complications (if this happens, vessels are provided with icebreaker assistance). Ports located in the Volga delta are unable to accept ships with a draught of more than 4.5 m. The maximum permissible draught in the Port of Makhachkala is 6.5 m.

According to the Association of Marine Commercial Ports in the Russian Federation, the turnover of Russian Federation ports in the Caspian Sea is currently significantly lower than capacity. From 2011 to 2017, cargo turnover decreased from 10.7 to 3.9 million tons. On average, total cargo turnover for 2012–2016 amounted to 7.7 million tons, including 3.5 million tons of dry cargo and 4.2 million tons of liquid cargo. Average annual turnover during this period was 4.6 million tons at Makhachkala, 2.7 million tons at Astrakhan, and 0.4 million tons at the Port of Olya.

The Astrakhan Transport Hub, including the ports of Astrakhan and Olya, the port railway stations and Aksarayskaya border station, is being developed in conjunction with the creation of the International North–South Transport Corridor (INSTC), connecting Astrakhan, Baku and Tehran, and the increase in the capacity of the Astrakhan Transport Hub to 30 million tons per year.

Regarding marine transport development, the Astrakhan Water Transport Hub will be modernized as part of the development of the INSTC, and car ferry crossings to the countries bordering the Black Sea and Caspian Sea basins will be established from the Caucasus ports, Novorossiysk, Olya and elsewhere.

It is expected that the existing transport capacity of the Russian Federation sector of the Caspian basin will increase by 6.0 million tons per year (energy and raw materials scenario) or by 9.0 million tons per year (innovative scenario), and will reach approximately 30.4 million tons (energy and raw materials scenario) or 33.4 million tons (innovative scenario) by 2030. The main growth will come from developing the ports of Olya (adding a second cargo area) and Makhachkala (Government of the Russian Federation 2010).

The new international port in Turkmenbashi was commissioned on 2 May 2018. The port project was developed in accordance with the international Green Port standard, an important point in terms of conserving the ecology of the Caspian Sea. During construction of the port, consideration was given to environmental aspects and the ecological state of the Caspian Sea (Komarov 2018).

6.6. Submarine cables and pipelines

In addition to the direct adverse impact (disturbance of the seabed surface entailing the death of benthic organisms, the formation of large volumes of suspended matter covering large areas and causing both plankton death and a significant reduction in productivity), laying pipes also results in secondary pollution. This is particularly evident in areas near river mouths, where significant proportion of the pollutants carried along with river run-off is deposited.

Transporting hydrocarbons to processing facilities can also pose a threat. This applies more to pipelines during operation (rather than tankers), and the potential for accidents also remains. Taking into account increased levels of seismic activity in various parts of the Caspian Sea (which affects the Middle and Southern Caspian to a greater extent), laying pipes in such areas is fraught with accidents and extensive oil spills (Kashin 2017)

Despite the safety precautions that are taken, there are genuine risks of damage or malfunction associated with offshore pipeline operation. These risks include pipeline defects, non-standard technical processes and procedures, human hazards, geological processes and phenomena, natural climatic and geological factors, the activities of third parties, and scientific, industrial and military activities in the vicinity of offshore pipelines.

Based on an analysis of statistical data about offshore pipeline accidents, it has been found that, taking into account measures to improve reliability and safety, the offshore pipeline accident rate has fallen consistently and is currently in the range of 0.02– 0.03 accidents per year per 1,000 km of pipeline. For comparison, in the Russian Federation the average accident rate is 0.17 accidents per year per 1,000 km for gas pipelines and 0.25 accidents per year per 1,000 km for oil pipelines (Neftegaz 2015).

7. Response

Countries are taking steps to respond to challenges and address emerging problems, and given the complexity of these problems, they are striving to pool those efforts. One of the ways in which they are doing this is by developing and strengthening international cooperation at the regional level.

7.1. Regional governance

The current forms of international environmental cooperation in the Caspian Sea region include:

- bilateral cooperation within the framework of relevant agreements
- joint activities under multilateral environmental agreements

The Tehran Convention, which entered into force in August 2006, is the international legal framework for regional cooperation in the field of environmental protection and sustainable management of natural resources in the Caspian. In accordance with the natural and international legal features that apply to the Caspian Sea, the Convention enables the introduction of modern forms of regional cooperation aimed at preventing, reducing and controlling pollution; protecting, preserving and restoring the marine environment; applying the Caspian Sea marine environment impact assessment; monitoring the marine environment; carrying out research and development; and sharing information.

At the third Meeting of the Conference of the Parties to the Tehran Convention in Aktau (Republic of Kazakhstan, 2011), Azerbaijan, Iran, Kazakhstan, the Russian Federation and Turkmenistan signed the Protocol Concerning Regional Preparedness, Response and Cooperation in Combating Oil Pollution Incidents (Aktau Protocol 2011). This was the first protocol to be ratified by all Parties, and came into force in 2016.

At the fourth Meeting of the Conference of the Parties to the Tehran Convention in Moscow (Russian Federation, 2012), the Caspian littoral states adopted and signed the Protocol for the Protection of the Caspian Sea against Pollution from Land-based Sources and Activities (Moscow Protocol 2012).

At the fifth Meeting of the Conference of the Parties to the Tehran Convention in Ashgabat (Turkmenistan, 2014), the Caspian littoral states adopted and signed the Protocol for the Conservation of Biological Diversity to the Tehran Convention (Ashgabat Protocol 2014).

At the Fourth Caspian Summit (September 2014, Astrakhan, Russian Federation), the heads of the Caspian littoral states welcomed the entry into force of the Agreement on Security Cooperation in the Caspian Sea, signed in Baku in November 2010, and confirmed the need to continue efforts to develop cooperation.

The Agreement on Cooperation in Emergency Prevention and Response in the Caspian Sea, the Agreement on the Conservation and Sustainable Use of the Aquatic Biological Resources of the Caspian Sea and the Agreement on Cooperation in the Field of Hydrometeorology of the Caspian Sea were also signed at the Astrakhan Summit.

Multilateral agreements signed by the Caspian littoral states at the Fourth Caspian Summit include agreements on interaction with the Commission on Aquatic Bioresources of the Caspian Sea and with CASPCOM.

In accordance with a decision taken at the fifth Meeting of the Conference of the Parties to the Tehran Convention, a memorandum of understanding covering interaction between CASPCOM and the Tehran Convention was signed.

The twentieth CASPCOM Session (October 2015) recommended that monitoring of pollution in the marine environment of the Caspian Sea and provision of hydrometeorological information for regular assessment of the state of the Caspian Sea should be considered as the main areas for interaction between CASPCOM and the Tehran Convention.

The development of the Intergovernmental Integrated Programme on Hydrometeorology of the Caspian Sea was a key task under the Agreement on Cooperation in the Field of Hydrometeorology of the Caspian Sea The programme is intended to be an effective tool for setting up a regional system to receive and share information on the state of the Caspian Sea in the interests of ensuring safety of life and the development of economic activity at sea.

Overall, the main outcomes of CASPCOM activities in 2014–2016 included: increased cooperation between national meteorological and hydrological services in the field of hydrometeorology and monitoring of the Caspian Sea, and the population of CASPCOM catalogues with new data (on sea level, water temperature, regional atmospheric circulation and surface run-off).

Interaction with the Commission on Aquatic Bioresources of the Caspian Sea took place during the Commission's meetings (December 2013 in Astrakhan, May 2015 in St. Petersburg, Russian Federation, and June 2016 in Astana, Republic of Kazakhstan). At these meetings, recommendations on the total allowable catch of aquatic biological resources for the relevant period are adopted and the issue of prolonging the ban on commercial sturgeon fishing in the Caspian basin is discussed. Sturgeon may be caught for research and artificial reproduction purposes only; export quotas for caviar and other products derived from natural sturgeon populations are therefore set to zero.

Issues related to the fulfilment of quotas for marine and sturgeon fish species, and the reproduction and protection of fish stocks are also discussed, and data on the state of aquatic biological resource stocks based on the results of scientific studies are reviewed.

The CEP, which operated from 1998 to 2012, made an important contribution to the development of environmental cooperation between the Caspian littoral states and to the drafting and signing of the Tehran Convention. The CEP included international projects by the GEF, UNDP, European Union (EU) and Technical Assistance to the Commonwealth of Independent States (TACIS) programme in the fields of scientific research, capacity-building, water quality and pollution monitoring, and coastal zone management.

7.2. Bilateral cooperation

In addition to the regional agreements, bilateral cooperation also makes an important contribution.

In 2014, Kazakhstan and Turkmenistan signed an inter-State agreement on the delineation of the bottom of Caspian Sea (Republic of Kazakhstan and Turkmenistan, 2014).

The Russian Federation engaged in the following cooperation under bilateral agreements with Caspian littoral states:

- with the Republic of Azerbaijan under an agreement between the Government of the Russian Federation and the Government of the Republic of Azerbaijan on cooperation in the field of sustainable use and protection of the water resources of the transboundary Samur River reached in 2010 (including water apportionment and monitoring of water resources, surveying of the main groundwater intakes, establishment of the required gauging stations, surveying of the technical condition of the Samur hydraulic engineering project)
- with the Islamic Republic of Iran, within the framework of the memorandum of understanding between the Russian Federation Ministry of Natural Resources and Environment and the Iranian Department of Environment on cooperation in the field of ecology for 2015–2016, and the Working Group on Water Management of the Permanent Russian–Iranian Commission for Trade and Economic Cooperation in such areas as environmental protection, sustainable use of water resources, safeguarding of biodiversity, monitoring of atmospheric pollution, reduction of greenhouse gas emissions, water desalination, estimation of reserves, and exploration and monitoring of groundwater
- with the Republic of Kazakhstan under an agreement between the Government of the Russian Federation and the Government of the Republic of Kazakhstan on joint use and protection of transboundary water bodies (in such

areas as monitoring of transboundary water bodies, including the Ural River, improving the quality of transboundary water resources, procedures for carrying out environmental impact assessments in a transboundary context and construction of a reservoir for the Bolshaya Uzen and Malaya Uzen rivers)

7.3. National governance

Countries are actively improving national environmental management, including by strengthening institutional structures and national environmental legislation.

The National Strategy of the Republic of Azerbaijan on Conservation and Sustainable Use of Biodiversity for 2017–2020 was approved in 2016. Combined with the promotion of reforms in this area, the national strategy will have a positive impact on boosting cooperation between international organizations and governments on biodiversity and general environmental protection activities (National Contribution).

The Azerbaijan 2020: A Look into the Future development concept was adopted in 2012. It focuses on developing renewable energy sources to diversify and strengthen the economy of Azerbaijan to enable sustainable development. This document seeks to:

- provide incentives for the accelerated development of alternative renewable energy sources
- create a satisfactory institutional environment
- strengthen the potential of renewable energy sources
- train experts and raise public awareness about the use of renewable energy sources
- introduce flexible tariffs for renewable energy sources to encourage private-sector involvement

Azerbaijan hosted the first, inaugural Session of the Commission for the Conservation and Sustainable Use of Aquatic Biological Resources and the Management of Shared Stocks of Such Resources on 21–23 November 2017 in Baku (National Contribution).

Forest cover in Azerbaijan has increased from 11.4 to 12 per cent of the country's total territory in recent years. Over the past five years, large-scale landscape projects employing modern techniques have been implemented in the city of Baku and on the Absheron Peninsula. On a total area of 3,776 ha, 4.8 million trees and shrubs have been planted, and a modern drip irrigation system installed for all planted areas. A hazardous waste landfill site was built near Sumgayit to process hazardous waste in accordance with international norms and standards.

Azerbaijan has undertaken significant efforts in recent years to mitigate the effects of climate change. It signed the Paris Agreement of the UNFCCC (2015), which requires a 35 per cent reduction in greenhouse gas emissions (compared with the 1990 level) by 2030.

Azerbaijan has adopted a State Programme on the Use of Alternative and Renewable Energy Sources and set up a State Agency on Alternative and Renewable Energy Sources (SAARES). By 2030, Azerbaijan plans to increase the share of renewable energy used in electricity generation to 25 per cent.

Iran passed the Clean Air Act on 9 August 2017, replacing the previous law on air pollution. The new act covers a wider range of pollution sources, including ships (Nachmany et al. 2018).

As a member of the International Convention for the Prevention of Pollution from Ships (MARPOL Convention), Iran closely monitors compliance with the requirements of the Convention's annexes. Moreover, with the entry into force of the International Convention for the Control and Management of Ships' Ballast Water and Sediments (Ballast Water Management Convention) in September 2017, the Iranian Ports and Maritime Organization, in cooperation with the Environmental Protection Agency, monitors implementation of this convention at Iranian ports (PMO 2017).

Iran has plans to develop the Sardar-e Jangal oil and gas fields in the future. In November 2017, the country signed a memorandum of understanding with Norway, setting out an intent to cooperate and gain access to essential technology. This could boost the attractiveness of Caspian

oil and gas fields (Financial Tribune 2017). However, the Minister of Petroleum stated in 2016 that, while it may be on the agenda, oil production in the Caspian Sea is not a priority.

The Sixth Five-Year Development Plan of Iran stipulates that the installed capacity of renewable energy should grow by 5,000 MW by 2018 (Wheeler and Desai 2016). Iran has also announced its intended nationally determined contribution (INDC) of a 4 per cent unconditional reduction in greenhouse gas emissions compared with its business as usual scenario by 2030 (Mobara 2017).

The Paris Agreement was adopted on 12 December 2015 at the twenty-first session of the Conference of the Parties to the UNFCCC. Kazakhstan signed the Paris Agreement on 2 August 2016 and ratified it on 6 December 2016 (Nugumanova et al. 2017).

The Concept for the Transition of the Republic of Kazakhstan to a Green Economy was adopted in 2013. The concept sets quantitative targets for water use, air pollution and waste reduction, and forecasts potential incremental improvements in energy efficiency by the years 2020, 2030 and 2050 (Kazakhstan 2050 Strategy 2017). The concept sets out some ambitious goals, including:

- Energy sector: increase share of renewable energy to 50 per cent
- Energy efficiency: 10 per cent increase by 2015, 25 per cent increase by 2025 (compared with 2008 base year)
- Water resources: solve all problems with water supply to households by 2020 and to agriculture by 2040
- Waste management: by 2030, ensure that 100 per cent of households are covered by municipal waste services, that 95 per cent of waste is stored in sanitary and safe conditions and that 40 per cent of waste is recycled (50 per cent by 2050)
- Air pollution: reduce air pollution to European levels by 2030 (Green Bridge Partnership Program 2017)

Management of environmental activities in the Russian Federation is the responsibility of the Ministry of Natural Resources and Environment of the Russian Federation, which includes the

Federal Agency for Mineral Resources (Rosnedra), the Federal Service for Supervision of Natural Resources (Rosprirodnadzor), the Federal Agency for Water Resources (Rosvodresursy) and Roshydromet.

The following executive authorities also carry out a number of environmental protection and safety functions as part of their responsibilities:

- The Ministry of Transport of the Russian Federation, including the Federal Agency for Sea and Inland Water Transport
- The Ministry of Agriculture of the Russian Federation, including the Federal Agency for Fisheries and the Federal Service for Veterinary and Phytosanitary Supervision
- The Ministry of Health and Social Development of the Russian Federation, including the Federal Service for Supervision of Healthcare
- The Ministry for Civil Defence, Emergencies and Elimination of Consequences of Natural Disasters of the Russian Federation
- The Ministry of Industry and Energy of the Russian Federation

Institutional environmental management structures that comply with the constitutional principles for the division of powers between the federal centre and the regions operate in the Caspian regions of the Russian Federation.

The Astrakhan Oblast Natural Resource Management and Environmental Protection Service regulates natural resource management and environmental protection in Astrakhan Oblast (Decree of the Government of Astrakhan Oblast No. 190-P of 13 June 2006 (as amended on 22 December 2016)).

Regional waste management in Astrakhan Oblast is regulated by the Ministry of Construction, Housing and Communal Services of Astrakhan Oblast (Decree of the Government of Astrakhan Oblast No. 210-P of 19 May 2010 (as amended on 30 December 2016)).

The Ministry of Natural Resources and Ecology of the Republic of Dagestan is the authorized executive authority in the republic which manages, regulates and controls natural resource management and environmental protection within the limits of its competence (Decree of the Government of the Republic of Dagestan No. 85 of 29 March 2007).

The equivalent executive authority in the Republic of Kalmykia is the Ministry of Natural Resources and Environmental Protection of the Republic of Kalmykia.

Environmental monitoring in Turkmenistan is entrusted to the Ministry of Agriculture and Environment Protection. Monitoring covers most aspects of the natural environment, including pollution of surface and groundwater, as well as atmospheric pollution.

As part of a project undertaken by the State Committee for Environmental Protection and Land Resources in partnership with GEF and UNDP, "Strengthening effective management of the system of specially protected natural areas in Turkmenistan, 2009–2014" (UNDP Turkmenistan 2009), a programme to develop the system of specially protected natural areas in Turkmenistan, covering the period to 2030, was established. The programme seeks to provide a vision on issues related to the expansion, reform and creation of new types of protected areas, and to the development of mechanisms and recommendations to improve effective management of protected areas over the long term (up to 2030). It is an important step towards protecting biodiversity at the ecosystem level.

The Institute of General and Applied Biology at the Oguz Khan University of Engineering Technologies is currently implementing a programme to study the biodiversity of the Caspian Sea in a changing climate and how to protect this biodiversity, covering the period 2016–2020). The Hazar State Nature Reserve is exploring the ecology of wetland birds in the South-Eastern Caspian. Winter counts of birds conducted over the past two years have shown that up to 200,000 individuals of various species remain in the Turkmenistan sector of the sea for wintering (up to 500,000–600,000 have previously been observed).

In the specially protected Caspian Sea zone, staff working at the reserve continue to monitor the number of Caspian seals. In this regard, it should be noted that the project entitled "Conservation of the Caspian seal in the Turkmenistan sector of the Caspian Sea and proposed areas for regular monitoring" (2010) identified Caspian seal habitats and rookeries on the Turkmenistan coast of the Caspian Sea.

Human-made forests in the foothills of the Kopet Dag mountain range, around the country's capital, cities and district centres now cover 100,000 ha. More than 60 million seedlings have been planted: they are part of a process of afforestation and reforestation and play a significant role in the biodiversity conservation.

Specialists in the country are carrying out important work on including natural sites in Turkmenistan on the UNESCO World Heritage List. These sites are natural phenomena and the historical home of many rare animals and plants of exceptional value to the global gene pool, ensuring the planet's ecological balance and sustainable development. They include:

- Badkhyz State Nature Reserve, famous for its tectonic faults and ancient volcanoes, natural massifs of pistachio-coloured lowlands, and populations of Turkmenian kulan, gazelles and argali
- Koytendag State Nature Reserve with its many outstanding caves, unique canyons, a viable population of winter goats, and the Starostin's loach, a blind fish that is not found anywhere else in the world

In 2012 and 2013, two key strategic thematic documents covering biodiversity conservation were adopted by a Resolution of the President of Turkmenistan:

- National Climate Change Strategy of Turkmenistan, 15 June 2012 (NCCST 2012)
- National Forestry Programme of Turkmenistan, 11 January 2013 (NFP 2013).

The following regulatory documents have been developed recently:

- Methodological guidelines and provisions for the development of promising interdepartmental plans
- Methodology for assessing the value of biodiversity resources and calculating the harm caused by damaging, removing and/or destroying them in the territory of Turkmenistan
- Methodology for assessing and calculating environmental damage due to the pollution of water bodies in Turkmenistan
- Methodology for assessing and calculating environmental damage due to soil contamination in Turkmenistan
- Methodology for assessing and calculating environmental damage caused by air pollution in Turkmenistan
- Tariffs for calculating penalties to be recovered in the event of damage caused by illegal mining, the destruction of plant and animal species and the use of natural resources
- Directive on the Department of State Fishery Protection under the State Committee for Fisheries of Turkmenistan
- Directive on the protection of aquatic biological resources and regulation of fisheries in the territorial and inland waters of Turkmenistan

Since there has been a reduction in the level of threat affecting certain species of animals and plants, a third edition of the Turkmenistan Red Book has been issued (Redlist Committee of Turkmenistan, 2011).

Efforts are under way to inventory the biodiversity of achievements in the field of plant and animal breeding. Agricultural seed resources are preserved in storage facilities.

The nature reserves in Turkmenistan have gained sufficient experience of ex-situ conservation (the breeding of rare species of flora and fauna in nurseries) (Turkmenistan, Ministry of Nature Protection of Turkmenistan 2015).

7.4. Policy and legislation

Solving socioeconomic problems to ensure the preservation of a favourable environment, biodiversity and natural resources is a strategic goal of state policy in the Caspian littoral states.

In 2012, Azerbaijan adopted Azerbaijan 2020: A Look into the Future (Decree of the President of the Republic of Azerbaijan 2012), which focuses on developing renewable energy sources to diversify and strengthen the country's economy and ensure sustainable development. The de-

velopment concept seeks to provide incentives for the accelerated development of alternative renewable energy sources, create a satisfactory institutional environment, build renewable energy research and development potential, train experts, raise public awareness about the use of renewable energy sources and introduce flexible tariffs for renewable energy sources to encourage private-sector involvement. Azerbaijan has also implemented various policies to improve air quality. These include adopting the Euro IV standard from 1 April 2014, replacing outdated infrastructure, replacing medium-sized buses with large ones to increase efficiency and so on. (National Contribution).

As noted above (see National governance section), the main strategic document defining the policy of Azerbaijan in the field of environmental protection is the National Strategy of the Republic of Azerbaijan on Conservation and Sustainable Use of Biodiversity for 2017–2020, which was approved in 2016 (National Contribution).

In 2016, the President of the Republic of Azerbaijan approved the Strategic Road Maps for the National Economy and the Main Sectors of the Economy. The main goal of these documents is to promote the sustainable and competitive development of the country's non-oil sector. The Strategic Road Maps include an economic development strategy and action plan for 2016–2020, as well as prospects for the period leading up to and beyond 2025. It should be noted that the main difference between the Strategic Road Maps and previously adopted state programmes is that the Strategic Road Maps define specific indicators that allow the results achieved in each of the priority areas for development of the Azerbaijani economy to be measured.

The Law on Environmental Impact Assessment of the Republic of Azerbaijan was adopted on 12 June 2018. It contains, inter alia, provisions for a strategic environmental assessment process.

The Sixth Five-Year Economic, Cultural and Social Development Plan of the Islamic Republic of Iran and the General Policies announced by the Supreme Leader contain a series of targets relating to the Caspian Sea environment. The plan requires average annual growth of 8 per cent, an average annual investment growth rate of 21 per cent and 0.8 per cent annual reduction in unemployment. Iran subsequently implemented numerous strategies and pieces of legislation covering water resources, the environment, energy, transport, earthquakes, the exploitation of forests and pastureland, tourism and other sectors (National Contribution).

In 2012, the Government of Iran allocated €500 million from the National Development Fund for green energy development (Hosseini et al. 2013). Iran has also announced its INDC, including a 4 per cent unconditional reduction in greenhouse gas emissions below its business as usual scenario by 2030 (Mobara 2017).

The Government of Kazakhstan devotes significant attention to environmental protection and sustainable natural resource management. The need to take effective measures in these areas is reflected in several policy documents, including the Strategic Development Plan of the Republic of Kazakhstan until 2020, approved by Presidential Decree No. 922 dated 1 February 2010, the Concept for the Transition of the Republic of Kazakhstan to a Green Economy and Decree No. 577 of the President of Kazakhstan dated 30 May 2013. The Strategic Development Plan envisages the implementation of measures to develop the Aktau agglomeration as a regional industrial centre (petrochemical, chemical and metalworking production facilities), and the development of industries to service the oil and gas sector (service and transport facilities) (Republic of Kazakhstan 2014-2016).

The strategic goal of state policy on environmental development in the Russian Federation is to address socioeconomic issues to ensure the preservation of a favourable environment, biological diversity and natural resources (Decree of the President of the Russian Federation 2012).

Environmental sustainability in the Russian Federation depends on the state of specific natural resources and on the level and types of human impact on the environment. The main indicator of environmental sustainability is the level of permissible environmental risk (Decree of the President of the Russian Federation 2017).

The goal of the Concept for the Long-Term Socioeconomic Development of the Russian Federation to 2020 is to ensure a sustainable improvement in the well-being of Russian citizens and rapid economic development over the long term. The concept was approved by a decree issued by the Government of the Russian Federation on 17 November 2008 (Decree of the Government of the Russian Federation 2008).

The following federal and regional strategic documents define the national policy of the Russian Federation in the field of environmental protection:

- Socioeconomic Development Strategy of the Southern Federal District to 2020 (Decree of the Government of the Russian Federation dated 5 September 2011)
- Socioeconomic Development Strategy of Astrakhan Oblast to 2020 (approved by a Resolution of the Government of Astrakhan Oblast, 2010)
- Socioeconomic Development Strategy of the North Caucasus Federal District to 2025 (Order of the Government of the Russian Federation dated 6 September 2010)
- Socioeconomic Development Strategy of the Republic of Dagestan to 2025 (Law of the Republic of Dagestan dated 15 July 2011)
- Socioeconomic Development Strategy of the Republic of Kalmykia to 2020 (Resolution of the Government of the Republic of Kalmykia, 2008)

The following strategic documents also hold particular significance for the Caspian region of the Russian Federation:

- Water Strategy of the Russian Federation to 2020 (2009)
- Energy Strategy of the Russian Federation to 2020 (2003)
- Climate Doctrine of the Russian Federation (2009)
- Concept for the Development of Specially Protected Areas to 2020 (2011)
- Strategy for the Conservation of Rare and Endangered Animal, Plant and Fungi Species in the Russian Federation to 2030 (2014)

The main goal of the Russian Federation Environmental Protection 2012–2020 State Programme is to reduce anthropogenic pressures on the environment by improving the ecological efficiency of the economy (Resolution of the Government of the Russian Federation of 2014, revised and amended in 2018).

Regional environmental programmes adapt the federal environmental protection programme to suit conditions in the regions and aim to reduce the anthropogenic impact on the marine and coastal environment of the Caspian Sea and promote integrated management of coastal zones (Resolution of the Government of the Russian Federation 2014, revised and amended in 2018; Resolution of the Government of the Republic of Dagestan 2007; Resolution of the Government of the Republic of Kalmykia 2008).

Reforms of the environmental protection legislation of the Russian Federation targeted two federal laws, "On environmental protection" (Federal Law No. 7 of January 2002, as amended by No. 404 in December 2016) and "On production and consumer waste" (Federal Law No. 89 of June 1998, as amended by No. 254 in July 2016).

Changes were adopted and previously adopted changes came into force. These changes related primarily to payments for adverse environmental impact; the redistribution of powers to manage production and consumer waste, the accumulated damage to the environment, best available technologies and public oversight, including empowering citizens to exercise it. It is envisaged that all 14 existing types of state environmental monitoring will be combined in a single state environmental monitoring system.

The following laws of particular importance to the Caspian regions were also amended:

- The federal law "On specially protected natural areas" (1995 federal law "On environmental expertise", as amended in 2015) regulates relations in the field of environmental assessment
- The 1995 federal law "On wildlife", as amended in 2016
- The federal law "On strategic planning in the Russian Federation" (dated 28 June 2014), which established the legal basis for the development and operation of an integrated strategic socioeconomic development planning system in the regions of the Russian Federation

Regional environmental protection legislation was also supplemented by a number of new laws, such as the 2014 law in Astrakhan Oblast "On certain issues of legal regulation of environmental protection and biodiversity conservation in Astrakhan Oblast".

The primary law setting the direction of environmental protection in Turkmenistan is the law "On protecting nature", which systematizes and summarizes the basic principles and tasks of environmental protection. The law significantly expanded the range of nature protection regulations, a fact explained by the beginning of greater awareness regarding the danger of uncontrolled environmental impact as the economy expanded and increased anthropogenic pressures. Thus, in recent years, a lot of work has been done to create a regulatory and legal framework for environmental protection and sustainable natural resource management (Kepbanov 2016).

Turkmenistan operates on the premise that reforming the accounting and economic valuation system for natural resources and the system for paying for natural resources is key to striking a balance between the extraction of raw materials, the environment and the economy. Regulatory fees for environmental pollution by enterprises, organizations and institutions of all forms of ownership within Turkmenistan were approved by Order of the Ministry of Nature Protection and agreed by the Ministry of Finance in 2014 (Kepbanov 2015).

As of 1 January 2018, 25 environmental protection and environmental management laws have been adopted and are in force in Turkmenistan. In addition, there are a number of regulatory acts that affect the environmental field to some extent. The new laws adopted in recent years include laws "On chemical safety" (21 March 2011), "On fishing and conservation of aquatic biological resources" (21 May 2011), "On waste" (23 May 2015), "On pastures" (18 August 2015), "On protecting plants" (18 June 2016), "On the collection, conservation and sustainable use of the genetic resources of cultivated plants" (4 February 2017) "On environmental security" (3 June 2017), and "On the State Land Registry" (25 November 2017).

New versions of the following laws have been developed and adopted: "On specially protected natural areas" (31 May 2012), "On flora" (4 August 2012), "On fauna" (2 March 2013), "On protecting nature" (1 March 2014), "On environmental assessment" (16 August 2014), "On protecting atmospheric air" (26 March 2016), the Water Code of Turkmenistan (15 October 2016), and the law "On environmental security" (15 June 2018). The process of reforming environmental legislation is still ongoing (Kepbanov 2016).

7.4.1. Fishing

The relevant legislation of the Caspian littoral states is important for maintaining and restoring stocks of valuable commercial species in the Caspian Sea region.

Since early 2011, the legal and policy framework for fisheries in Azerbaijan has been coordinated with FAO to ensure that the framework covering the rapidly developing aquaculture sector is in line with international standards, best practices and agreements.

With technical support from FAO, the Ministry of Ecology and Natural Resources facilitated the adoption of the Law of the Republic of Azerbaijan "On Amendments to the Law of the Republic of Azerbaijan 'On Fisheries', dated 27 June 2014" (Republic of Azerbaijan 2014).

The Aquatic Bioresources Development, Rehabilitation and Protection Fund was established in 2016. In connection with amendments to the Law of the Republic of Azerbaijan "On fisheries", the following regulatory documents were adopted by the Cabinet of Ministers during 2016 and 2017:

- Registration form and rules for registering entities in the fishing industry
- Regulations and case studies for releasing new and hybrid varieties of fish and other aquatic bioresources into natural water bodies that are fished
- Regulations for the transport of acclimatization resources and the acclimatization of fish and other aquatic bioresources
- Regulations on the application of a special protection regime for fish and other aquatic bioresources in marine protected areas and coastguard strips
- Guidelines for listing important water bodies for fishing and the restriction of water use
- Regulations on catching fish and other aquatic bioresources
- Guidelines for aquaculture
- Regulations on conducting fishery assessments

In the Russian Federation, legislation to maintain and restore valuable commercial species in the Caspian Sea is associated with amendments made in July 2016 to Federal Law No. 166, dated 20 December 2004, "On fisheries and the conservation of aquatic biological resources". The amendments relate to implementing federal state monitoring (oversight) of fisheries and marine bioresource conservation and improving the allocation of catch quotas for aquatic biological resources. Numerous changes were also made to the conceptual apparatus. Terminological amendments were introduced, replacing the concept of "fishing area" with the words "fishery area".

In the new version of the law, commercial fishing and (or) coastal fishing in the Caspian Sea are designated as areas governed by the international treaties of the Russian Federation on fisheries and aquatic biological resource conservation. The list of aquatic biological resources of the Caspian Sea will be subject to the approval of the Government of the Russian Federation.

The new version also clarifies ownership rights to the extracted (caught) aquaculture resources of fish farms engaged in anadromous pasture aquaculture.

Within the framework of regulated fisheries, the total allowable catch should be considered as a controllable fishery parameter which has an impact on the stocks of aquatic biological resources, and the federal law has been supplemented with new provisions on improving the allocation

of catch quotas for aquatic biological resources, covering, inter alia, commercial fishing, the distribution of the total allowable catch of aquatic biological resources in relation to the catch quota for aquatic biological resources in marine waters or to the international quota granted to the Russian Federation.

The Volga-Caspian Branch of the Russian Federal Research Institute of Fisheries and Oceanography (CaspNIRKh) is responsible for developing materials to substantiate the total allowable catch of aquatic biological resources in the Southern Fishery Area of the Volga-Caspian Fisheries Basin, providing a biological justification for the total allowable catch forecast and the possible or recommended catch of aquatic biological resources.

The Fishing Rules for the Volga-Caspian Fisheries Basin play an important role in maintaining and restoring valuable commercial species. The rules regulate the catch of aquatic biological resources for commercial fishing, coastal fishing, fishing for research and monitoring purposes, fishing for training, cultural and educational purposes, fishing for aquaculture (fish farming), and amateur and sport fishing.

Turkmenistan adopted a law "On fisheries and the conservation of aquatic biological resources" in 2011, along with a host of other environmental policies and pieces of legislation to bolster the impact of the law "On protecting nature", which sets out the main direction of environmental protection in the country (Kepbanov 2016).

7.4.2. Waste

Waste management legislation is an important measure for minimizing pollution from land-based sources.

Azerbaijan has acceded to the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal, and the legal framework on hazardous waste has been improved in accordance with the requirements of the convention. New legislation has entered into force in recent years. Regulation of the transboundary movement of hazardous waste strengthened controls to prevent the illegal entry and exit of waste and the transit of waste through the country.

In 2018, the Republic of Azerbaijan National Solid Waste Management Strategy for 2018–2022 was adopted. One of the main outcomes expected from the implementation of the strategy is the improvement of solid waste collection, transportation, treatment and neutralization processes.

In addition, the Action Plan to Reduce the Negative Impact of Plastic Packaging Waste on the Environment in the Republic of Azerbaijan for 2019–2020 was approved. The plan includes measures to expand opportunities to manage plastic packaging waste and increase the use of alternative packaging materials.

The Green Growth concept introduced in Kazakhstan (Green Bridge Partnership Program 2017) sets out current environmental priorities, one of which outlines a goal that, by 2030, 100 per cent of households will be covered by municipal waste services, 95 per cent of waste will be stored in sanitary and safe conditions and 40 per cent of waste will be recycled (50 per cent by 2050).

From 2014 to 2016, federal legislation on waste management in the Russian Federation changed radically in light of a redistribution of waste management powers at the federal, regional and local level, and the introduction of the institution of "regional operators" to deal with solid municipal waste.

Federal Law No. 89 "On production and consumer waste", dated June 1998 and amended in July 2016, aims to improve legal regulation in the field of production and consumer waste management. The new version introduces the concepts of "waste recycling", "waste treatment", "solid municipal waste", "waste neutralization facilities" and so on.

The law provides for a ban on disposing waste that includes useful components which can be recycled, the development of regional waste management schemes, mandatory recycling by producers and importers of waste products from the use of these goods in accordance with the recycling standards established by the Government of the Russian Federation or payment of environmental charges.

Turkmenistan also implemented a law "On waste" in 2015, as well as a number of other laws designed to strengthen environmental protection and natural resource management legislation (Aarhus Centre 2015).

7.4.3. Wastewater

To prevent the discharge of untreated sewage into the sea, Azerbaijan is investing heavily, carrying out large-scale projects, renovating and upgrading major sewage treatment plants and building modern new sewage treatment plants and sewerage systems. Recently built or modernized treatment facilities alone have a capacity of up to one million cubic metres of water per day. The main sources of polluted water discharged into Baku Bay have been eliminated. In addition, to prevent the sea from being polluted by small local sources that are not connected to the central sewer system, modular treatment plants have been installed along the Caspian coast on the Absheron Peninsula.

In addition to the bilateral and multilateral agreements that Iran has signed with other littoral states, the country has implemented a number of measures to reduce the impact of sewage, including designing and implementing collection and treatment of municipal and industrial wastewater under contracts for the sale or disposal of sewage from facilities.

In 2015, the Russian Federation made changes to a number of regulatory acts on wastewater disposal that applied to certain categories of subscriber (establishment of wastewater disposal regulations based on the composition of wastewater and collection of appropriate fees for any excess). The requirements for filing a declaration on wastewater composition and properties by all categories of subscriber were also established. Subscribers for facilities which incur value added tax were assigned a duty to make provisions for the preliminary treatment of wastewater (Decree of the Government of the Russian Federation 2015).

Domestically, Turkmenistan has introduced national regulatory fees for environmental pollution by enterprises, organizations and institutions of all forms of ownership within Turkmenistan (approved by Order of the Ministry of Agriculture and Environmental Protection and agreed by the Ministry of Finance, 2014).

The wetland environment on the Turkmenistan coast of the Caspian Sea is home to unique fauna and in 2012 and 2013, the Government passed the following laws: "On specially protected natural areas", "On flora" and "On fauna" (Kepbanov 2015).

7.4.4. Air emissions

Modernization of the National Environmental Monitoring System of Azerbaijan, an EU-funded partnership project based on the EU practices, has supported the development of air quality management and monitoring systems. The project helped to strengthen the institutional capacity of the Ministry of Ecology and Natural Resources in the field of air quality monitoring through training. In addition, new techniques were adopted to control air quality, including modelling the distribution of pollution and calculating emission inventories.

The air quality monitoring system has been improved by developing guidelines for conducting analyses in accordance with the requirements of ISO 17025 and standard operating procedures for various types of monitoring and laboratory work. Azerbaijan is also introducing technical standards for air quality monitoring into the national standardization system.

In Kazakhstan, atmospheric pollution legislation is also a means to minimize pollutant emissions from diffuse sources of pollution.

The Green Growth concept (Green Bridge Partnership Program 2017) mentioned above sets out the current environmental priorities in Kazakhstan, one of which outlines the goal that Kazakhstan will achieve European air pollution levels by 2030 (Khazakstan 2050 Strategy 2017).

In the Russian Federation, the relevant 2014–2016 version of the federal law "On environmental protection" introduced significant changes to the 1996 federal law "On protecting atmospheric air", in accordance with which work is being carried out to prepare regulatory acts updating the procedures for rationing and issuing emissions permits, to determine emissions using calculation, to update methodological approaches to calculating diffuse pollutants in the atmosphere and to establish automated control systems for pollutant emissions and discharges at large industrial enterprises classified in the first category for environmental impact.

As part of efforts to improve the protection of atmospheric air, a list of pollutants in respect of which state environmental protection regulation measures are applied has been approved (Government of the Russian Federation 2015).

On 26 March 2016, the Mejlis of Turkmenistan adopted a new law on the protection of atmospheric air. It determined the legal and organizational basis for protecting atmospheric air from pollutant emissions to ensure environmental security and prevent the harmful effects of economic and other activities on the environment and public health. The law emphasizes that the pollution of the atmosphere with ozone-depleting substances is regulated by the law on the protection of the ozone layer. The Ministry of Agriculture and Environmental Protection has been designated as the responsible state body for the protection of atmospheric air. In addition, the law sets out the duties of legal entities and individuals whose activities are related to pollutant emissions and harmful physical effects on atmospheric air (Kepbanov 2015).

8. Monitoring and compliance

It is widely recognized that a properly organized monitoring and compliance system is required to underpin environmental protection efforts, to understand ecosystem pressures, status, impact and response, and to develop measures to prevent or mitigate undesirable changes.

International environmental conventions, treaties, agreements and resolutions on the protection and management of natural resources are vital tools which establish a foundation for global environmental policy. There are currently around 500 international agreements covering various aspects of environmental protection.

United Nations General Assembly resolutions and the World Charter for Nature account for the majority of international legal instruments relating to environmental protection. These instruments play a key role in the implementation of international legal environmental cooperation principles and provisions. They cover almost all types of natural resource and the most hazardous human activities.

To ensure that marine pollution is identified and addressed in a timely fashion, the Caspian Sea Integrated Environmental Monitoring Department under the Ministry of Ecology and Natural Resources of Azerbaijan monitors the entire coastal strip and the open sea, including via offshore facilities and floating vehicles. Monitoring to assess the state of pollution in the sea includes identification of pollution sources, determination of qualitative and quantitative discharge/run-off parameters, and assessment and forecasting of pollution.

Water pollution is monitored at standard depths and near the bottom. Hydrometeorological parameters are measured at all monitoring stations (water temperature, speed and direction of flow, atmospheric pressure, wind speed and direction, precipitation and relative humidity).

The Caspian Sea Integrated Environmental Monitoring Department has established 128 stations on land and 55 stations in the open sea. To establish environmental criteria, as well as qualitative and quantitative indicators of anthropogenic impact, stations are regularly monitored, and water samples and bottom sediments are collected and analysed. Analytical, biological, eco-toxicological and microbiological analysis of water samples, bottom sediments, drill cuttings and drilling fluids are carried out in the Ministry of Ecology and Natural Resources laboratory.

The parameters of microbial pollution in the coastal waters of Iran, used for recreation and swimming, have been monitored in accordance with the standards of the World Health Organization (WHO) since 2016. The public is informed via the media, including through publication on the Ministry of Ecology website, where a map shows safe water in blue and highlights the risk of microbial contamination in yellow.

State environmental monitoring of pollution in the Russian Federation part of the Caspian Sea is carried out by Roshydromet, the executive authority that performs monitoring in the sea area within the Russian Federation section of the seabed, in the mouths of rivers carrying water to the Caspian from the Russian Federation (the Volga, Terek and Sulak rivers) and at an integrated background monitoring station on the sea coast (inside the Astrakhan Biosphere Reserve). Roshydromet also monitors atmospheric and soil pollution and radiation on the sea coast.

The Roshydromet monitoring network includes 10 surface water pollution observation points in the mouths of the Volga, Terek and Sulak rivers and 46 marine pollution observation points, of which 33 are in coastal areas and the rest are in the open part of the Caspian Sea.

Monitoring of individual indicators of the state of the marine environment and pollution is also included as part of the aquatic biological resource monitoring programme implemented in the Russian part of the Caspian Sea by the Federal Agency for Fisheries (Rosrybolovstvo 2018).

The national system for monitoring invasive alien species in water bodies now includes 10 permanent sites in the Azov, Caspian and Baltic Seas, and in a number of other water bodies along the invasive corridor.

Rosnedra monitors the state of subsoils. In addition, monitoring of the state and pollution of the environment as a human habitat on the coast and at sea are carried out by Rospotrebnadzor as part of social and hygienic monitoring, the aims of which include identifying cause-and-effect links between the health of the population and the state of the habitat.

Monitoring of the state and pollution of the marine environment in areas of economic activity are carried out by organizations engaged in this activity. This is known as industrial environmental monitoring, which, on the one hand, is part of industrial environmental control, a duty of all enterprises that have an adverse impact on the environment, and on the other hand, is part of engineering and environmental surveys and, with respect to individual components of the environment, a local subsystem of state environmental monitoring. Enterprises engaged in the exploration and development of offshore oil and gas fields in the Russian Federation part of the Caspian Sea, such as LUKOIL-Nizhnevolzhskneft, therefore carry out two types of industrial environmental monitoring: 1) background monitoring throughout the waters of licensed areas; 2) facility monitoring close to production facilities (Monakhov 2012).

Roshydromet publishes the outcomes of monitoring of the state and pollution of the Caspian Sea, its coastline and the rivers flowing into it in information and analytical materials, including annual surveys of the state and pollution of the environment in the Russian Federation, surveys of the background state of the environment within the Commonwealth of Independent States (CIS), yearbooks on seawater quality by hydrochemical indicator and yearbooks on the quality of the surface waters of the Russian Federation ((Federal Service for Hydrometeorology and Environmental Monitoring of Russia 2018; Federal Service for Hydrometeorology and Environmental Monitoring of Russia [Roshydromet] 2017; Russian Federation, State Oceanography Institute 2012–2016).

The results of social and hygienic monitoring are published in the annual state reports on the sanitary and epidemiological welfare of the population issued by Rospotrebnadzor and regional subsidiaries in Caspian regions of the Russian Federation. The results of industrial environmental monitoring by oil and gas companies are published in scientific journals, as well as in reviews posted on company websites (LUKOIL-Nizhnevolzhskneft n.d.).

Monitoring of compliance with the relevant legislation in the Russian Federation is carried out by the supervisory authorities: Rosprirodnadzor and the Federal Service for Supervision of Healthcare for compliance with sanitary requirements, and the Federal Environmental, Industrial and Nuclear Supervision Service (Rostechnadzor) for compliance with industrial safety requirements. The Ministry of Justice of the Russian Federation monitors law enforcement jointly with the federal and regional executive bodies and authorities.

The Ministry of Agriculture and Environmental Protection of Turkmenistan, which is the specially authorized state body for environmental policy and monitoring of compliance with environmental legislation, the protection of ecosystems and sustainable natural resource management, plays an important role in the country's environmental activities.

The Ministry has a broad mandate, including monitoring of the implementation of existing environmental protection laws. In addition to the Department for the Coordination of International Environmental Cooperation and Projects, whose main task is to monitor compliance with environmental legislation, the Ministry also includes the Department of Plants and Animals, the Department for International Relations and Planning, and the Department of Land Resources.

HazarEcoControl monitors compliance by legal entities and individuals with the established protection order for the use of water bodies, atmospheric air and coastal zones, and also monitors dredging operations in the waters and coastal zone of the Caspian Sea.

9. Participation and outreach

NGOs engage in various environmental activities in the Caspian littoral states. These activities include disseminating information on the state of the environment, contributing to the development of strategic environmental assessments, assessing the possible impact of investment projects on the environment and implementing various international environmental projects.

Azerbaijan acceded to the Convention on Access to Information, Public Participation in Decision-making and Access to Justice in Environmental Matters (Aarhus Convention) on 23 March 2000 and, with the assistance of the Organization for Security and Co-operation in Europe (OSCE), has set up a Public Environmental Information Centre (Aarhus Centre) in Baku to implement its provisions. The centre's main objectives are to promote the use of environmental information, public participation in decision-making, public transparency on environmental matters and good governance. Its facilities can be used by NGOs, government authorities, representatives of international organizations and anyone interested in environmental issues.

In 2010, the Public Environmental Council was established under the Ministry of Ecology and Natural Resources. The Council's members are NGOs and community leaders and its main objectives are to cooperate with NGOs and to implement the Aarhus Convention provisions as effectively as possible.

Since the seventh Environment for Europe Ministerial Conference (2011) in Astana, which took the decision to establish the Shared Environmental Information System (SEIS), and the subsequent Batumi Conference in 2016, Azerbaijan has made significant progress in setting up and rolling out SEIS.

Progress has also been made in ensuring that the United Nations Economic Commission for Europe (UNECE) environmental indicators are accessible. The indicators are increasingly being published on the websites of national environmental authorities, statistical agencies and open data portals. Currently, 44 out of the 49 indicators, which offer a practical and cost-effective way to assess the state of the environment, are available on the State Statistical Committee's website.

The Islamic Republic of Iran is implementing a large number of environmental protection programmes in close cooperation with NGOs, including the Without Plastic campaign, the Caspian Seal programme and the Protecting Migratory Birds from Illegal Hunting programme (National Contribution).

Kazakhstan has ratified the Aarhus Convention. Pursuant to the provisions of the Environmental Code of the Republic Kazakhstan, the state authorities are obliged to disseminate environmental information via the media, including information relating to the state of the environment, as well as drafts of regulatory acts and international agreements on environmental protection.

Aarhus Centres operate in Aktau and Atyrau, where they cooperate with NGOs, including the Kazakhstan NGO EcoForum. National Reports on the State of the Environment are published annually in Kazakhstan, and the texts are published on the Ministry of Energy website (Republic of Kazakhstan 2014-2016).

A number of NGOs engaged in a variety of environmental activities are active in the Caspian regions of the Russian Federation. Long-established branches of national ecological (geographical, ornithological and nature protection) associations and societies, local student organizations and environmentally focused educational institutions for children operate here.

Local universities and nature reserves carry out important educational work.

The following environmental NGOs are active in Astrakhan Oblast:

- Astrakhan branch of the Russian Bird Conservation Union

- Center for Environmental Policy and Culture
- Astrakhan regional branch of the All-Russian Society for Nature Conservation
- Astrakhan regional branch of the Russian Geographical Society

The following public organizations are working to protect the Caspian Sea in the Republic of Dagestan: the Republic of Dagestan branch of the Russian Geographical Society, the Berkut Scientific and Ornithological Student Association, the regional branch of the Green Planet movement and the Center for Environmental Policy and Culture.

Active organizations in the Republic of Kalmykia include the regional branch of the national Center for Environmental Policy and Culture, the Normativ Scientific and Analytical Centre and the Republic of Kalmykia regional office of the Russian Bird Conservation Union.

The activities of public organizations operating in the Caspian region of the Russian Federation are closely linked to the main activities of state universities and state nature reserves in the region.

Most state structures are established with the assistance of the universities and nature reserves, and focus primarily on education, research and awareness.

Environmental education is one of the most important areas of work carried out by nature reserves such as the Astrakhan Biosphere Reserve, the Dagestan Nature Reserve and the Chornye Zemli (Black Lands) Nature Reserve.

In 2015, staff at the Astrakhan Biosphere Reserve hosted 75 environmental education events, which were attended by a total of around 18.000 people.

The Chornye Zemli (Black Lands) Nature Reserve organizes educational activities in such key areas as the state of landscapes in the Republic of Kalmykia, conservation of the saiga antelope population and habitat and protection and research efforts in the continental wetland (Manych-Gudilo).

The annual Caspian Sea Day, which marks the anniversary of the entry into force of the Tehran Convention, is an important form of Tehran Convention activity in the Russian Federation and the main event for implementing the convention's public participation strategy to engage public stakeholders in implementing the provisions of the convention.

The Caspian Sea Day activities dedicated to safeguarding biodiversity and ecosystems in the context of oil and gas development in the Northern Caspian, taking account of the Tehran Convention (2014), and an event entitled "The Tehran Convention and Stakeholder Interaction in Addressing the Environmental Problems of the Caspian" (2015) were the marine and coastal environment protection events which had the most impact.

The Mejlis of Turkmenistan ratified the Aarhus Convention on 30 April 1999, following which the convention's provisions began to be implemented. The main provisions are already reflected in legislation, and this is making a noticeable and positive contribution to accelerating implementation of the convention in Turkmenistan.

The National Centre of Trade Unions, the Women's Union, the Makhtumkuli Youth Organization, the Peace Fund of Turkmenistan and a number of other public organizations, including environmental organizations, operate in Turkmenistan. The largest of these is the Nature Conservation Society of Turkmenistan, a member of the IUCN. The society's Balkan branch actively participates in the annual Caspian Day event.

To effectively disseminate relevant local and international information on planned and ongoing activities and environmental emergencies and engage with the public, the Department for the Coordination of International Environmental Cooperation and Projects has been established within the Ministry of Agriculture and Environmental Protection. The department's role includes assisting with the dissemination of information via television and radio and publishing articles on environmental topics. Since 2013, the country has published a quarterly magazine, Ecological Culture and Environmental Protection, in three languages. The magazine provides broad and professional coverage of biodiversity conservation and the sustainable use of bioresources. Information on the state of the environment, including on biodiversity, is regularly published in the media (the Turkmen-language Turkmenistan newspaper and the Russian-language Neutral Turkmenistan). Environmental events such as photo exhibitions and competitions and children's art exhibitions are held as part of various international environmental projects supported by international partners accredited in Turkmenistan (UNDP, GIZ, UNEP, EU, etc.).

The national Altyn Asyr television channel broadcasts a weekly Saturday programme called In Harmony with the Environment, featuring scientists from nature reserves and specialists from the Ministry of Agriculture and Environmental Protection. The Turkmenistan channel regularly broadcasts Nature of Turkmenistan, presenting videos, documentaries and information on nature reserves and unique parts of the country. The channel broadcasts in seven languages.

As part of the implementation of the Agreement on the Conservation of African-Eurasian Migratory Waterbirds and the Ramsar Convention, World Migratory Birds Day is celebrated during the second weekend of May every year. Employees at the Institute of Flora and Fauna and at the country's nature reserves, together with national experts on biodiversity, hold various environmental events to mark the International Day for Biological Diversity and World Day to Combat Desertification and Drought, including hosting round tables, giving lectures in universities and schools around the country and publishing articles in the media. Staff at the Ozone Centre in Turkmenistan celebrate the International Day for the Preservation of the Ozone Layer. Annually since 2007 on August 12, the Caspian Day is widely celebrated on the Turkmen coast.

The Turkmenistan Aarhus Centre was established in 2012. It supports the implementation of the Aarhus Convention in Turkmenistan by facilitating access to information on the environment, public participation in environmental decision-making and access to justice in environmental matters. To promote awareness of environmental standards and human rights among citizens and other stakeholders, the centre has established an environmental database, which includes national legislation. It also develops environmental information materials for publication in the national media.

One active public organization is the National Falconry Society of Turkmenistan. This organization aims to promote hunting with hunting birds, instilling a tradition of looking after populations of birds of prey and other animals in their natural habitats. The society is a member of the International Association of Falconry and Conservation of Birds of Prey. It contributes to ecological and veterinary monitoring of the bird of prey population and supports the breeding of rare predatory birds for falconry, including such species as the peregrine falcon, gyrfalcon and saker falcon. It should be noted that falconry is included on the UNESCO Intangible Cultural Heritage List. It is very common throughout the world and is considered natural, environmentally friendly and safe.

The expert and analytical agency Ynanch-Vepa was established in 2009 as a non-profit organization to build the capacity of organizations in Turkmenistan through sharing experience and knowledge with foreign colleagues, establishing professional partnerships, disseminating information on best global practices and introducing cutting-edge techniques. The agency is currently bringing together the efforts of leading experts in the fields of nature conservation, agriculture and water management, including specialists who train staff for these sectors within the higher education system in Turkmenistan (Tebigykuwwat 2018).

10. Measures

The Tehran Convention obliges Parties to engage in bilateral and multilateral cooperation on virtually the full range of environmental problems in the Caspian Sea, including the development of protocols that prescribe additional measures, procedures and standards for implementing the Convention.

In accordance with their obligations under the Tehran Convention, the Caspian littoral states, independently or jointly, take all measures necessary to prevent, reduce and monitor pollution in the Caspian Sea, and to protect, preserve and restore its marine environment. They use the resources of the Caspian Sea in such a way that they do not damage its marine environment and they cooperate with each other and with competent international organizations to achieve the convention's goal.

The unique Caspian ecosystem can only be successfully preserved through effective cooperation under the Tehran Convention, the introduction of modern economic mechanisms that minimize anthropogenic pollution and other adverse impacts on the marine environment and the establishment of a common Caspian system of specially protected land and marine areas.

To ensure the sustainable development of the Caspian Sea region, there needs to be a shift towards integrated regional and economic development planning which takes account of changing natural conditions, including climate change.

It is necessary to determine the environmental risks associated with economic activities in coastal marine areas, and to regulate any other activities that may harm or impact species, or endanger the conservation of ecosystems.

Measures proposed by Azerbaijan

Azerbaijan proposes to:

- Intensify cooperation to create a unified system of assessment criteria and standards for the Caspian Sea as a closed water basin, drawing on existing standards and limits commonly applied to special bodies of water
- Rehabilitate land contaminated by oil and oil products
- Reduce the discharge of untreated sewage into the sea
- Develop green agriculture
- Strengthen cooperation in the protection and sustainable use of aquatic bioresources
- Strengthen regional cooperation in the monitoring and management of marine litter, especially where it is contaminated with plastics and microplastics

Measures proposed by Iran

- Develop national and provincial territorial action plans
- Develop at least 54 rural business clusters, build and commission 98 rural industrial areas and create 1.914 million jobs in villages and nomadic areas through the construction and development of competitive and export-oriented enterprises in the private sector
- Identify villages exposed to the risk of natural disasters, develop and implement actions in collaboration with the responsible authorities and engage the population and local authorities, so that at least one third (30 per cent) of villages are protected from the risk of natural disasters
- Develop a feasibility study for solid waste collection systems in rural areas
- In conjunction with the private sector, develop and build sewage treatment plants in priority villages located near rivers, wetlands, dams and villages that experience difficulties with wastewater disposal
- Develop green agriculture
- Convert 500,000 ha of land with large slopes into gardens
- Ensure optimal use of pesticides, plant protection products and chemical fertilizers, and wider use of organic fertilizers (compost) and biofuels; establish rules for the use of fertilizers and chemicals
- Produce healthy, organic products, introduce national standards for the quality control of agricultural products, expand integrated pest and plant disease control, make optimal use of materials, including chemicals and fertilizers,

- and support organizations involved in protecting plant life as part of efforts to promote public health
- Introduce a ban on the release, production, import and consumption of genetically modified crops under the Law on the Biological Safety of the Islamic Republic of Iran

Measures proposed by Kazakhstan

Measures proposed by Kazakhstan include efforts to:

- Establish a state research institute on Caspian Sea issues
- Create specially protected areas on the Tyuleniy Archipelago and the Durnev Islands in the Komsomolsky Gulf
- Introduce environmental zoning, identifying environmental capacity, i.e. the permissible level of human pressure for each ecological zone within the northern and north-eastern parts of the Caspian Sea shelf

Measures proposed by the Russian Federation

The measures proposed by the Russian Federation aim to:

Increase the efficiency of aquatic bioresource use

Management of aquatic bioresources should take into account the ecological and geographical integrity of the Caspian Sea and build on modern ecological principles, including the need to preserve the main habitats of fishery resources and the normal functioning of the Caspian's aquatic and coastal ecosystems.

The Tehran Convention includes biodiversity conservation under the sustainable management of bioresources in the Caspian Sea as the "natural" foundation of this economically important activity, which directly affects the interests of people living in coastal areas. It is therefore necessary to promote the interdependence of environmental and fishery issues in the Caspian Sea.

There is a need to develop research and development, including innovations, to ensure the rapid introduction of modern technologies that enable:

- modernization of fishing methods and techniques
- zero waste use of catches
- development of progressive fishery (aquaculture) technologies

Preserve the habitat of rare and endangered species in the Caspian Sea in accordance with the Tehran Convention and the Ashgabat Protocol

It is important to understand that creating a common Caspian system of specially protected natural sites as the basis for safeguarding biodiversity and the bioresource value of the Caspian Sea is a priority.

It is vital to expand specially protected areas as a proportion of the total area of the territory, improve the efficiency of public management and operation of specially protected areas and improve the regulatory framework for specially protected areas.

In existing specially protected areas, there is a need to strengthen the effectiveness of research, environmental monitoring and efforts to restore natural landscapes and prevent human activities from changing them.

To minimize the adverse impact associated with invasive species, which are one of the threats to marine biodiversity, early detection and rapid response and risk analysis techniques need to be strengthened at an early stage of the invasion, when the population is still small.

Minimize oil pollution associated with hydrocarbon development

Given the ecological vulnerability of the Caspian, additional measures to preserve the marine environment should be taken before embarking on planned economic activity in the sea. A technological chain of production applying the "zero-discharge" principle should be introduced everywhere.

To avoid negative impact on the benthic environment during the operation of oil reservoirs and once operations are complete, construction and other work that disrupts the seabed should be

minimized during the most vulnerable period of the benthic life cycle (from April to June), when communities are replenished as juveniles settle on the floor. This period is also the most sensitive for sturgeon and other fish species, which spawn at this time.

The construction of an offshore pipeline system necessitates strict compliance with environmental requirements. While laying the pipeline along the seabed, only processes that will ensure minimal negative impact on the environment and quick recovery once construction has been completed should be used.

In waters that are important for commercial fishing, measures must be taken to conserve and restore biological and fishery resources

Measures proposed by Turkmenistan

Environmental protection of the Caspian Sea:

- Update pollutant databases based on the results of the Environmental Monitoring Programme and taking into account the outcomes of the work of the regional Working Group on Monitoring and Assessment of the Caspian Environment
- To improve ongoing regular monitoring of seawater quality, supply CaspEcoControl with modern equipment and guidelines for conducting hydrochemical analysis; conduct staff training and share best practices

Biodiversity conservation:

- Conduct a count of all fish species in the Turkmenistan sector of the Caspian Sea and study the trophic food chain
- Monitor the Caspian seal population and study its food sources
- Continue to monitor Mnemiopsis numbers
- Continue to monitor resident and migratory birds
- Protect sites used by migratory bird species (wetlands under the Ramsar Convention)

Sea level fluctuations:

- Design coastal structures that take account of sea level fluctuations and surges
- Train designers, architects and seismologists to take account of sea level fluctuations and other hazards

11. Conclusion

Many of the challenges associated with preserving the unique biodiversity and resources of the Caspian Sea have yet to be addressed. The human factors and activities that have been identified are putting significant pressure on the environment and heavily impacting the well-being and sustainable livelihoods of local people.

A key issue at this point in time is maintaining a balance between the need to further develop industry and agriculture, while implementing sustainable measures to preserve ecological and environmental services. The oil, gas and fishing industries are the leading contributors to the economy, but they also have the greatest impact on the environment, significantly increasing the risks of environmental damage. All of the Caspian littoral states plan to continue exploiting the natural resources found in the Caspian Sea, and although oil production has decreased since prices fell in 2014, the gas industry has flourished and development increased between 2006 and 2016.

Population growth, especially in the western part of the Caspian Sea, is causing an accumulation of hazardous waste and pollution, both in the air and in the sea, leading to a reduction in the Caspian Sea's biodiversity. Waste management remains an urgent issue, although total chemical and organic run-off decreased between 2011 and 2015. Marine litter is another pressing issue which still needs to be addressed.

Another major threat requiring a response is climate change, as its impacts are very difficult to predict, especially in a rapidly changing environment like the Caspian Sea. Globally, continued and increasing greenhouse gas emissions are exacerbating the impact of other negative factors. Energy, industry and agriculture account for 90 per cent of these emissions. In addition, the number of natural disasters is expected to increase and variations in the temperature and salinity of the sea will become even more difficult to anticipate. Although the sea level stabilized in

2016/2017, it had been falling continuously since 2006, while the water temperature has risen 0.06 degrees per year over the last 30 years.

Measures to respond to these issues have been taken at several levels. The first legally binding step to establish and improve international cooperation between the Caspian Sea states was the ratification of the Tehran Convention in 2006. Since then, policies and legislation on air pollution, fishing and wastewater have been implemented at the national and bilateral levels.

Another key achievement is the progress that has been made in using compliance monitoring tools to facilitate international cooperation, providing governments and the public with important information. The results of national monitoring are made public so that they are accessible to all. For instance, the development of new tools such as the CEIC portal enables governments and experts to update data on the Caspian Sea on an ongoing basis, and to access the information supplied by others. This portal is expected to become a multilateral cooperation tool.

Finally, the governments of the Caspian littoral states encourage participation and outreach. NGO awareness campaigns and educational initiatives by universities and nature reserves are essential for public awareness. These efforts are also in line with the principles of the Aarhus Convention, to which Azerbaijan, Kazakhstan and Turkmenistan are all Parties. To embed current standards in everyday practice, effectively preserve the Caspian Sea and fulfil the obligations set out in the Tehran Convention, several aspects of international cooperation will need to be improved.

Some technical changes are expected in the near future, including the introduction of modern economic mechanisms and best available technologies in industrial production, the establishment of a unified Caspian system of specially protected areas and marine and coastal protected areas and regional economic development planning. The Caspian littoral states will also need to take account of the impact of climate change in the environmental policy that is deployed in the coastal marine areas of the Caspian region.

Conservation of the marine and coastal environment of the Caspian Sea in the twenty-first century will be the most important challenge for international environmental cooperation between the Caspian littoral states under the auspices of the Tehran Convention.

Notes

1. Oil and natural gas rent is the difference between the value of production at world prices and the total costs of production (World Bank 2017b). Oil rent as a percentage of GDP shows the economic contribution of oil production to the national economy.

2. Source: Expert of the State committee for nature protection and land resources.

3. Albedo is a measure of how well a surface reflects solar energy. The albedo effect has a significant impact on climate: the lower the albedo, the more solar radiation is absorbed by the planet, which causes temperatures to rise.

4. A positive radiation effect means that the Earth emits less energy into space compared to what it receives from the Sun. Burning fossil fuels increases this mismatch, making the atmosphere warmer.

5. Hereinafter – Mnemiopsis.

6. Hazard classes according to GOST 12.1.007-76 “Harmful substances. Classification and general safety requirements.”

7. Shirvan National Park, Hasan Aliyev Zangazur National Park (established in 2012), Hirkan National Park, Altyaghach National Park, Ag-Gel National Park, Absheron National Park, Shahdag National Park, Goygol National Park, Samur-Yalama National Park and Gizil-Agach National Park.

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The main aim of this report is to provide the necessary information on changes and trends in the state of the marine and coastal environment of the Caspian region for the 2012–2016 period, based on regular reporting of the Caspian littoral states and other literature sources.

This report presents the current state of the Caspian Sea's marine environment, taking into account sea level fluctuations and its pollution, including pollution from land-based sources, pursuant to the provisions of the Tehran Convention and its protocols.

The report is based on the United Nations Environment Programme DPSIR methodology (Driving Forces-Pressures-State-Impacts-Reponses), which shows the relationship between human activities, the state of and trends in the environment and the well-being of society. Following this methodology, the report provides a brief description of the region's current socioeconomic situation, including the state of the population.

The report reveals that certain industries, specifically mining (in particular the oil and gas sector), fishing, agriculture and tourism industries, are driving forces, influencing the state of the Caspian Sea's environment.

Information on indirect natural driving forces that are affecting the state of the Caspian Sea's marine and coastal environment, related to climate change and sea level fluctuations, which are characteristic of this closed water body, is of particular importance.