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The Geopolitics of Connectivity: Transformational Harbinger for the Silk Road Region

Critical Raw Materials and the Reconfiguration of Global Power
Han Ilhan

The Corridor Changing Eurasia
Eric Rudenshiold

The Zangezur Concept
Onur İşçi

The Role of the Middle Corridor in Eurasian Connectivity
Melina Torús

Slipping Out of 'Old Geopolitics' Through TRIPP
Vasif Huseynov

Divergent Paths in the South Caucasus
Laura Linderman

The Case for Azerbaijan's Strategic Recalibration

Why Baku Needs to Adjust to a Global Polarized Reality
Jahangir E. Arasli

The Caspian's Declining Water Level

Drivers, Consequences, and Impacts on Littoral States
Vali Kaleji

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Caspian Sea Water Level Decline

Drivers, Consequences, and Impacts on Littoral States

Vali Kaleji

Fluctuations in the water level of the Caspian Sea and the shoreline's retreat are not new phenomena; they have happened repeatedly throughout the sea's long history. My hometown is in Mazandaran Province on the southern coast of the Caspian in Iran, and I personally observed a significant rise in water levels after the Soviet Union's implosion, during which many houses and coastal facilities were submerged. About thirty years later, I saw a notable retreat of the Caspian from its shores again. What is especially notable, however, is that the current rate of shoreline retreat—caused by a decline in the sea's water level—is much greater than during previous historical periods. Scientific reports and empirical studies further support these observations.

The average water level of the Caspian Sea has fluctuated over the past century, but has generally remained between 26 and 27 meters below the Baltic Sea level. According to the Convention on the Legal Status of the Caspian Sea (signed in Aktau at the presidential level in August 2018), the sea level was officially set at -28 meters, meaning 28 meters below the level of the world's oceans and open seas, using the Baltic Sea as the reference point for measuring fluctuations in the Caspian Sea. Specialists at the Volga–Caspian Fisheries Research Institute have reported that the Caspian Sea's water level has dropped to more than 29 meters below the Baltic Sea (-29 m), which serves as the standard reference system in Russia and several post-Soviet states for measuring water levels in landlocked bodies of water.

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The water level of the Caspian Sea has been declining since the mid-1990s, with the pace of decline speeding up after 2005, leading to a drop of about 1.5 meters. Between 2005 and 2023, roughly 185 centimeters of water level reduction resulted in the loss of approximately 31,000 square kilometers of surface area. In recent years, many reports have documented this ongoing decline. According to one estimate, the Caspian Sea's water level could fall by 9 to 18 meters by the end of the twenty-first century, potentially shrinking its surface area by nearly a quarter and exposing about 93,000 square kilometers of dry land—an area similar in size to Portugal. Additionally, estimates by the European Institute for Asia Studies (EIAS) suggest that the northern part of the Caspian Sea, where water depths are less than 5 meters, may disappear within 75 years if water levels continue to decline at an average rate of 7 centimeters per year.

Fluctuations in the water level of the Caspian Sea and the shoreline's retreat are not new phenomena; still, some experts warn that the Caspian Sea might be nearing a point of no return.

According to a study published in the journal *Nature*, a drop of 9-18 meters in the Caspian Sea's water level would expose the vast northern Caspian shelf, the Turkmen shelf in the southeastern sector, and all coastal zones in the central and southern parts of the sea. Additionally, Kara-Bogaz-Gol Bay along the eastern edge would become completely desiccated. Overall, the Caspian Sea's surface area would decrease by roughly 23 percent with a 9-meter drop, and by about 34 percent with an 18-meter decline in sea level.

Substantial shoreline retreat has taken place along the coasts of the littoral states due to the decline in the Caspian Sea's water level. Along the Russian shoreline, the retreat is estimated at roughly 15-70 centimeters per year, varying by local conditions and data sources, leading to exposure of former seabeds and significant ecological and economic impacts. In Derbent, Dagestan (Russia), the shoreline has receded by nearly 100 meters, resulting in the formation of new sand dunes.

In Kazakhstan, the shoreline has moved seaward by over 20 kilometers in the past twenty years. Likewise, in Turkmenistan, the shoreline in one coastal town has retreated by around 800 meters within a relatively short timeframe. Furthermore, a significant and rapidly accelerating retreat has been observed along Azerbaijan's coast, where a 2.5-meter sea-level drop has uncovered about 218 square miles of new land and caused shoreline shifts of 10-20 meters in some areas, highlighting the extent of the change. Finally, along Iran's southern Caspian coast, the shoreline has moved inland by about 300 meters, and if current trends continue, this retreat could reach 500-600 meters, possibly leading to desert-like conditions.

These projections are very concerning, and some experts warn that the Caspian Sea might be nearing a point of no return.

Causes and Reasons

The declining water level of the Caspian Sea is driven by multiple factors, making it impossible to assign the recent decline to a single cause. These factors include a mix of natural and human influences, similar to those seen in other environmental crises like the Aral Sea disaster. There appear to be six main natural and anthropogenic factors contributing to the Caspian Sea's declining water level.

One, *a cyclical process of Caspian Sea water level fluctuations*. Some experts consider the recent decline in the Caspian Sea's water level to be part of a natural cycle, characterized by repeated periods of rise and fall throughout history. According to a study published in the journal *Nature*, at the beginning of the twentieth century, the Caspian Sea level was approximately -25.8 meters relative to the global mean sea level. It subsequently declined by 2 meters, stabilized during the 1950s and 1960s, and then fell sharply between 1970 and 1977, reaching its lowest point in a century at -29 meters. Between 1978 and 1995, the water level rose by 2.5 meters. However, reports indicate that the decline resumed in 1995, with a drop of approximately 2 meters between 2006 and 2024, bringing the sea to its lowest recorded level of -29 meters.

Some experts predict that this downward trend is likely to continue. On the other hand, other experts see recent events as a manifestation of a well-recorded cyclical pattern of Caspian Sea water level fluctuations. For example, Telman Zinalov, Director of the Azerbaijan Environmental Forecasting Centre, stated in a 2022 interview that "the fluctuation of the Caspian Sea's volume has a cyclical and recurring nature, which has been repeated many times throughout history." Similarly, Hamid Alizadeh, a professor at the National Institute of Oceanography and Atmospheric Sciences in Iran, has noted that "there is a possibility for the Caspian Sea's water level to rise. Just as in 1977, when the sea reached its lowest level and most predictions anticipated further decline, the water level began to increase in 1978."

However, the sharp decline in the Caspian Sea's water level, coupled with the significant, continuous, and accelerating retreat of water from the coast, has raised concerns that the current trend may exceed the historical cyclical patterns of rise and fall. Aida Amangeldina, coordinator at the Sustainable Kazakhstan Research Institute at Narxoz University, notes that between 1930 and 1941, sea level declined by an average of 14.7 centimeters per year. From 1941 to 1978, the Caspian Sea continued to shrink, albeit at a slower rate of approximately 3 centimeters per year. By contrast, as noted earlier, the water level declined by approximately 2 meters between 2006 and 2024.

Two, *climate change—particularly atmospheric warming, reduced precipitation, and increasing evaporation*. As CNN Senior Climate Writer Laura Paddison explains, while climate change is driving global sea-level rise, the situation is different for landlocked bodies of water, such as the Caspian Sea. These systems depend on a delicate balance between river inflows, precipitation, and losses through evaporation.

As the climate warms, this balance is being disrupted, leading to the shrinkage of many lakes. Since 1979, the average surface temperature of the Caspian Sea has increased by approximately 1°C. Under medium to high greenhouse gas emission scenarios, the Caspian Sea level is projected to decline by 9-18 meters by the end of the twenty-first century, primarily due to a substantial increase in evaporation that is not offset by rising river inflows or precipitation. The ecological consequences of such a decline would be severe.

Research led by the University of Leeds indicates that water levels in the Caspian Sea are declining, as higher temperatures drive greater evaporation than inflow. Even if global warming is limited to below 2°C—the goal established at various Conferences of

the Parties (COPs) to the United Nations Framework Convention on Climate Change (UNFCCC), starting at COP15 in Copenhagen in 2009—the Caspian Sea level is projected to fall by 5 to 10 meters; under higher warming scenarios, water levels could decline by as much as 21 meters by 2100.

The Leeds study estimates that an area of approximately 112,000 square kilometers—larger than Iceland—could be exposed, even under the more optimistic scenario of a 10-meter decline. Given that many of the region's most ecologically and economically important zones are located in shallow waters, such changes could have severe implications for biodiversity and the sustainability of local human populations. In addition, intensified wind speeds enhance evaporation across the sea, with moisture transported eastward, resulting in a net loss for the Caspian Sea drainage basin.

Three, *increasing population in coastal cities and exploitation of river water resources*. The Caspian Sea receives inflows from approximately 130 large and small rivers across its five coastal countries, including the Volga (Russia), Ural (Kazakhstan and Russia), Aras (Türkiye, Armenia, Iran, and Azerbaijan), Kura (Türkiye, Georgia, and Azerbaijan), Samur (Azerbaijan), Atrek (Iran and Turkmenistan), and the Sepid-Rud and Gorganrud (Iran).

Simultaneously, more than 15 million people reside along the Caspian coastline in cities and ports across these countries, including Makhachkala, Olya, Astrakhan, Solyanka, and Lagan (Russia); Baku, Sumgait, and Lankaran (Azerbaijan); Bandar Anzali, Astara, Amirabad, Nowshahr, and Bandar Turkmen (Iran); Turkmenbashi (Turkmenistan); and Aktau and Atyrau (Kazakhstan).

The economies and livelihoods of these populations are closely linked to the Caspian Sea, particularly in fisheries, maritime transport, shipping, and tourism. In recent decades, rapid population growth, migration, industrial expansion, port development, and urbanization have intensified the exploitation of river water resources, contributing to the decline in the Caspian Sea's water level. The accelerated construction of desalination plants for human consumption, cotton cultivation, and agriculture has further compounded these pressures. Population density is highest along Iran's southern shores and in Azerbaijan, reflecting a favorable climate, fertile land, and abundant economic opportunities.

Four, *desalination projects*. The Caspian Sea's water level is also influenced by desalination projects undertaken by Kazakhstan, Turkmenistan, Azerbaijan, and Iran. As Aida Amangeldina notes, desalinated water is gradually becoming an increasingly important source for the countries of the Greater Caspian Region. It has, for example, played a pivotal role in the development of Kazakhstan's Mangystau Province, including the port city of Aktau. Similarly, Turkmenistan's new port city of Turkmenbashi and Azerbaijan's ports of Alat and Sumgait plan to rely on desalination for freshwater supply. Iran, facing its own water shortage challenges, recently entered this process, launching its first desalination plant in August 2025 in the coastal city of Neka, located in central Mazandaran Province.

It is understandable that these coastal states turn to desalination of Caspian Sea water to address local water shortages. However, it is noteworthy that approximately five tons of desalinated water are required to produce just one megawatt of energy. Aida Amangeldina notes that Kazakhstan is pursuing several projects in cooperation with the EU and some of its member states to produce and import hydrogen. While such initiatives contribute to improving the EU's environmental situation by reducing greenhouse gas emissions, they have adverse impacts on the Caspian Sea by accelerating the decline in water levels. Moreover, desalination processes leave behind about 37 to 38 grams of salt per liter of water, which further exacerbates the environmental challenges facing the Caspian Sea.

Five, *oil exploitation and hydrocarbon production*. While Russia and Iran do not exhibit significant activity in hydrocarbon production within the Caspian region, Kazakhstan, Azerbaijan, and Turkmenistan actively extract and export oil, contributing to oil spills and pollution in the Caspian Sea. Just in the Kazakh sector of the Caspian, approximately 8,000 tons of oil enter the sea annually. Oil spills from Azerbaijan have been particularly significant, as the country operates most of the Caspian Sea's oil wells and maintains the highest production rates.

Aida Amangeldina identifies three primary ways in which hydrocarbon production has accelerated the decline in the Caspian Sea's water level. First, hydrocarbon extraction releases greenhouse gases, reducing precipitation over the basin and promoting desiccation. Second, the process induces soil erosion, which further contributes

to declines in water levels. Finally, the production process itself heavily pollutes the water, representing the most direct negative impact of hydrocarbon activity in the Caspian Sea. Consequently, a key consideration for sustainable development and integrated management is mitigating the environmental impacts of hydrocarbon production, including pollution and water-level decline.

Six, *Russia's dams and intensified agricultural development along the Volga River*.

Although approximately 130 large and small rivers from the five coastal countries flow into the Caspian Sea, about 80 percent of its water resources are supplied by the Volga River. Consequently, the Volga, geographical Europe's longest river, plays a crucial and vital role in sustaining the Caspian Sea.

The river is integrated with a series of eight major hydroelectric dams—collectively known as the Volga-Kama Cascade—including Volzhskaya, Cheboksary, Zhiguli, and Nizhny Novgorod, most of which were constructed during the mid-twentieth century under the Soviet Union. As a result of these dams and hydroelectric plants, the Caspian Sea's volume decreased by an estimated 25 cubic kilometers annually between 1956 and 1969.

Lidiya Parkhomchik, a researcher at the Institute of World Economics and Politics, notes that shipping was adversely affected as navigation channels, particularly in the Volga delta and along the northern Caspian coast, became shallower. In response, in 1970 the USSR Government issued Resolution No. 612 outlining land reclamation and development plans for 1971-1985, including flow regulation and redistribution measures. By 1976, the Siberian rivers flow transfer project was incorporated into the Main Directions of USSR Economic Development. Consequently, from 1978 onward, the Caspian Sea's water level gradually rose, a trend that continued until 1995. This historical sequence clearly illustrates the pivotal role of Russian water management along the Volga River in influencing the Caspian Sea's water levels.

Currently, these hydroelectric dams control a catchment area of approximately 1.38 million square kilometers and account for over 80 percent of the Caspian Sea's total inflow. Although no entirely new dams are under construction or have recently been completed on the Volga River, Russia has intensified agricultural development along the river since the onset of the present phase of the conflict over Ukraine, leading to increased water consumption. This expansion aims to strengthen domestic food production amid global supply chain disruptions.

In 2024, Russia's grain harvest reached a record 147 million metric tons, with the total cultivated area expanding by 300,000 hectares to 84.5 million hectares, including 20 million hectares of winter crops. According to a report by the FAO Liaison Office with the Russian Federation, the Volga Federal District produced approximately 27.4 million tons of grain in 2024, representing a 10 percent decline compared to 2023, alongside 4.81 million tons of sunflower seeds (up 19 percent) and 0.662 million tons of soybeans (up nearly 80 percent). To support this intensified cultivation, irrigation along the Volga River has significantly increased, placing additional stress on an already declining water supply and exacerbating the pressure on the Caspian Sea's water levels.

Under these circumstances, the Volga River has experienced a significant decline in water levels, exposing areas that were previously submerged. In 2025, the reduction was so severe that it sparked disputes over water use between Russia's upper and lower Volga regions. Upper Volga areas, such as Tatarstan, prioritize maintaining high water levels to support energy production and shipping, whereas lower Volga regions, like Astrakhan, emphasize a full-water regime to sustain fish farming. These competing demands have generated public policy debates over the allocation of water resources.

The reduction in water inflow from the Volga River, which has significantly contributed to the decline of the Caspian Sea's water level, has drawn criticism from coastal countries. Despite growing geostrategic alignment between Tehran and Moscow, Ali Salajegheh, former Head of Iran's Department of Environment, issued a notably strong statement in August 2023: "Water inflows, particularly from the Volga River, into the Caspian Sea have been blocked by neighboring countries. We hope to resolve water rights and pollution issues within the framework of the Tehran Convention"—that is to say, the Framework Convention for the Protection of the Marine Environment of the Caspian Sea, which was signed in November 2003 and entered into force in August 2006. Azerbaijan attributes part of the sea's decline to Russian dam operations on the Volga and has raised concerns through a

joint working group established in April 2025 to monitor and address the issue. Kazakhstan has similarly urged Russia to maintain minimum Volga flows to stabilize the Caspian, although Russia asserts its capacity to release additional water is limited. Addressing these challenges requires a balanced approach that reconciles both food security and environmental sustainability.

Implications

The environmental implications of the 'shrinking sea' are devastating. The consequences of the decline in the Caspian Sea's water level are very significant, and some of them are currently clearly visible, while others will have negative and destructive consequences in the medium and long term. What follows is a discussion of the seven top consequences of declining water levels for the Caspian Sea.

One, *the drying up of the northern Caspian Sea along Kazakhstan's coast*. The most immediate consequence of the Caspian Sea's declining water levels, if the current trend continues, will be the drying of the northern region along Kazakhstan's coast. According to a report by Carnegie Politika, Kazakhstan accounts for 29 percent of the Caspian coastline. Between 2001 and 2022, the surface area of the northeastern Caspian Sea decreased by 39 percent, while the shoreline receded by 37.25 kilometers. If the water level drops by 10 meters, the distance between the shoreline and coastal settlements in this sector could reach 89 kilometers, the largest along the entire Caspian Sea. Consequently, compared to other regions, the northern Caspian bordering Kazakhstan faces the most immediate threat from declining water levels.

The shrinkage is most pronounced along the northeastern coast near Aktau. Kazakhstan's Ministry of Ecology estimates that up to 22,000 square kilometers could be lost. As Aida Amangeldina notes, approximately 70 percent of the water area experiencing shallowing is in Kazakhstan. The northern region is particularly vulnerable due to its shallow depth, representing only 1 percent of the Caspian's total water volume, with an average depth of 4.5 meters. This negative trend became evident a few years ago in Aktau, located on the Caspian shore. On 8 June 2023, a state of emergency was declared in the port city due to declining sea levels. Shortly thereafter, Kazakhstan's Minister of Ecology, Zulfiya Suleimenova, stated that the environmental situation in the Caspian is severe, with the adverse consequences primarily affecting the Kazakh sector.

Two, *threats and loss of biodiversity*. The decline in the Caspian Sea's water level, along with rising salinity, is posing severe threats to the region's biodiversity. The sea supports more than 800 species of plants and animals, including 147 fish species, 450 species or forms of plankton, 87 species of algae, and 315 species of zooplankton. It is home to over 90 percent of the world's sturgeon population, and one of the rarest aquatic mammals globally, the Caspian seal (Pusa caspica), inhabits only the Caspian Sea and its tributary rivers.

The drying of the Caspian Sea is expected to have severe impacts on the Caspian seal population. These seals have already experienced a population decline of roughly 90 percent since the early twentieth century, with current estimates ranging from 75,000 to 270,000 individuals—dramatically lower than the over one million that once inhabited the sea. The most recent sharp decline occurred in 2022 along Russia's Caspian coast, where 2,500 dead seals were recorded. The results of the Leeds research indicate that the ongoing decline in the Caspian Sea's water level could create dead zones similar to those observed in global oceans, threatening biodiversity hotspots in both shallow and deeper areas of the sea.

Moreover, if the shallow northern Caspian dries up, the ecological consequences would be significant. A 10-meter drop in water level could result in the disappearance of four out of ten ecosystem types unique to the Caspian Sea, as well as reduce the coverage of existing marine protected areas by up to 94 percent. Caspian seals give birth to their white-coated pups on the northern Caspian ice between mid-January and early March. Studies show that a 5-meter decline in water level could shrink this critical habitat by up to 81 percent, placing enormous stress on an already diminished population.

Sturgeon, an ancient family of large fish, are critically endangered due to overfishing for their meat and roe (i.e., caviar). These fish typically inhabit the shallower regions of the sea during summer and autumn, but these areas are projected to shrink 25-45 percent as water levels decline, potentially preventing them from reaching the few remaining spawning sites in rivers that flow into the Caspian Sea.

Three, *degradation of coastal ecosystems, protected areas, and wetlands*. The receding waters of the Caspian Sea have put

coastal wetlands and protected areas around the sea at risk. A recent report by the *Tehran Times* warns that "Caspian Sea wetlands [are] imperiled." As the Caspian Sea shrinks, the sediment balance in these wetlands is disrupted, and the resulting height difference between the wetlands and the sea causes freshwater inflows to be discharged directly into the sea. This phenomenon is currently occurring in the Anzali Wetland along Iran's Caspian coastline. A major concern regarding the Anzali Wetland is the dramatic reduction in water depth, which has declined between 1 and 11 meters in recent years.

Wetlands in the eastern and northwestern Caspian, which covers an area of 40,000 square kilometers, are progressing toward complete aridification. If the Caspian Sea level falls to -29 meters, Qarebaghaz in Turkmenistan, the Astrakhan Wetlands, and the protected natural areas of the Volga Delta in Russia are at risk of severe depletion. While the impacts of the sea's decline on wetlands and protected areas in Turkmenistan, Kazakhstan, and Russia are particularly severe, biodiversity could also be threatened in Azerbaijan's Gizilagaj National Park on the southwestern Caspian coast—a critical wetland for the wintering and breeding of aquatic birds in the Western Palearctic region.

In the southern Caspian region, lagoons, coastal wetlands, and other protected areas in Iran—such as Anzali, the Miankaleh Peninsula, Gorgan Bay, and Gomishan—are also severely affected by fluctuations in the Caspian Sea's water level. These areas, characterized by submerged and floating vegetation as well as extensive reed beds, are shaped by the temperate climate of the southern Caspian coast. They hold international significance for the breeding, staging, and wintering of waterbirds. Consequently, the decline in the Caspian Sea's water level and the retreat of water, which reduces or interrupts water availability in these wetlands and protected areas, poses a serious threat to the natural functioning of the ecosystem and the region's biodiversity.

Four, *the drying of wetlands, expansion of salt flats, and an increase in dust and air pollution*. The drying of wetlands and the retreat of the Caspian coastline can lead to the formation of salt marshes, increased dust, and alterations in the weather of coastal countries. The Leeds research mentioned above indicates that exposed seabeds are likely to release dust containing industrial contaminants and salt, posing serious risks to human health, as was observed with the drying of the Aral Sea.

In recent years, the expansion of the Great Karakum Desert (350,000 square kilometers, equivalent to four-fifths of Turkmenistan), the increase in fine dust, and the environmental damage from the Aral Sea's desiccation in the Dash Aghuz region of northern Turkmenistan have severely affected northeastern provinces and cities of Iran with dust storms and air pollution. Consequently, the ongoing drying of wetlands and protected areas, coupled with water retreat and salt marsh expansion, could extend across the region, significantly impacting the climate and ecosystems of all Caspian Sea littoral states.

In addition, the loss of water from the Caspian Sea could reciprocally affect Central Asia's regional climate, leading to reduced rainfall and drier conditions, with indirect consequences for agriculture. In recent decades, air temperatures in Central Asia have risen at twice the global average, contributing to warming and desertification across the region. Under these circumstances, the Caspian Sea plays a crucial role in regulating the regional climate. However, the ongoing decline in water levels and the drying of wetlands and protected areas threaten to disrupt this vital climatic balance and moderating effect.

Five, *the negative impact of water retreat on ports, coastal facilities, shipping, and fishing*. Existing transport infrastructure, including piers, docks, cranes, and terminals, has been designed for current sea levels. As the Caspian Sea recedes, shallower waters around ports make it difficult for larger cargo ships, ferries, and fishing vessels to dock. Receding water may leave port facilities stranded inland, necessitating costly extensions and redesigns. Additionally, increased coastal dredging may be required to maintain sufficient depth and draft for ships, imposing substantial financial and logistical burdens. This is especially concerning since the cost-effective use of the Caspian's waters is critically important to the optimization of both the Middle Corridor and the International North-South Transport Corridor (INSTC).

Research led by the University of Leeds predicts a worrying future for industry, with major ports across all Caspian littoral states facing serious impacts. Baku (Azerbaijan), Anzali (Iran), and Aktau (Kazakhstan) could see the shoreline retreat by 1 kilometer or more, while Turkmenbashi (Turkmenistan) and Lagan (Russia; a planned

future site) might see increases of 16 kilometers and 115 kilometers, respectively. In northern Caspian areas, some settlements, ports, and industrial facilities could end up stranded tens or even hundreds of kilometers from the new shoreline.

In Turkmenistan, the port of Turkmenbashi now lies approximately 2.42 kilometers from the water's edge as sea levels decline. In the Avaza tourism zone, beaches that were once popular have turned into rocky seabeds, with beach infrastructure now located 150-200 meters inland, making swimming hazardous. The retreat of the Caspian Sea also significantly impacts Kazakhstan's ports, especially Aktau, Kuryk, and Bautino, disrupting oil export terminals, ship docking, and the export of grains and metals. In Azerbaijan, the declining water level is increasingly affecting key ports, notably the Port of Baku (Alat), along with smaller regional ports such as Sumgait, Lankaran, and Neftchala. Despite major investments to modernize and improve the competitiveness of these ports, falling sea levels pose long-term risks to infrastructure, trade, and regional connectivity.

The cost-effective use of the Caspian's waters is critically important to the optimization of both the Middle Corridor and the INSTC.

Overall, the declining water levels of the Caspian Sea threaten port operations and infrastructure in Azerbaijan, Kazakhstan, and Turkmenistan, with possible impacts on trans-Caspian connectivity routes.

If the current trend of declining Caspian Sea levels continues, all piers at the Bandar Anzali port in northern Iran are projected to lose about 30 percent of their operational capacity by 2027 and will need repairs. At Nowshahr Port, at least six piers are expected to face a similar 30 percent reduction in performance, requiring maintenance. All docks at Amirabad Port are also likely to encounter serious operational challenges. Moreover, as sea levels keep falling, Iranian ports will need an additional 750,000 cubic meters of annual dredging—an amount that surpasses the country's current capacity and financial resources.

Furthermore, this decline poses a serious threat to Russian ports, including Makhachkala, Olya, Astrakhan, Solyanka, and Lagan. Notably, access to the Caspian Sea for international shipping via the Volga River would be critically impacted by a 5-meter drop, with significant effects on navigation and trade. In recent years, inadequate dredging of the Volga River and the Volga-Don Canal has led to falling water levels, making navigation increasingly difficult. Currently, ships can operate only at a draft of 3.7 meters, limiting their cargo to about 70 percent of capacity. To enable full-capacity shipping, dredging to reach a 4.5-meter draft is necessary. As a result, declining Caspian Sea levels will worsen existing challenges for the Volga River and Volga-Don Canal, harming maritime transit and shipping between coastal states and Russia, and disrupting both the volume and speed of trade along the Middle and North-South Corridor routes connecting Russia and Iran.

Six, *threats related to pipelines, offshore oil and gas fields, and terminals*. Pipelines and offshore terminals associated with oil (but also gas) fields are particularly vulnerable, especially in the shallow coastal zones of the Caspian Sea. The relatively low water depths in the northern and central sectors have facilitated the construction of offshore oil and gas facilities in Azerbaijan, Kazakhstan, and Turkmenistan. However, the ongoing decline in Caspian Sea water levels poses significant risks to these installations, as well as to ports and other marine infrastructure. According to *Nature*, current operations at offshore platforms rely on ship-based logistics, which could be severely disrupted or rendered landlocked if sea levels drop by 5 to 15 meters. Notably, the Kashagan field in Kazakhstan and the Filanovsky field in Russia, located in the northern Caspian, represent two of the region's most critical hydrocarbon production sites and are particularly susceptible to these emerging challenges.

Seven, *declining economic growth and population displacement in coastal cities*. The declining water level of the Caspian Sea and the retreat of its coastline pose serious threats to the economies of littoral states, particularly through losses in shipping, maritime industries, and fisheries. This could result in cascading human and social consequences. Ecological changes induced by these water-level declines may drive migration and population decreases in coastal cities, towns, and villages surrounding the Caspian Sea. The experience of the Aral Sea provides a stark precedent for the potentially profound socio-economic impacts of such environmental transformations.

The Leeds study indicates that northern coastal communities are especially vulnerable, as declining fish stocks diminish local incomes and harsh climatic conditions further constrain agricultural productivity, thereby threatening social stability. In addition, Aida Amangeldina notes that in January 2023, adverse weather caused a water intake channel in the port city of Aktau to freeze, disabling desalination operations and leaving residents without water for over ten days. This incident underscores the critical dependence of coastal populations on the Caspian Sea and highlights the severe risks to human well-being should the sea continue to recede.

Lessons from the Aral Sea and Lake Urmia

Until the mid-20th century, the Aral Sea was the fourth-largest lake on Earth, covering about 68,000 square kilometers—similar in size to Ireland. Extensive diversion of its inflowing rivers for cotton and rice irrigation, combined with dam construction and a steady drop in water levels, caused the Aral Sea to break into smaller, mostly dried-out basins by the 1980s and 1990s. By 2010, its surface area had shrunk by over 50,000 square kilometers (19,000 square miles), marking an unprecedented ecological disaster.

The desiccation of Lake Urmia, located in northwestern Iran, closely resembled the decline of the Aral Sea. At its peak, Lake Urmia was Iran's largest inland lake, the biggest in the Middle East, and the sixth-largest saltwater lake worldwide, covering about 6,000 square kilometers. Over twenty years, the lake's water level dropped at an average of 40 centimeters per year. This gradual drying is driven by multiple interconnected factors, including excessive water withdrawal from the lake's watershed, unregulated agricultural growth that uses basin water resources, dam construction, and climate change—shown by higher temperatures, less rainfall, and more evaporation. The rising salinity in the remaining water caused widespread ecosystem collapse, resulting in the loss of many fish and animal species.

The drying processes of the Aral Sea and Lake Urmia are remarkably similar: in both cases, the lakes fragmented into smaller basins before eventually facing near-complete desiccation.

If warnings are ignored and proper mitigation measures are not taken, the Caspian Sea could face ecological disasters similar to those experienced by the Aral Sea and Lake Urmia. However, the environmental, social, human, and economic impacts in the Caspian region would likely be much more widespread and severe, significantly affecting all littoral states. Until recent decades, few would have expected such disasters to happen, even in areas with abundant river systems like the Amu Darya and Syr Darya in Central Asia or the rivers and freshwater sources in northwestern Iran. The lessons from the Aral Sea and Lake Urmia highlight the urgent need for coordinated sustainable water and ecosystem management in the Caspian basin.

If warnings are ignored and proper mitigation measures are not taken, the Caspian Sea could face ecological disasters similar to those experienced by the Aral Sea and Lake Urmia.

In recent years, Central Asian countries have undertaken efforts to restore the Aral Sea, supported by collaborative ecological and scientific initiatives. To coordinate funding and implementation, the International Fund for Saving the Aral Sea (IFAS) was established. These efforts have produced important results, especially in the northern part of the Aral Sea in Kazakhstan, where some ecological recovery has occurred. Conversely, restoring the southern Aral Sea in Uzbekistan continues to be a significant challenge. Similarly, in Iran, the Urmia Lake Restoration Headquarters has been established, and considerable financial and logistical resources have been dedicated to restoration activities. Some experts believe that the relative success in reviving the northern Aral Sea could serve as a model for ecologically restoring Lake Urmia.

The substantial financial investments and budgets allocated in recent years for restoring the Aral Sea and Lake Urmia—neither of which have completely succeeded—highlight a vital lesson: preventive policies and proactive programs must be prioritized by the leadership and policymakers of Caspian coastal countries. Immediate action is crucial to halt the ongoing decline of the Caspian Sea's water levels, the retreat of water from its shores, and the environmental issues that follow. In this context, all available financial, technical, advisory, and scientific resources from the international community should be mobilized to prevent ecological crises like those experienced by the Aral Sea and Lake Urmia from recurring.

These efforts should be guided by a coordinated, policy-driven, and time-sensitive framework with full commitment and cooperation from all Caspian littoral states.

Shared Responsibility

The Caspian Sea is a shared natural and cultural heritage for all littoral nations and must be protected to ensure that future generations do not see deserts and salt flats, as happened with the Aral Sea, instead of its unique landscapes, wetlands, and protected areas. Addressing the challenges facing the Caspian Sea—including environmental degradation, pollution, and declining water levels—requires a commitment to sustainable and balanced development, as well as coordinated management among all coastal countries. Responsibility cannot fall on a single country; instead, all five littoral states have a duty to preserve the sea's ecological health and manage the environmental conditions in their respective sectors.

I believe that the biggest risk in this situation is viewing the Caspian Sea's declining water level as just a natural cyclical event, one that recurs over time and will inevitably restore balance. Focusing too much on this idea distracts from the important influence of human activities and climate change in causing the current worrying trends, which could lead to delays in taking necessary action and implementing effective management strategies.

Indeed, a variety of human interventions—including dam construction, inter-basin water transfers, agricultural expansion, port and dock development, rapid growth of coastal populations, and increased groundwater extraction—have significantly decreased the amount of water entering the Caspian Sea. These activities have also led to higher levels of urban, industrial, and agricultural waste entering the sea through rivers and coastal runoff, posing a serious threat to the Caspian ecosystem. Adding to these pressures, climate change—evident through rising temperatures, reduced rainfall, and increased evaporation—has further worsened the decline in the Caspian Sea's water level.

Therefore, improving the condition of the Caspian Sea must be seen as a shared responsibility among all five littoral states. Although the Convention on the Legal Status of the Caspian Sea has not yet been ratified by all five signatory states, the Tehran Convention arguably provides an adequate enough legal and institutional framework for coordinated joint efforts by the coastal states.

Unfortunately, the Tehran Convention has not been effectively implemented, and many of its provisions remain largely on paper. Even the most comprehensive treaties and agreements are of limited value if they are not enforced, and the environmental challenges of the Caspian Sea cannot be addressed without actionable implementation—this includes the ratification of the Convention on the Legal Status of the Caspian Sea by the last holdout.

Achieving sustainable and balanced development in the Caspian region is therefore essential. Additionally, measures should be taken to limit new dam construction and the expansion of agricultural lands in the upper reaches of the Volga River, as these activities significantly decrease the water flow into the Caspian Sea. In this context, the Russian Federation—home to most of the Caspian's inflowing rivers—must implement sustainable irrigation practices while carefully monitoring both the quantity and quality of discharged water. Such measures could help offset some impacts of climate change, including rising temperatures, increased evaporation, and reduced precipitation. Essentially, Russia today has the potential to play a role similar to that of the former USSR in 1976, when the Siberian rivers flow transfer project contributed to rising Caspian Sea levels by 1978.

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Like all conflicts, the ongoing conflict over Ukraine will eventually conclude, and the affected regions will eventually be rebuilt. However, there is no guarantee that the water resources and ecological balance of the Caspian Sea will naturally recover. Historical precedents, such as the desiccation of the Aral Sea from the 1960s to the 1980s and the recent drying of Lake Urmia in northwestern Iran, serve as stark reminders that similar environmental crises could occur in the Caspian Sea over the long term. Until the mid-twentieth century, when the Aral Sea was the fourth-largest lake on Earth, few could have envisioned that such a vast water body could one day disappear entirely, leaving behind desertified landscapes. These

sobering examples underscore the urgent responsibility of the Caspian Sea littoral states to act collectively and decisively to address ongoing and future environmental threats.

Speaking at ADA University in Baku on 17 February 2026, Nazim Mahmudov, the head of Azerbaijan's National Hydrometeorological Service, said that "effective management of the Caspian's hydrometeorological regime directly depends on the level of interstate cooperation, and only joint actions based on mutual trust can ensure the region's sustainable future." This and similar logic reinforces my belief that the five Caspian littoral states should establish a joint working group tasked with formulating policies and implementing comprehensive measures to mitigate the impact of anthropogenic pressures on the sea's water level. This framework should include strengthened hydrometeorological data sharing among coastal countries about trends in Caspian Sea water levels, related effects, and risk assessments; Russia's commitment to maintaining sustainable flows from the Volga River; monitoring and regulating desalination projects; shared advanced climate modeling; coordinated dredging efforts along coastlines and ports; and joint initiatives to lower hydrocarbon pollution.

Such coordinated actions are crucial to prevent further acceleration of water level decline and to protect the region's economic, social, and environmental stability—its sustainable development. BD