



A New Strategy for Merging the Environmental and Commerce Challenges of the Caspian

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ABSTRACT

Recent geopolitical events have thrust the Caspian region into a time of unparalleled opportunity. Specifically, the Middle Corridor (“MC”) has been presented as a potential savior for trans-Eurasian commerce. At the same time, its success relies on a sea that is in an ecologically precarious state. Saving the Caspian for all future uses, including trade, will require unprecedented engagement and coordination amongst all its bordering states. This paper proposes a strategy for using the newfound focus on the MC to highlight its inherent connection to the Sea’s ecological precarity - thereby linking strategies of developing Trans-Caspian commerce with the efforts to preserve the Sea’s ecology against both existing and emerging threats. The paper begins by summarizing recent geopolitical developments connected to the MC that have accentuated the Caspian’s global importance for commerce. It then explores a related challenge - the simultaneous efforts of several littoral states to pursue desalination of Caspian seawater at a time when the Sea’s level is already declining from pre-existing causes. While these are two separate issues, we argue that they are, in fact, interrelated and that the coordination and governance challenges for improving commerce are very similar to those necessary for regulating desalination. Next, we analyze the challenge of regulating desalination in the context of water geopolitics and the unique features of the current Caspian Treaty. Finally, we review the language of the existing Caspian Treaty to identify areas where enhancements are necessary to better reflect both emerging challenges.

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1. Introduction

Russia's war on Ukraine has revealed the precarity of existing supply chains for essential commodities. It has, in turn, magnified the potential importance of the Caspian Sea and its littoral states, particularly Kazakhstan, Turkmenistan, and Azerbaijan, whose gas reserves may aid the West in diversifying away from Russian energy sources. In addition, these states are projected to play an essential role in the Middle Corridor ("MC") - an initiative that seeks to integrate the goods movement economies of Central Asia, the Caucasus, and Southeastern Europe in a way that avoids Russian territory. As such, the Caspian region and its littoral states have become a geo-economic linchpin amidst the war in Ukraine.

At the same time, the Caspian faces the looming threat of an ecological collapse, the cost of which could easily dwarf any trade benefits the MC could produce. While the West has focused on the role the Caspian can play in serving short-term strategic goals, such as reducing the control of Russia on trans-Eurasian cargo movement and energy, the littoral states of the Caspian will ultimately bear the cost if this approach does not appreciate the Sea's ecological precarity. In particular, the threat posed by excessive desalination of Caspian seawater is currently unaddressed by the Convention on the Legal Status of the Caspian Sea (the "Treaty"). It is the Sea's essential value for all these purposes that should make the clearest case for its preservation through coordinated action. While external parties may be able to assist, the Sea's fate will rest on the littoral states that must share its resources.

The Caspian has long served as a textbook case of an ecological governance challenge in which the tragedy of the commons looms large. However, while the Caspian's traditional ecological challenges, such as preventing overfishing and reducing pollution from petrochemical exploration remain, the Sea faces additional emerging threats related to water loss and salinity.

In some ways, Caspian governance is currently more robust than it has been at any time since the breakup of the Soviet Union owing to the near complete ratification of a governance treaty amongst the littoral states. Yet, we argue that the same treaty which aids Caspian management from an economic perspective fails to comprehensively address, and in some ways may accelerate its ecological demise.

In addition, while the Treaty discusses ecological and economic problems of mutual concern, its language fails to establish a sufficient and coherent basis for regional coordination. It also fails to coordinate interest groups, including development banks and environmental nonprofits, that have maintained a compartmentalized approach - failing to appreciate the interconnectedness of ecological, energy, and trade considerations. In this paper, we argue that the Caspian's primary governance deficiency is structural and that while the new Treaty makes some progress on this front, it retains a narrow and Coasian approach to the Sea's management.

In certain economic spheres, such as near shore extraction, a “divide-and-conquer” approach to Caspian management may make economic if not ecological sense (Norton Rose Fulbright, 2018). However, for the Sea’s greatest long-term economic opportunities, including the development of MC commerce, as well as for protecting the Sea’s ecology, the current governance structure remains inadequate. We thus conclude the paper by presenting a new framework for better integrating the ecological and economic considerations of Caspian governance. But before understanding the potential solutions to these problems, we must first understand why the Caspian today holds such outsized geopolitical importance.

2. Methods

This paper begins by analyzing recent data on trade and investment related to the development of MC commerce and its role in enhancing trans-Caspian economic coordination. This analysis is supplemented with expert interviews to document where de facto coordination is occurring and to identify the most likely threats to successful corridor development.

The next phase of the paper examines the current state of desalination activity and plans by the different littoral states as a new forum for coordination. We briefly examine why each state is pursuing this policy and assess the implications of full implementation on future Caspian Sea levels (CSL) and salinity levels using data from AQUASTAT.

The final phase of the paper examines the current state of trade and environmental governance that would regulate both activities through the current Treaty. Based on the identified needs, we propose specific addenda to the treaty language that would potentially enable the littoral states to prevent commons abuse in either the trade or desalination dimension.

3. Background: The Caspian’s Growing Importance in Eurasian Trade

Before Russia’s invasion of Ukraine, trans-Eurasian trade by rail had been growing rapidly (RailFreight.com, 2022). This growth was spurred by Chinese infrastructure investment in “Silk Road” rail corridors and associated operating subsidies. An extreme spike in maritime freight rates in December 2020 tied to coronavirus (COVID-19) -related supply disruptions further clarified the need for an overland option to substitute for the instability of Asia-Europe maritime trade.

The lack of accessibility to maritime assets has made Eurasian rail trade an essential component of reconstituting robust Asia-Europe trade following the pandemic, and it was gaining belated acceptance from the global logistics community. Due to the Russian invasion of Ukraine, Kazakhstan, Turkmenistan, and Azerbaijan have become increasingly critical for overland trade between East Asia and Europe.

When comparing the Northern and Middle Corridors for cargo routing as was envisioned prior to the war as a core component of China's Belt and Road Initiative ("BRI"), the Northern Corridor, ("NC") in addition to avoiding the modal change between rail and ship on the Caspian, also offered a more direct connection to Europe's leading industrial base in Germany. As such, up until February 24, 2022, the dominant option for moving trade between Asia and Europe was through Kazakhstan, Russia, and Belarus as this route is objectively more straightforward from an operational perspective. While warning signs of Russia's unreliability as a trade corridor existed, Belarus (and not Russia) was viewed as the riskiest link in the chain (Hutson, 2019).

The NC thrived just long enough to demonstrate its efficacy in potentially alleviating Central Asia's suffocating economic seclusion (CEIC, 2005-2014) before the Russian invasion threatened to again isolate the region both politically and economically (Hutson, 2022). Yet, despite its simplicity, the NC had two fundamental shortcomings.

The first deficiency was that the NC was unlikely to substantially impact the connectivity and development trajectory of Central Asian states outside of Kazakhstan. Thus, from a perspective of economic development, the corridor did not create the type of linkages necessary to reconnect Central Asian economies to each other. It was, rather, a linkage between East Asia and Europe that happened to pass through Kazakhstan on the way. The second risk factor was that the NC empowered political pariah Belarus as the lone gatekeeper to Poland and the rest of Europe.

Recognizing the lack of discrete development opportunities from the NC on Central Asia's internal development as well as its uncomfortable reliance on an increasingly aggressive Russia, the World Bank, in 2019, evaluated the viability of a rail link that had been proposed by the governments of Uzbekistan and the Kyrgyz Republic to connect China to a warm water port at Gwadar, Pakistan or Chabahar, Iran (World Bank, 2020). This route would utilize the Mazar-e-sharif to Herat railway in Afghanistan and would also include a proposed corridor from Xinjiang across the Kyrgyz Republic to the Ferghana Valley. However, the 2021 fall of the Afghan government to the Taliban made this option seemingly impossible.

This series of events has left the MC as the "last route standing" but also one that has a much clearer path toward aiding Central Asia's and the Caucasus' internal development. Unlike the NC, which would have primarily impacted Kazakhstan, the MC has the potential to more directly aid Turkmenistan and Uzbekistan, countries that have been rendered even more isolated from global trade by the war, particularly for non-petroleum exports outside of Russia. (World Bank, 2021) However, the logistical complexity of the corridor, which involves a rail/sea modal change between either Kazakhstan or Turkmenistan via the Caspian Sea, raises the bar for coordination amongst participant states.

According to analyses by the World Bank and the European Bank for Reconstruction and Development, if the corridor received sufficient investment, it could provide a viable workaround for Trans-Eurasian trade that avoids Russian territory. In addition, the MC can help to integrate the economies on both sides of the Caspian, creating new economies of scale and scope that will allow the region to expand its collective geopolitical and economic standing and allow these states to serve as a counterweight to the current regional powers of Russia and Iran.

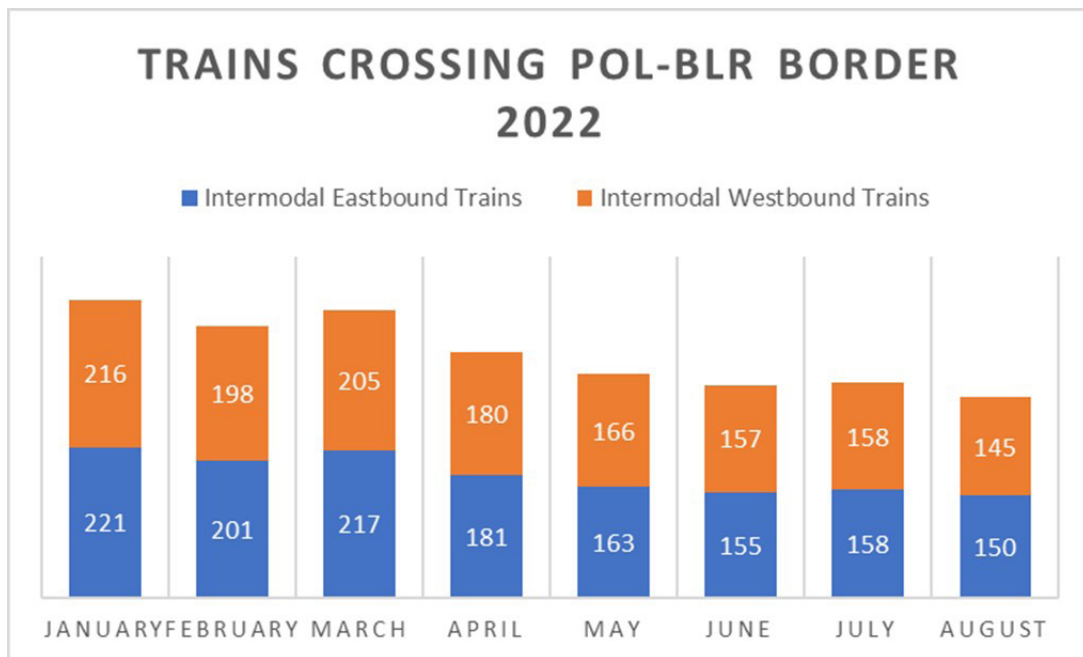
Table I illustrates the emerging trade dynamic that highlights the importance of the MC. The robust gains that the NC through Russia and Belarus had enjoyed in recent years (Reuters, 2022) have been reversed by the war leading to a 30% reduction in total corridor volume as of October 2022.

Table I. Transport from China to Europe via the NC October 2021 - October 2022 compared to the same period the prior year (Eurasian Rail Alliance, 2023).

Point of departure	Arrival point	Volume of transported goods		Average travel time, days
		TEU	Thousand tons	
		140 822	898,41	8,84
		(-30,29%)	(-21,97%)	(-44,75%)
China	Belgium	8 854	53,59	10,06
		(-23,62%)	(-15,82%)	(-37,36%)
China	Hungary	4 258	30,34	8,28
China	Italy	100	0,56	9,46
		(-79,92%)	(-84,72%)	(-32,57%)
China	Poland	91 364	588,42	8,14
		(-12,00%)	(+0,64%)	(-44,63%)
China	Germany	30 988	191,01	10,46
		(-52,96%)	(-50,98%)	(-42,34%)
China	Netherlands	3 896	26,17	9,87
		(-72,78%)	(-64,78%)	(-36,40%)
China	France	92	0,61	8,92
		(-92,92%)	(-91,03%)	(-50,96%)

Figure 1 reflects data from Polish railways that shows a consistent falloff in rail volumes on the NC and its diminishment as a viable transit option for cargo between East Asia and Europe. Allan Mustard, former U.S. Ambassador to Turkmenistan, noted that the MC has a relatively short window of opportunity in which its key competitor is sidelined. If the countries in the region find a way to coordinate, they could consolidate the trade advantage and emerge in a far stronger position after the war concludes (Mustard, 2023).

Figure 1. Trains crossing from Belarus into Poland (Polish National Railways, 2022).



4. Role of The Middle Corridor in Facilitating Economic Development

The specific role that the corridor will play in future global supply chains is still uncertain. First, there is the question of whether the corridor will have sufficient capacity to handle both trans-Eurasian cargoes, such as those originating in China, along with the latent demand from trade between Central Asia and the Caucasus. When cargo simply passes through an intermediate country, it is less likely to generate economic development opportunities. Such transit trade is most beneficial in cases where a country has a surplus of available rail and port capacity and would otherwise not cover its cost of capital. Yet, for the countries of the MC, where capacity is already limited, it is critical to choose those freight connections most likely to generate direct economic development stimulus (Batyrbekova, 2023).

Existing trade volumes between Central Asia and the Caucasus remain low and reflect both the legacy of path-dependent development of Soviet-era transport networks (Sehring, 2009) and the difficulty of moving cargo in significant volumes across the Caspian. For example, Azerbaijan's combined exports to Kazakhstan and Uzbekistan account for less than 1% of its total exports (OEC, 2022).

The lack of mutual economic engagement between states on either side of the Caspian complicates their ability to solve complex governance issues such as trade, water and ecosystem management related to the Caspian. Thus, while most international attention has focused on the MC's role in connecting East Asia to Europe,

its more essential function is to tie together Central Asia with the Caucasus. This is particularly important given Azerbaijan's, Georgia's, Kazakhstan's, and Uzbekistan's efforts to separate their development course from dependence on Russia since the invasion of Ukraine to avoid secondary sanctions (Agaidarov & Rahardja, 2023). We argue that the benefits of coordination on the MC may eclipse short term freight-related benefits if they enable coordination in other spheres. For example, agreements on coordinated rail and maritime capital investments are necessary to prevent "white elephants." In contrast, agreements on tariff setting and transparency on border operations, including through digitalization, are necessary to prevent rent-seeking behavior (Aragones, 2021).

At present, numerous infrastructure investments are under consideration to enhance cross-Caspian commerce. Yet, projects must produce tangible benefits to the countries of the region - not external parties only seeking to bypass Russia. There are several justifications for this position. First, the present international fascination with the MC is driven by what all parties hope is a temporary situation - Russia's pariah status owing to its continued assault on Ukraine. A rash of infrastructure investments that are only justified if the NC is compromised may quickly become obsolete should normal cargo operations on the NC resume. For example, if the MC is developed as a bypass to the NC, this would steer investments toward the types of cargo and supply chains currently served by NC commerce, including high-value, time-sensitive containerized goods. These are not necessarily the same cargo types that will be most beneficial for enhancing trade development between Central Asia and the Caucasus. In other words, the development of East Asia-Europe transit trade that uses the Caspian as a bypass may end up as merely a second-best approximation of the NC that would be abandoned if and when the NC resumes normal operations.

5. Recent Middle-Corridor-Related Infrastructure Investments

Maritime and rail infrastructure investments on both shores of the Caspian have accelerated in recent years. The Port of Alat south of Baku and the Port of Turkmenbashi in Turkmenistan were both opened in 2018 and were constructed to modern standards during a period when the concept of the MC was already being formulated. They quickly established a robust trade that has only accelerated since the outbreak of the war in Ukraine.

The Port of Turkmenbashi occupies 152 hectares with ferry, passenger, and cargo terminals. It can receive 300,000 passengers annually, handle 75,000 cargo-carrying trucks and 400,000 Twenty-Foot Equivalent Units (TEUs) (Ministry of Foreign Affairs of Turkmenistan, 2018).

Despite these improvements, border disputes continue to impact commerce - particularly in the case of Turkmenistan which has repeatedly closed its borders

to truck traffic from Uzbekistan and Kazakhstan in recent years (Al'ternativnye Novosti Turkmenistana, 2019). Turkmenistan also maintains elevated transit tariffs (Al'ternativnye Novosti Turkmenistana, 2016). Additionally, while it was granted observer status to the World Trade Organization as of 2020, Turkmenistan's customs, taxes, insurance, and export financing regime do not yet conform to that of a market economy (BTI Transformation Index, 2022).

Ambassador Allan Mustard noted in his interview that, in alliance with the "Concept for the Development of the digital economy in Turkmenistan in 2019-2025 (Turkmenportal, 2021)" and the "State Program for the Development of the Digital Economy in Turkmenistan for 2021-2025," the Turkmen government could digitalize the customs clearance at checkpoints to streamline the processes (Mustard, Interview with the Authors, March 2023). The same challenges in infrastructure coordination and transparency exist on many other points along the MC route.

6. The Spectre of Environmental Collapse

The promise of the MC and other joint economic development projects in the Caspian Sea faces a looming threat from declining Caspian Sea levels that could restrict the size of vessels that can sail (JAXLNG, 2023). The threat has not reached the level of alarm that would otherwise be expected because, from the late 1990s to the mid-2010s, unusually high rainfall temporarily reversed a long-term decline in water levels. However, over the past three decades, the Caspian's surface level has declined by about 2 meters and its area by about 15,000 km² (Akbari et al., 2020).

A multitude of causal factors have contributed to water loss from the Caspian including mismanagement of inflow rivers (Nandini-Weiss, Prange, Arpe, Merkel, & Schulz, 2020). According to Chen et al. (2017), increasing evaporation rates due to climate change have played a large role in seawater level decline in the Caspian Sea. The newest emerging challenge is the rush by Kazakhstan, Azerbaijan, Iran, and Turkmenistan to construct desalination plants that threaten to not only cause further water loss but to disrupt the Sea's fragile salinity balance (Micklin, 1988). Unlike the Aral Sea, whose decline proceeded continually, the decade-long break in the Caspian's decline raised the question of whether its water level was cyclical (Chen et al., 2017). However, it is now clear that the prior period was an aberration in an otherwise consistent process of atrophy (Modabberi et al., 2020). The global focus on the Caspian brought about by the war on Ukraine presents a unique opportunity to focus both regional and global attention on this threat. Like MC coordination, the investments that any one party makes in improving its own impact on water extraction can easily be undermined by other parties who would free-ride on these investments. A unified desalination policy is thus necessary to overcome the collective action problem.

7. Overview of Desalination Plants

Desalinated water currently plays a modest but rapidly growing percentage of supply for the littoral states of the Caspian. While desalination is still an extraordinarily costly and non-preferred option for the lower-middle-income countries that border the Sea, the severity of the regional water crisis has nevertheless led the states to reconceptualize the salt water of the Caspian as a freshwater resource.

Desalination has been key to the development of Kazakhstan's Magystrau province, which includes the port city of Aktau. Similarly, Turkmenistan's new port city of Turkmenbashi and Azerbaijan's port of Alat have almost no local sources of freshwater and plan to rely on desalination, creating a direct connection between desalination policy and the viability of MC commerce. Additionally, when the Port of Aktau was engineered in the 1990s, Caspian Sea levels were abnormally high. For this reason, its docks are particularly ill-suited to water loss (Aragones, 2023).

By some metrics, Turkmenistan is the most water-stressed country on the Caspian. It is constructing a new desalination plant per a 2022 order from President Serdar Berdimuhamedov (Taganova, Cholico Santoyo, Mattur, Best, Shabanova, 2022). While desalination is traditionally a costly process, given that the Sea's average salinity is far lower than that of seawater, the reverse osmosis process may, depending on location within the Sea, be less carbon-intensive and less costly than the desalination of ocean water. For example, Iranian researchers estimate that their Caspian desalination process is 50% less costly than desalination from the Sea of Oman (Yusefi, Zahedi, & Ziyaadini, 2021).

Turkmenistan consumes an extreme amount of water per capita and has one of the highest rates of water consumption per dollar of GDP due to poor water management (Varis, 2014). For example, the Karakum Canal ruptured in January - February 2023, leaking at least 100 million cubic meters of water, and forming a channel almost twenty kilometers in length. Nevertheless, Turkmenistan has elected to embrace desalination in lieu of more pragmatic water management strategies. It operates three desalination facilities which can desalinate, respectively 50,000 m³/day (Gorkey, 2015); 1,200,000 m³/day for two qualities of water (drinking 1,057,535 m³/day and irrigation 142,765 m³/day) (TYPASA, 2022); and 5,000 m³/day (PWT, 2008). Its reported desalination of 1.8 million cubic meters per year in 2008 rose to more than 18 million cubic meters per year by 2016 (AQUASTAT). Because of the country's lack of transparency, development agencies in the region have often failed to engage with Turkmenistan. Yet, the dramatic potential externalities of Turkmenistan's new desalination plants are a clear example of why this policy is both untenable and ultimately self-defeating. Turkmenistan's importance to the MC is another reason why it is essential to include Turkmenistan in the decision-making process.

In 2012, Iran announced plans to transfer water from the Caspian Sea to drought-stricken Semnan Province through an underground pipeline of 460km (285 miles), with pump stations to pull water over 2000 meters to cross the Alborz Mountains (Tehran Bureau, 2016). However, it was not until April 2019 that the Iranian parliament approved the start of a pilot project, which would produce 100 million cubic meters of desalinated Caspian Sea water per year (Caucasus Watch, 2019).

With numerous desalination projects, both existing and planned, water extraction from the Caspian Sea would only accelerate its depletion. It is estimated that the northern portion of the Caspian Sea, in which water depths are less than 5 meters (The Conversation, 2020), may disappear in 75 years if the CSL continues to decrease at 7 cm/yr (Chen et al., 2017), representing a major threat to fragile ecosystems and wreaking havoc on the region's climate and local economy. According to another study, 25,000 km² of Sea is susceptible to sea level fluctuations by desiccation, with 70% of this vulnerable area located in Kazakhstan (Akbari et al., 2020). There is thus a mismatch between which parties have the most aggressive desalination policy and which bear the highest cost from sea level depletion.

A related threat to desalination for human consumption and agriculture is the production of “green” hydrogen through electrolysis. One of the most contentious projects among these is the HyrAsia One initiative in Kazakhstan, with ambitions to provide a significant portion of the EU's future hydrogen imports (Lillis, 2022). The appeal of the HyrAsia One project to both Germany and Kazakhstan is evident, as it seeks to build a new energy partnership that could enable both parties to reduce their uneasy economic ties with Russia (Barlow and Rzegocki, 2023). Nevertheless, the presumption that hydrogen is inherently “cleaner” than conventional fuels from an ecological standpoint faces scrutiny (Verzoni, 2023). For instance, the production of hydrogen through electrolysis requires five metric tons of water for every megawatt of potential energy (Hodgkinson, 2022). While imports of Kazakh-produced hydrogen would aid the EU in reaching its CO₂ reduction goals, the cumulative impact on scarce resources, including Caspian seawater, must be considered - especially in the context of having the global north export its ecological sustainability burdens to the global south. From a comparative perspective, establishing a clean hydrogen industry in Central Asia could be prioritized over, for example, the desalination of Caspian water for cotton production. Nevertheless, it presents yet another competing use that relies on the same precarious foundation.

8. Environmental Impact and Regulatory Uncertainty of Desalination

The attractiveness of desalination, like the excessive harvesting of the Caspian's prized sturgeon caviar, presents a classic “commons problem” (Spiliakos,

2019) rife for abuse absent effective governance. Any one state's desalination goals would likely have an acceptable impact. Still, the combined impact of four straws from four water-stressed states is a substantial and growing threat. In a very literal sense, it could create a race to the bottom. Maureen Walschot, an expert in desalination policy, said in an interview that countries like Turkmenistan and Iran, which have tenuous relations with their neighbors related to shared water resources, often embrace desalination to avoid more difficult water governance challenges. However, Walschot noted, in this case, the desalination approach does not facilitate a "go it alone" strategy precisely because the water withdrawn from the Caspian, as an inland sea, directly impacts other stakeholders in the region (Walschot, 2023).

The desalination process can provide an alternative water supply, changing the nature of water in the public consciousness from that of a public good to a manufactured commodity. International law and international conventions such as the U.N. Watercourses Convention, the Helsinki Rules, and the Berlin Rules, among others, govern transboundary river basins. The existing international water law, however, does not explicitly address the artificial water extraction of saltwater for the purpose of desalination. Caspian desalination is one of the only instances in which salt water is extracted from an inland water body. As such, it is a legal unicorn that creates uncertainties as to whether any established legal principles could apply.

9. What Are the Drivers of Caspian Sea Level Variations?

As controversial as desalination has become, it remains another exacerbating factor rather than the core threat to the Caspian Sea's water balance. Most of the desalination data for desalination plants removing water from the Caspian comes from Iran, Turkmenistan, Azerbaijan, and Kazakhstan. A large increase in desalination production capacity for some plants in the mid-2010s, correlated with a drop in water levels during the second half of 2010 but the data is thus far preliminary when compared to longer term analyses of traditional drivers of variation.

Several previous studies have looked at natural and anthropogenic factors influencing sea level variations in the Caspian Sea, including the impact of human-induced climate change (Arpe, Tsuang, Tseng, Liu, & Leroy, 2018; Chen et al., 2017; Renssen et al., 2007). While CSL change largely reflects a balance between inflow from rivers and precipitation as well as outflow from surface evaporation, a detailed understanding of how desalination plants are impacting the CSL is lacking (Aragones, 2023). The modeled projections of future CSL have so far mostly not incorporated human water extraction. The only exceptions are studies conducted by Kudekov (2006) based on national-level data (Kudekov, 2006); Denim (2007) based on data compiled from various economic and government sector reports for the years 1970-2003; and Koriche, Singarayyer, and Cloke (2021) based on prediction for the future water extraction between 2015 and 2100.

Volga River inflows, which are vital to CSL, have been severely comprised by dam constructed since Soviet times. The Volga River includes a catchment area covering approximately $1.38 \times 10^6 \text{ km}^2$ (Chen et al., 2017). According to the global Food and Agriculture Organizations' (FAO) AQUASTAT database of 14,000 dams, including nine in the Caspian Sea Basin (Food and Agriculture Organization of the United Nations, 2021). The total capacity of reservoirs is 223 km^3 (>75% of the total discharge to the Caspian Sea), which are mostly located in the Volga River watershed (Akbari et al., 2020).

Fluctuations in the Volga River discharge have been linked to reductions in rainfall upstream and dam constructions in the catchment area since the 1980s (Chen et al., 2017). For example, the Volgograd power station's average annual water discharge decreased from $10,654$ to $5,609 \text{ m}^3 \text{ s}^{-1}$ between 1993 and 1996, resulting in a 46.7 cm/yr^{-1} decline in sea surface height (SSH) (Lebedev & Kostianoy, 2008). Studies by Arpe, Molavi-Arabshahi, and Leroy (2020) have shown a correlation between the CSL changes with the occurrence of El Niño-Southern Oscillation (ENSO) (Arpe et al., 2020). Specifically, Arpe et al. (2020) found that the increase in wind speed leads to enhanced evaporation over the Caspian Sea and blowing moisture off to the east, leading to a net loss for the Caspian Sea drainage basin, thus confirming the conclusions from earlier studies which suggest that the evaporation over the Caspian Sea is a major driver for the CSL variability (Chen et al., 2017) and supporting those conclusions by suggesting that the wind is not only important for enhancing the evaporation but perhaps more important for reducing the moisture available within the Caspian Sea catchment.

Overall, the higher air temperatures and increased winds, combined with the reduction in the Volga River inflows, significantly impact CSL. For example, during the second half of 2010, CSL dropped by 31-44 cm due to increased evaporation caused by the hot, dry summer and reduced discharge from the inflowing Volga River (lower by 35 km^3) (Syrlybekkyzy et al., 2014). The CSL in 2017 was barely a meter (3 feet) above its historic low in the 1970s (Advance Earth and Space Science, 2017).

The CSL is sensitive to climatic conditions in its catchment area. Between 1979-1995 and 1996-2015, the average yearly surface temperature over the Caspian Sea rose by about one degree Celsius (1.8 degrees Fahrenheit)—a likely result of climate change (Advance Earth and Space Science, 2017). According to the World Bank, the average annual temperature in the Central Asian region is expected to increase by between 1.3°C and 5.1°C by the mid-2090s, depending on emission projections which will further increase evaporation of the Caspian Sea. Counteracting this increased evaporation would require, at minimum, an equivalent increase in discharge from the rivers that feed the Caspian. Evaporation from dams, together with climate change and increased water extraction, resulting in insufficient inflows



to the Caspian, will be the leading driver of changes in the CSL. This will seriously impact the ecosystems, economies, and livelihoods of millions of people in the nations surrounding the Caspian Sea.

9.1. Fluctuations of The Caspian Sea Level and Their Impact on Ecosystems, Economies, And Livelihoods

CSL changes have environmental and socioeconomic effects such as damage to coastal enterprises, loss of livelihoods, migration, and infrastructure degradation (Eurasian Research Institute, 2020). For example, the traditional economy of the Republic of Dagestan, one of the Russian Federation's poorest regions, with a per capita GDP of less than \$3,500, heavily depends on the Caspian fishing industry (Korzhev, 2018) which constituted 17.2% of the Republic's GDP in 2017.

The wide range of ecological and economic impacts that would be created by a precipitous fall in CSL should be prominently addressed alongside the Caspian's economic functions like enabling shipping. Objectively, desalination of the Caspian Sea for any one state is not an unreasonable position given that reality of water stress in the region. However, as is the case with tradeable carbon credits, the only way for some states to sustainably withdraw more water is if these withdrawals are offset by a commensurate increase in inflows - primarily from Russia's Volga River. Thus, despite the concerns about engaging with Russia, given its recent gross violations of international law, it nevertheless must be brought to the table if the Sea is to be preserved.

In addition to the absolute water level, another problem is increased salinity from the redistribution of brine water. Thus, another option for lowering the environmental impact of brine discharge is through different sequestration strategies, including the beneficial reuse of brine (MIT, 2019). The Caspian is an appropriate test case for these technologies given that the externalities from added salinity are borne directly by all parties if these externalities could be effectively priced.

Caspian salinity varies substantially by location, with area bordering Turkmenistan having a much higher salinity than the northern Caspian due to its higher evaporation rate and distance from inflow rivers (GRID-Arendal, 2007). This presents a unique situation in which the net impact of desalination depends not only on how much water is desalinated but where the desalination occurs. If, for example, Turkmenistan was to repurpose the brine from its desalination process, this could actually result in a net loss of salinity for the Sea as a whole. If this is not economic, it could justify a Pigouvian subsidy in which the party contributing to a net loss of salinity would be compensated for this benefit.

9.2. *Incorporating Desalination into Transboundary Water Hydropolitics*

The idea that desalination is a “magic bullet” that will overcome the 21st century’s water challenges risks neglecting other vital institutional mechanisms for transboundary water management (Katz, 2021). For instance, the increasing reliance on desalination in Israel undermined demand management efforts (Katz, 2016) where consumers, aware of the increases in potential supply, discount the importance of conservation. In the case of the Caspian littoral states, the lack of regulatory mechanisms and transparency in resource-sharing agreements can lead to abuse of the commons (Baechler, 1998). In cases like Israel or other states that have substantial experience in governance challenges connected to desalination, it is critical for technical assistance to be accompanied by best practices for governance. Israel is actively aiding Azerbaijan in its desalination plans for the Caspian, and it is likely this partnership will include consulting on technology and strategies for addressing governance challenges (AZERNEWS, 2023). Successful joint governance of the Caspian Sea will depend on maintaining robust political connections, cooperative and multilateral institutions, and governance structures (Zeitoun & Warner, 2006)

Desalination is not a new technology. Nevertheless, the literature describing how its rise as a source of freshwater has shifted water management and hydropolitics is sparse. Some scholars (Aviram, Katz, & Shmueli, 2014) have pointed out that a large-scale desalination project can alleviate scarcity and compensate for natural variability and competition over scarce resources, thus increasing cooperation between riparian states (Walschot, 2018). For instance, March (2015) writes, “Desalination is presented as a conflict-free and resilient solution to the global water challenges of the 21st century”. Contrary to these assumptions, David Katz argues that desalination can create new arenas of dispute by introducing new water sources (e.g., seawater and brackish sources) into the calculus of transboundary management, thereby removing the need for cooperation (Katz, 2021). Similarly, other scholars have pointed out that desalination could be a source of future conflict due to its potentially adverse transboundary environmental impacts - particularly in the case of the Caspian, where brine discharge has a deleterious impact on shared resources (Larson, 2012).

In Central Asia, similar to the global trend, the issue of water scarcity is being aggravated by population growth. (Makhanov, 2020) Between 1990 and 2019, the collective population of Central Asia has expanded by 46.1%, surging from 50.1 million individuals to 73.2 million, a rate nearly on par with the worldwide population growth and eclipsing that of most other post-Soviet states. By 2050, it is projected that the population of Central Asia will rise by 36.9%, surpassing the global average of 26.2%, reaching a significant milestone of over 100 million people. This population growth leads to an increased demand for water resources across Central Asia. Furthermore,

population growth is often occurring in areas, like Turkmenbashi, with no natural water sources. The Amu Darya River, a shared resource between several Central Asian states, has traditionally compelled a degree of cooperation out of necessity. Additionally, the potential reduction in water, driven by the promise of desalination, has provided Turkmenistan and Kazakhstan with added negotiating leverage (Aviram et al., 2014) and a certain degree of flexibility in their transboundary water management strategies. However, in the context of Turkmenistan, where cooperation with its Central Asian neighbors is already weak, the availability of “resource alternatives” may exacerbate its uncooperative behavior.

However, desalination’s impact should not solely be relegated to relationships between riparians. Specifically, international water law has not yet evolved to explicitly address water augmentation technologies like desalination (Larson, 2016). Because desalination effectively imports new water to river basins, it is unclear whether international water law principles such as equitable and reasonable utilization and the obligation not to cause significant harm even apply in this context (Larson, 2016). As desalination becomes a disruptive technology, it accelerates the need for reconsideration of the applicable international legal regime. In other words, desalination of the Caspian is a unique case and calls for the establishment of new international legal principles that explicitly address water augmentation processes like desalination.

10. Policy Recommendations - Justification and Guideposts for New Language on Trade Development and Desalination in The Caspian Treaty

It took 26 years for the Treaty - formally known as the Caspian Sea Legal Status Convention - to be signed, yet it still does not provide an adequate system for addressing existing or emerging challenges.

Many aspects of the treaty are unrelated to either freight commerce or environmental issues. Thus, this paper focuses only on those sections that are of direct relevance. Substantial changes have occurred regarding baseline economic conditions, environmental realities, and economic opportunities since the signing of the 2018 agreement. First, the environmental precarity of the Caspian has become more well-documented and urgent. In addition, the importance of the Caspian for Asia-Europe commerce has been greatly elevated building upon investments that have been made in Turkmenistan (Port of Turkmenbashi), Kazakhstan (Ports of Atkai and Kuryk), and Azerbaijan (Port of Alat) in addition to the completion of the Tbilisi-Kars railway.

The fortuitous construction of the Port of Turkmenbashi has augmented Turkmenistan’s potential power - setting aside its substantial gas reserves. Azerbaijan

and Kazakhstan's bargaining position has also been magnified due to their location, solid diplomatic relations with Western powers, and recent substantial investment in port and rail infrastructure.

By contrast, Russia and Iran, who had served as the regional hegemons during the negotiation of the original treaty, have seen their bargaining power decrease in recent years, given the sharp decline in Iran's GDP and the political isolation of Russia. It is also important to note that a failure to address the ecological precarity of the Caspian and water level loss has the potential to destabilize Russia further politically. The Republic of Dagestan in Russia stands to suffer the greatest economic and ecological harm from Caspian water loss as this would undermine the republic's traditional fishing and aquaculture industry. The region has been an area of particular concern for the Kremlin since its invasion by Chechen separatists in 1999. Dagestan saw some of the most sustained, intense, and sometimes violent protests against forced conscription in 2022 (FRANCE 24 English, 2022). Thus, while Russia has shown less concern regarding the ecological status of the Caspian, it may be inclined to take actions supporting the Sea's health if these actions are likely to pacify Dagestan (Bayramov, 2023). Russia also has expressed dissatisfaction with the current Caspian governance (Port News & Information Mediterranean, 2022). This may make Russia a more willing participant to a potential treaty renegotiation process than it would appear on the surface.

10.1. Description and Critique of The Existing Caspian Treaty Required Changes to Environmental Language.

The Treaty establishes sovereign and exclusive rights for each littoral state to their respective "territorial waters," but it recognizes that the Caspian Sea is a common resource for all coastal states to use (Fifth Caspian Summit, 2018). Concerning environmental conservation, the preamble notes that all parties are "Aware of their responsibility before the present and future generations for the preservation of the Caspian Sea and sustainable development of the region." According to the Treaty, littoral states are required to ensure the protection and prohibition of activities that harm the Caspian Sea's biodiversity. Specifically, Article 3(14) calls for the "Protection of the environment of the Caspian Sea, conservation, restoration and rational use of its biological resources." According to one interpretation, this text could be used to address the contribution of desalination to increased salinity which potentially harms fishing stocks. However, no language explicitly addresses the impact of water extraction activities that impact the water level.

Thus, while there is a substantial focus on the mineral resources that exist beneath the seabed and, to some extent, the biological organisms that hold economic value within the seawater, the seawater itself is not recognized as a resource writ large. This conceptual shortcoming would ultimately impede the ability of parties to

regulate seawater use under the current regulatory framework and would need to be corrected in order to determine whether extractions of water for desalination and the associated brine water discharge do not harm the overall sea ecology.

10.2. On the Role of Transboundary Rivers

A revised treaty must also recognize that the Caspian ecosystem relies on adequate river inflows. The Treaty establishes sovereign and exclusive rights for each state to their respective “territorial waters,” (Fifth Caspian Summit, 2018) and recognizes the Caspian as a common resource for all (Freshfields Bruckhaus Deringer, 2018). However, by failing to account for the influence of diversions from damming, the Treaty excludes an important recourse for downstream states.

For the last 20 years, the five littoral states have disagreed over whether the Caspian is a lake or a sea and have thus granted it a “special status” under the Treaty. Article 1 of the Treaty defines the Caspian Sea as a “body of water surrounded by the territories of the Parties.” Due to this ambiguous definition, neither the United Nations Convention on the Law of the Sea nor customary international rules regarding international lakes apply. If the Caspian were to be considered a lake, this would better capture the negative externalities associated with the various forms of economic exploitation it is currently experiencing, given that it would make each nation an equal stakeholder in the Caspian’s future. It is important to note that although the Convention on the Protection and Use of Transboundary Watercourses and International Lakes tends to play a rather limited role in the actual governance of transboundary waters (Bernauer & Kalbhenn, 2010), especially in the post-Soviet spaces, it can still serve as guidance for the development of a new refined treaty.

10.3. Definition of Pollution as it Relates to Desalination

The existing language of the Treaty precludes “any act of willful and serious pollution contrary to this Convention.” Though it is not specifically called out, by this definition, brine water discharge could be definitively designated as a pollutant. The definition of pollution used in the Treaty is “substances, organisms or energy into the ecological system of the Caspian Sea, including from land-based sources, which results or is likely to result in deleterious effects.” It is thus sufficiently broad to encompass brine water. The conundrum is in the definition of the term “serious” in determining what amount of additional salinity could be accommodated without posing significant harm.

Article 15 is key to governing pollution regulation. While the Treaty is lacking in enforcement mechanisms, Provision 3, which prohibits “Any activity damaging the biological diversity of the Caspian Sea,” would justify the prevention of desalination that harms the Sea’s salinity. As there are already many existing activities that

negatively impact the Sea's ecological health, the most straightforward way to read the treaty language is that it should prevent new threats to the Sea. If interpreted in this manner, the novel threat of desalination would be an obvious target.

As part of the revised treaty, mechanisms should be established for managing brine concentrate discharge without causing harm to fragile and ecologically significant estuaries and important marine species. Degradation and depletion of the Caspian water resources (Hauge & Ellingsen, 2018) may serve as an additional exacerbating factor and point of contention that would make future negotiations on managing the Caspian seabed's oil and gas reserves among the five littoral states more difficult. Evidence suggests that even when countries share close historic and cultural bonds, environmental degradation and pollution of a common water resource can lead to sustained tension. (See example of Argentina and Uruguay in Piscitello & Andrés, 2007).

Kazakhstan, Azerbaijan, and Turkmenistan, in turn, should also respect their obligations under the Convention on the Protection and Use of Transboundary Watercourses and International Lakes "to strengthen cooperation, on bilateral and multilateral levels, for the prevention, control, and reduction of transboundary pollution." The Caspian Sea has already been polluted due to oil and gas byproducts from crude oil extraction and coastal areas and marine transportation of crude oil and its derived products. Degradation of water quality contributes to political disputes (Wolf, 2007). Early coordination among riparian states can ameliorate these sources of friction. The littoral states should consider creating integrated water management institutions with the following essential functions: (1) harmonizing the interests of littoral states; (2) monitoring water quantity and quality and identifying precise allocation schedules and water quality standards; (3) developing and monitoring the implementation of the joint action programs and creating mechanisms to enforce treaty/convention provisions; (4) regulating the exchange of information, and enforcing the revised Treaty; (5) ensuring that the supply and quality of water are sufficient to meet both human and ecological needs without compromising the requirements of future generations; and (6) incorporating clear mechanisms for resolving conflicts.

10.4. Required Changes Regarding Economic Coordination

One of the most glaring deficiencies of the current Treaty is its focus on what each state must not do but an almost complete absence of discussion of proactive coordination in the economic sphere. The Treaty fails to mention the Sea's role as a marine highway. The term "commerce" never appears in its text, and even "economic development" bears only a passing mention. Economic activity is addressed by the Treaty, yet in all cases, it describes how each party may extract the Sea's resources while staying out of the other's way. By comparison, the E.U., through the TEN-T

transport network (European Commission, 2023), sets out not only what each party must not do to impede commerce but what it should do to facilitate more robust maritime commerce (European Commission, 2023). For those who would argue that these treaties only function in the context of a unified political space, consider that the founding documents for the Central Commission for Navigation on the Rhine (CCNR) date to 1815. Infrastructure coordination for maritime commerce, thus, need not occur only in the context of political unity.

On the second identified inhibitor to commerce - rent-seeking behavior at border crossings - the treaty appears somewhat closer to the objective. Specifically, the language of the Treaty that most closely addresses this issue is Article 10(4), which reads,

The Parties shall have the right to free access from the Caspian Sea to other seas and the Ocean and back. To that end, the Parties shall enjoy the freedom of transit for all their means of transport through the territories of transit Parties.

If a party argues that tariffs or non-tariff barriers are encumbering trade, this could be seen as grounds for relief. Additional clarification of this language to specify the definition of freedom of transit would be useful.

Finally, the Treaty should directly forbid Russia's current use of the Caspian Sea as a staging ground to launch missile attacks on Ukraine as it is in clear violation of Article 3, section 2, which requires (Alimova, 2002)

Using the Caspian Sea for peaceful purposes, making it a zone of peace, good-neighborliness, friendship and cooperation, and solving all issues related to the Caspian Sea through peaceful means.

In fact, in response to those who envision the Middle Corridor as a means to "Russia-proof" trans-Eurasian commerce, it remains clear that the war undermines this commerce regardless of what corridor is chosen. Beyond the direct attacks on Ukraine, the war has substantially impacted the risk and price premium of shipping on the Black Sea. Ukraine itself is also an essential link in the Middle Corridor. Thus, as long as Russia's attack on Ukraine continues, the Middle Corridor can never reach its true potential.

Conclusions

The Caspian has a vital role to play in Eurasian integration. It has long been considered the dividing line separating the Caucasus from Central Asia and has been, at best, a space where the littoral states strive to pursue their own self-interests while staying out of each other's way. However, as this paper has demonstrated, this course is untenable for the Sea's future and its potential contribution to the shared prosperity of Eurasia. Far from a barrier, the efficiency of modern maritime

commerce should make the Transcaspian component one of the most energy-efficient and cost-effective links of the Middle Corridor. The main impediment in transforming the Caspian from a commerce barrier to a commerce facilitator is political rather than physical.

Despite three decades of independence, post-Soviet transport networks remain Moscow-centric. Neither the Central Asian nor Caucasian states have established robust trading networks amongst themselves or with each other. The impetus for a paradigm shift began with the Belt and Road Initiative, which recentered Central Asia as a trade corridor, yet it took the war on Ukraine to place the Transcaspian Middle Corridor front and center. To paraphrase John F. Kennedy, the Middle Corridor is not attractive because it is easy but because it is hard. For the Middle Corridor to work effectively, the littoral states would need to coordinate their actions in a way that they have, up until this point, been unwilling to do. Yet, this coordination would likely be augmented and backstopped by unprecedented support from development banks, given the pressing need to secure routes that bypass the territory of Russia. We argue that the benefit of Middle Corridor coordination would eclipse the direct commercial benefits in simultaneously providing a framework and a track record of experience for tackling even more complex regional problems.

Desalination of the Caspian is a wicked problem that makes coordination on the Middle Corridor look facile by comparison. Not only does its solution necessitate the involvement of all littoral states, including Russia and Iran, but it also would mean replacing or at least substantially augmenting a treaty that, in our view, alternatively ignores or doubles down on past mistakes in the environmental sphere. The fact that the Caspian sturgeon is not extinct indicates that collective action on environmental causes is possible in this space, but most environmental issues will not have such a tangible and lucrative payoff. We see one fundamental problem in formulating a coordinated desalination policy: the Sea's water level is falling even absent desalination due to diversions from the Volga and in the context of climate change. Thus, the other littoral state parties must influence Russia to reduce diversions from the Volga for the benefit of the Caspian's ecology. While these states, excepting Iran, have historically been politically subservient to Russia, recent events have reversed this relationship making Russia heavily dependent on maintaining acceptable ties with the littoral states, including Iran. We further project that Russia will itself suffer severe political destabilization from falling CSL which would disproportionately harm the politically-restive Republic of Dagestan.

We also argue that a zero-tolerance policy for the desalination of Caspian seawater would be untenable. Not only have some states, like Kazakhstan, engaged in limited desalination since Soviet times, but the economic development priorities of several states also require adding population to arid coastal areas, such as

Turkmenbashi and Alat, which have no other viable water sources. Thus, we argue that the goal should be to agree on what uses of desalinated seawater should be considered essential. The greatest threat is that desalination would become a gateway for expanding already unsustainable cash crop agriculture, such as cotton. This would create a forum for regional competition rather than coordination, leading the Sea and its dependent populations to suffer. From consulting with experts in conflict literature, it is clear that desalination often exacerbates conflict resolution in cases where water independence convinces countries that they no longer have to work together to manage shared water resources. The Caspian context is even more problematic as, unlike the case with desalination of open ocean withdrawals, the removal of water from an inland sea itself generates negative externalities for all involved parties - yet ones that are less evident on a short-term basis when compared to diversions of shared freshwater resources.

Despite the sensitivities of desalination on political dialog, development bodies continue to champion and aid the direct use of desalination for agriculture in arid areas. While each project must be evaluated independently, we fear that the desalination for agriculture will become an irresistible “prestige technology” that the littoral states may champion as a demonstration of modernity in lieu of more responsible but politically challenging demand management strategies.

Finally, we argue that while the states themselves must lead the resolution of both challenges, the international community has a strong role to play as well. The efficacy of infrastructure investments aimed at bolstering Middle Corridor commerce is undermined by Russia’s continuing attack on Ukraine as it destabilizes a key component of the route - the territory of Ukraine - while also raising the cost of shipping in the Black Sea (Apple Podcasts Preview, 2023). Thus, international development aid for bolstering Middle Corridor commerce should not be offered to any state which enables this activity. Furthermore, international consulting and technical advice on Caspian desalination will likely come from global leaders in the Middle East, like Israel and the UAE. It is critical that when advice on the technical side of desalination is offered, it is appropriately contextualized with the niche desalination should play in a comprehensive water management policy. This approach will potentially prevent a technology that can alleviate human suffering owing to inadequate water access from simultaneously sowing a new source of regional conflict.

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References

- Advance Earth and Space Science. (2017, August 29). Caspian sea evaporating as temperatures rise, study finds. *Advancing earth and space science (AGU)*. <https://news.agu.org/press-release/caspian-sea-evaporating-as-temperatures-rise-study-finds/>
- Agaidarov, A., & Rahardja, S. (2023). Kazakhstan economic update: Economic recovery during challenging times. Washington, DC: World Bank Group
- Ahmar, A. (2023). UAE oil power farms the desert in quest for food security. Reuters. <https://www.reuters.com/world/middle-east/uae-oil-power-farms-desert-quest-food-security-2023-02-15/>
- Akbari, M., Baubekova, A., Roozbahani, A., Gafurov, A., Shiklomanov, A., Rasouli, K., Ivkina, N., Kløve, B., & Haghighi, A. T. (2020). Vulnerability of the Caspian sea shoreline to changes in hydrology and climate. *Environmental Research Letters*, 15(11), 115002. <https://doi.org/10.1088/1748-9326/abaad8>
- Al'ternativnye Novosti Turkmenistana (Alternative News of Turkmenistan). (2019, February 05). Turkmenija zakryla granicy dlja tadjihskih fur [Turkmenistan closed borders to Tajik trucks]. <https://habartm.org/archives/10116>. [in Russian]
- Al'ternativnye Novosti Turkmenistana [Alternative News of Turkmenistan]. (2016, August 15). Neozhidannaja vojna tamozhen Turkmenistana protiv Irana [Unexpected war of Turkmenistan customs against Iran]. <https://habartm.org/archives/5491>. [in Russian]
- Alimova, Y. (2002, December 02). Russia is using the Caspian sea to launch strikes against ukraine. So why are the caspian countries silent? Radio Free Europe/ Radio Liberty (RFERL). <https://www.rferl.org/a/caspian-sea-ukraine-war-russia-peace-friendship-convention/32158822.html#:~:text=On%20June%2026%2C%20Russia%20fired,person%20and%20injuring%20five%20others>
- Apple Podcasts Preview. (2023). Episode 18: Russia's war on ukraine and the rise of the middle corridor. [Audio podcast edpisode]. <https://podcasts.apple.com/us/podcast/episode-18-russias-war-on-ukraine-and-the-rise/id1551577816?i=1000613035988>

- AQUASTAT - FAO's global information system on water and agriculture. (2021). Food and Agriculture Organization of the United Nations. <https://www.fao.org/aquastat/en/databases/dams>
- Aragones, V. (2021, October 20). Caspian Ports and Shipping Conference [Conference presentation]. Aktau, Kazakhstan.
- Aragones, V. (2023, May 15). Interview with the Authors
- Arpe, K., Molavi-Arabshahi, M., & Leroy, S. A. G. (2020). Wind variability over the Caspian Sea, its impact on Caspian seawater level and link with ENSO. *International Journal of Climatology*, 40(14), 6039-6054. <https://doi.org/10.1002/joc.6564>
- Arpe, K., Tsuang, B.-J., Tseng, Y.-H., Liu, X.-Y., & Leroy, S. A. G. (2018). Quantification of climatic feedbacks on the Caspian Sea level variability and impacts from the Caspian Sea on the large-scale atmospheric circulation. *Theoretical and Applied Climatology*, 136(1-2), 475-488. <https://doi.org/10.1007/s00704-018-2481-x>
- Ayuzov, O. (2022, October 26). World's biggest uranium miner seeks extra shipping capacity bypassing Russia. Reuters. <https://www.reuters.com/markets/commodities/worlds-biggest-uranium-miner-seeks-extra-shipping-capacity-bypassing-russia-2022-10-26/>
- Aviram, R., Katz, D., & Shmueli, D. (2014). Desalination as a game-changer in transboundary hydro-politics. *Water Policy*, 16(4), 609-624. <https://doi.org/10.2166/wp.2014.106>
- Azerbaijan (AZE) Exports, Imports, and Trade Partners (2022). The Observatory of Economic Complexity (oec.world)
- Baechler, G. (1998). Why environmental transformation causes violence: A synthesis. *Environmental Change and Security Project Report*, 4(1), 24-44. <https://www.wilsoncenter.org/publication/why-environmental-transformation-causes-violence-synthesis>
- Balazh, A. (2020, December 23). The Caspian Sea is set to fall by 9 metres or more this century - An ecocide is imminent. The Conversation. <https://theconversation.com/the-caspian-sea-is-set-to-fall-by-9-metres-or-more-this-century-an-ecocide-is-imminent-152229>
- Barlow, J., & Rzegocki, S. ((2023, April 26). Kazakh Energy for German Cash: A New Power Partnership? *Center for European Policy Analysis (CEPA)*. <https://cepa.org/article/kazakh-energy-for-german-cash-a-new-power-partnership/>
- Batyrbekova, L. (2023, February 22). Interview with the Authors
- Bayramov, A. (2009, August 15). Personal communication
- Berdimuhamedov approved the new composition of the interdepartmental commission on digitalization. (2021, December 17). Turkmenportal. <https://turkmenportal.com/en/blog/42599/berdimuhamedov-approved-the-new-composition-of-the-interdepartmental-commission-on-digitalization>
- Bernauer, T., & Kalbhenn, A. (2010, March 01). The politics of international freshwater resources. In R. A. Denmark (Ed.), *The international studies encyclopedia*. Oxford: Blackwell Publishing. <https://doi.org/10.1093/acrefore/9780190846626.013.483>
- Caspian sea is a source of unlimited opportunities, says President Tokayev at Caspian sea summit in Ashgabat. (2022, June 30). The Astana Times. <https://astanatimes.com/2022/06/caspian-sea-is-a-source-of-unlimited-opportunities-says-president-tokayev-at-caspian-sea-summit-in-ashgabat/>
- Caspian sea-sea surface salinity. (2007). GRID-Arendal. <https://www.grida.no/resources/6116>
- Chandler, D. (2019). Turning desalination waste into a useful resource. MIT. <https://news.mit.edu/2019/brine-desalination-waste-sodium-hydroxide-0213>
- Chen, J. L., Pekker, T., Wilson, C. R., Tapley, B. D., Kostianoy, A. G., Cretaux, J. F., & Safarov, E. S. (2017). Long-term Caspian Sea level change. *Geophysical Research Letters*, 44(13), 6993-7001. <https://doi.org/10.1002/2017gl073958>
- Claude "bud" lewis carlsbad desalination plant new. Reliable. Drought-proof. (2023). San Diego County Water Authority. <http://carlsbaddesal.sdcwa.org/>
- Demin, A. P. (2007). Present-day changes in water consumption in the Caspian Sea basin. *Water Resources*, 34(3), 237-253. <https://doi.org/10.1134/s0097807807030013>

- des Nations Unies, O. Collection des Traités. (1992, March 17). 5. Convention on the protection and use of transboundary watercourses and international lakes. *United Nations Treaty Collection*. https://treaties.un.org/Pages/ViewDetails.aspx?src=TREATY&mtdsg_no=XXVII-5&chapter=27&clang=_en
- Design and construction of a Turnkey sea water desalination plant in Ekerem, Turkmenistan. (2008). PWT. <https://pwt.de/en/magazin/sea-water-desalination-plant-ekerem-turkmenistan/>
- Desperate Moscow seeks unified rules for Caspian Sea corridor ports. (2022). Port News & Information Mediterranean, Black & Caspian Seas. <https://www.portseurope.com/desperate-moscow-seeks-unified-rules-for-caspian-sea-corridor-ports/>
- EBRD researches sustainable transport connections between Central Asia and Europe. (2023, June 30). European Bank for Reconstruction and Development. <https://www.ebrd.com/news/publications/special-reports/sustainable-transport-connections-between-europe-and-central-asia.html>
- Eurasian Rail Alliance. (2023). Statistics. <https://index1520.com/en/statistics/?direction=all&view=list§ion=route&previousPeriodType=year&period=route&previousPeriodType=year&period>
- Fifth Caspian Summit. (2018, August 12). Convention on the legal status of the Caspian sea. <http://en.kremlin.ru/supplement/5328>
- FRANCE 24 English. Russia: Protests erupt in Dagestan over military mobilisation • FRANCE 24 English. [Video]. Youtube. <https://www.youtube.com/watch?v=07xVpuBx33k>
- Gorkey, H. (2015). Türkmenbaşy deniz suyu aritma tesisi 2015 / Turkmenbashi desalination plant 2015. [Video]. Youtube. <https://www.youtube.com/watch?v=9ZQwXOgyuvE>
- Nandini-Weiss, S. D., Prange, M., Arpe, K., Merkel, U., & Schulz, M. (2020). Past and future impact of the winter North Atlantic Oscillation in the Caspian Sea catchment area. *International Journal of Climatology*, 40(5), 2717-2731. <https://doi.org/10.1002/joc.6362>
- Hauge, W., & Ellingsen, T. (2018). Causal pathways to conflict. (P. Diehl Ed.), *Environmental conflict*, 36-57. New York: Routledge. <https://www.taylorfrancis.com/chapters/edit/10.4324/9780429500794-3/causal-pathways-conflict-wenche-hauge-tanja-ellingsen>
- Helsinki. (1992). Convention on the protection and use of transboundary watercourses and international lakes. <https://unece.org/fileadmin/DAM/env/water/pdf/watercon.pdf>
- Hessler, J., & Gronow, J. (2002). Caviar with champagne: Common luxury and the ideals of the good life in Stalin's Russia. *Slavic Review*, 64(4), 910. <https://doi.org/10.2307/3649951>
- Hodgkinson, A. (2022). The Importance of Water to the Hydrogen Industry. URL. Avisian.com
- Hutson, N. (2019). The Development Implications of China's Belt and Road Initiative for Russia, Kazakhstan and Belarus. University of Southern California. <https://www.proquest.com/openview/beff74237ea08df4bf2c3e34b728d763/1.pdf?pq-origsite=gscholar&cbl=51922&diss=y>
- Hutson, N. (2022, March 21). Perspectives | Russian invasion dealing China a silk road economic setback. <https://eurasianet.org/perspectives-russian-invasion-dealing-china-a-silk-road-economic-setback>
- Hutson, N. (2024) .The Silk Road Through Eurasia: A New Strategy for Eurasian Integration, Rowman & Littlefield, (forthcoming)
- JAXLNG. (2023). The Growing Need to Reverse Declining Caspian Sea Levels. The maritime executive. <https://maritime-executive.com/editorials/the-growing-need-to-reverse-declining-caspian-sea-levels>
- Iran plans to pump water from the Caspian Sea. (2019, April 24). Caucasus Watch. <https://caucasuswatch.de/news/1600.html>
- Katz, D. (2016). Undermining demand management with supply management: Moral hazard in Israeli water policies. *Water*, 8(4), 159. <https://doi.org/10.3390/w8040159>
- Katz, D. (2021). Desalination and hydrodiplomacy: Refreshing transboundary water negotiations or adding salt to the wounds? *Environmental Science & Policy*, 116, 171-180. <https://doi.org/10.1016/j.envsci.2020.11.012>
- Koriche, S. A., Singarayer, J. S., & Cloke, H. L. (2021). The fate of the Caspian sea under projected climate change and water extraction during the 21st century. *Environmental Research Letters*, 16(9), 094024. <https://doi.org/10.1088/1748-9326/ac1af5>

- Korzhev, N. (2018, November 4). Will Caspian deal help 'barely surviving' fishermen in Dagestan? Aljazeera. <https://www.aljazeera.com/features/2018/11/4/will-caspian-deal-help-barely-surviving-fishermen-in-dagestan>
- Kudekov, T. (2006). Climate change and vulnerability assessment report for the republic of Kazakhstan. *Caspian Environmental Programme*.
- Larson, R. B. (2012, March 16). Innovation and international commons: The case of desalination under international law. *Utah Law Review*, 759. <https://ssrn.com/abstract=2045038>
- Larson, R. B. (2016). Governing water augmentation under the watercourse convention. *Water International*, 41(6), 866-882. <https://doi.org/10.1080/02508060.2016.1214893>
- Lebedev, S. A., & Kostianoy, A. G. (2008). Integrated use of satellite altimetry in the investigation of the meteorological, hydrological, and hydrodynamic regime of the Caspian sea. *Terrestrial, Atmospheric and Oceanic Sciences*, 19(1-2), 71. [https://doi.org/10.3319/tao.2008.19.1-2.71\(sa\)](https://doi.org/10.3319/tao.2008.19.1-2.71(sa))
- Lillis, J. (2022, October 28). Kazakhstan: Oil-rich west to become green hydrogen hub: The plan is to turn waters from the Caspian Sea into clean hydrogen for export. *Eurasianet*. <https://eurasianet.org/kazakhstan-oil-rich-west-to-become-green-hydrogen-hub>
- Lmahamad, A. (2023, October 10). Azerbaijan, Israel ink MoU on establishing plant on desalination of Caspian Sea water. AZERNEWS. <https://www.azernews.az/business/200587.html>
- Makhanov, K. (2020). UN Population Prospects: Case of Central Asia. Eurasian Research Institute. <https://www.eurasian-research.org/publication/un-population-prospects-case-of-central-asia/#:~:text=Between%201990%20and%202019%2C%20the,the%20worldwide%20relative%20population%20growth>
- March, H. (2015). The politics, geography, and economics of desalination: A critical review. *WIREs Water*, 2(3), 231-243. <https://wires.onlinelibrary.wiley.com/doi/10.1002/wat2.1073>
- Micklin, P. P. (1988). Dessication of the Aral Sea: A water management disaster in the Soviet Union. *Science*, 241, 1170-1176. <http://www.ciesin.org/docs/006-238/006-238.html#:~:text=The%20Aral%20Sea%20in%20the,withdrawals%20of%20water%20for%20irrigation>
- Motorways of the sea. (2023). European Commission. https://transport.ec.europa.eu/transport-modes/maritime/motorways-sea_en
- Missimer, T. M., & Maliva, R. G. (2018). Environmental issues in seawater reverse osmosis desalination: Intakes and outfalls. *Desalination*, 434, 198-215. <https://doi.org/10.1016/j.desal.2017.07.012>
- Modabberi, A., Noori, R., Madani, K., Ehsani, A. H., Mehr, A. D., Hooshyaripor, F., & Kløve, B. (2020). Caspian Sea is eutrophying: The alarming message of satellite data. *Environmental Research Letters*, 15(12), 124047. <https://doi.org/10.1088/1748-9326/abc6d3>
- Mustard, A. (2023, January 17). (Amb.) Interview with the Authors
- New international seaport was put into operation in Turkmenbashi city. (2018, May 03). Ministry of Foreign Affairs of Turkmenistan. <https://www.mfa.gov.tm/en/news/770>
- Papatolios, N. (2022, April 18). World Bank: "Azerbaijan and Georgia can transform the Middle Corridor". RailFreight.com <https://www.railfreight.com/corridors/2022/04/18/world-bank-azerbaijan-and-georgia-can-transform-the-middle-corridor-heres-what-they-should-do/>
- Papatolios, N. (2022). Maersk launches third Far East-Europe intermodal service. RailFreight.com. <https://www.railfreight.com/beltandroad/2022/02/22/maersk-launches-third-far-east-europe-intermodal-service/>
- Piscitello, D. P., & Andrés, G. E. (2007). The conflict between Argentina and Uruguay concerning the installation and commissioning of pulp mills before the International Court of Justice and Mercosur. *Heidelberg Journal of International Law*, 67, 159. https://www.zaoerv.de/67_2007/67_2007_1_b_159_183.pdf
- Renssen, H., Lougheed, B. C., Aerts, J. C. J. H., de Moel, H., Ward, P. J., & Kwadijk, J. C. J. (2007). Simulating long-term Caspian Sea level changes: The impact of Holocene and future climate conditions. *Earth and Planetary Science Letters*, 261(3-4), 685-693. <https://doi.org/10.1016/j.epsl.2007.07.037>

- Rezaei, L., Alipour, V., Dehghani, M., & Hassani, A. H. (2022). Reverse osmosis water desalination plants and environmental impacts. <https://doi.org/10.21203/rs.3.rs-1645047/v1>
- Polish National Railways. (2022). Personal communication
- Sehring, J. (2009). Path dependencies and institutional bricolage in post-soviet water governance. *Water Alternatives*, 2(1), 61-81. <https://www.water-alternatives.org/index.php/all-abs/36-a2-1-5/file>
- Spiliakos, A. (2019, February 06). Tragedy of the commons: What it is and 5 examples. Harvard Business School Online. <https://online.hbs.edu/blog/post/tragedy-of-the-commons-impact-on-sustainability-issues>
- Syrlybekkyzy, S., Kenzhetayev, G. Z., Togasheva, A. R., & Tayzhanova, L. S. (2014). 17-year periods of rising and falling water levels in the Kazakhstan section of the Caspian sea. *European Researcher* (2), 401-413. ISSN 2219-8229. http://www.erjournal.ru/journals_n/1393749519.pdf
- Taganova, J., Cholico Santoyo, Z., Mattur, R., Best, J., Shabanova, A.. (2022, December 16). Should Turkmenistan use the Caspian sea to quench its thirst? Central Asia Program (CAP). <https://centralasiaprogram.org/turkmenistan-caspian-sea-quench-thirst>
- Tehran, B. (2016, May 09). A grand but faulty vision for Iran's water problems. The Guardian. <https://www.theguardian.com/world/2016/may/09/iran-desalination-water>
- The Caspian Sea level changes: Causes and consequences. (2020). Eurasian Research Institute. <https://www.eurasian-research.org/publication/the-caspian-sea-level-changes-causes-and-consequences/>
- The new convention on the legal status of the Caspian sea: New opportunities and new challenges. (2018). Freshfields Bruckhaus Deringer. <https://www.lexology.com/library/detail.aspx?g=f09d9201-9384-499e-a6d8-9d248d8d7a0f>
- The Republic of Dagestan. Investment Portal of the Regions of the Russian Federation "Invest in the Regions". URL. <https://www.investinregions.ru/regions/05/statistics/>
- Trans-European Transport Network (TEN-T). (2023). European Commission. https://transport.ec.europa.eu/transport-themes/infrastructure-and-investment/trans-european-transport-network-ten-t_en
- Tirone, J., & Motevalli, G. (2022, December 26). A sanctions-proof trade route. Bloomberg Businessweek.
- Turkmenistan logistics center will occur in the Astrakhan region within two years. (2022). Turkmenportal. <https://turkmenportal.com/en/blog/55622/turkmenistan-logistics-center-will-occur-in-the-astrakhan-region-within-two-years>
- Turkmenistan Country Report 2022. (2022). BTI Transformation Index. <https://bti-project.org/en/reports/country-report/TKM>
- Uzbekistan UZ: Cost to exports: USD per container. (2005-2014). CEIC. <https://www.ceicdata.com/en/uzbekistan/company-statistics/uz-cost-to-exports-usd-per-container>
- Varis, O. (2014). Resources: Curb vast water use in central Asia. *Nature*, 514(7520), 27-29. <https://doi.org/10.1038/514027a>
- Vezzoni, R. (2023, August 18). How 'Clean' is the Hydrogen Economy? Tracing the Connections between Hydrogen and Fossil Fuels. <https://ssrn.com/abstract=4543260>. <http://dx.doi.org/10.2139/ssrn.4543260>
- Water supply from the caspian sea. Desalination plant, transport pipelines and power generation plants. (2022). TYPSA. <https://www.tyrsa.com/en/proyectos/water-supply-from-the-caspian-sea-desalination-plant-transport-pipelines-and-power-generation-plants/>
- Whitney, C. (2018). The convention on the legal status of the Caspian sea - A sea or not a sea: That is still the question. Norton Rose Fulbright. <https://www.nortonrosefulbright.com/en/knowledge/publications/5f222b95/the-convention-on-the-legal-status-of-the-caspian-sea---a-sea-or-not-a-sea-that-is-still-the-question>

- Walschot, M. (2018). Desalination, transboundary water desecuritization and cooperation. *Desalination and Water Treatment*, 104, 38-44. <https://doi.org/10.5004/dwt.2018.21913>
- Wolf, A. T. (2007). Shared waters: Conflict and cooperation. *Annual Review of Environment and Resources*, 32(1), 241-269. <https://doi.org/10.1146/annurev.energy.32.041006.101434>
- Yusefi, F., Zahedi, M. M., & Ziyaadini, M. (2021). Evaluation for the optimization of two conceptual 200,000 m³/day capacity RO desalination plant with different intake seawater of Oman sea and Caspian sea. *Applied Water Science*, 11(2), 12. <https://doi.org/10.1007/s13201-020-01338-5>
- Zeitoun, M., & Warner, J. (2006). Hydro-hegemony - a framework for analysis of trans-boundary water conflicts. *Water policy*, 8(5), 435-460. <https://doi.org/10.2166/wp.2006.054>
- 2020 Policy notes: priorities for inclusive development in Afghanistan. (2021, January 12). World Bank. <https://thedocs.worldbank.org/en/doc/8033eefca38ca8af7b653869a3469087-0310012021/original/Policy-Notes-report-Jan-12-2021-Final-version-2.pdf>