

Integrated Environmental Assessment as a Comprehensive Governance Tool for the Caspian Littoral States to Control the Environmental Degradations

Lobat Zebardast*

ABSTRACT With the world's largest inland water basin, and the lack of an effective legal regime, the Caspian Sea has been an area of conflict over common resources. Important issues such as exploration and use of aquatic and fossil resources, transportation and environmental contamination have added to the urgency of developing frameworks for regional cooperation. In this paper, the Driving Force-Pressure-State-Impact-Response (DPSIR) model is used for implementing an Integrated Environmental Assessment (IEA), based on which, the causes and consequences of the environmental situation of the Caspian Sea and the effectiveness of the existing legal solutions and the possibility of upgrading them within a more comprehensive and integrated framework are examined. It is concluded that separated and individual efforts made by the littoral countries for the environmental conservation should be replaced with the comprehensive, integrated and inter-governmental approaches, such as Integrated Coastal Zone Management (ICZM), Integrated Watershed Management and Strategic Environmental Assessment (SEA) that are performed within the context of the existing regional governance structures.

Keywords Caspian Sea; Caspian Environmental Program (CEP); DPSIR Framework; Environmental Governance; Integrated Environmental Assessment; Iran

Introduction

Because of the increasing global focus on environmental and trans-boundary issues in the modern times, the relationship between the environment and human security has been greatly emphasized in international politics (Naghizadeh et al., 2016). This issue is more

* **Lobat Zebardast** is an Assistant Professor of Environmental Planning and Management in the School of Environment, the College of Engineering, the University of Tehran.
Corresponding Author's Email: lzebardast@ut.ac.ir/.

significant for the conflict over transboundary natural resources that cross political borders of one country. Marine areas which are important in various economic, transportation, military and geopolitical aspects (Monfared et al., 2017) are good examples of transboundary common natural resources. According to the United Nations Environmental Program, more than half of the world population lives within 60 km of the shorelines and are dependent on such areas for their livelihood. Apart from traditional usages such as fishing and transportation, nowadays exploitation of fossil resources has also become more widespread in marine areas (Soufi, 2018).

While all these mentioned items highlight the political and economic importance of coastal areas, the issues that are often overlooked are the environmental values and the vulnerability of the ecosystems in the marine areas, where some of the causes of damage are over the exploitation of biological and fossil resources, introducing artificial elements, and the discharge of pollutants (Jacob et al., 2017).

With the largest inland water basin of the world (Zverev and Kostikova, 2014), the Caspian Sea has always been an important region for common resources exploitations. Its valuable aquatic and fossil resources, transportation and environmental contamination have increased its importance and the necessity to develop frameworks for regional cooperation (Abdi, 2011).

Although the Caspian Sea connects the Middle East to Russia, Central Asia-Caucasus and Europe (Naghizadeh et al., 2016), it is a landlocked body of water. This special feature besides the lack of an effective legal regime have led to the destruction of the valuable ecosystem as a result of the extensive exploitation of fossil and aquatic resources as well as pollutions originating from the land drained by rivers.

In this study, the Driving Force-Pressure-State-Impact-Response (DPSIR) model is used for implementing an Integrated Environmental Assessment, based on which, the causes and consequences of the environmental situation of the Caspian Sea and the effectiveness of the existing legal solutions and the possibility of upgrading them within a more comprehensive and integrated framework are examined.

Study Area

Formed by the long-term geological dynamics over millions of years, the Caspian Sea (or lake) is the largest inland body of water (Efendiyeva, 2000), with abundant oil and gas resources exploited both on- and off-shore. It is also known for more than 90% of sturgeon and caviar production of the world (Jafari, 2010). The Caspian Sea possesses unique environmental features and a rich biodiversity, including 854 animal and 500 plant species. The famous sturgeon from which the valuable Caviar is obtained and the Caspian Seal (one of only two species of fresh water seal) are two examples of the precious biodiversity (Naghizadeh et al., 2016), which are flagship species for the conservation purposes in the region (Ermolin and Svolkinas, 2018).

Figure 1- The Location and Drainage Basin of the Caspian Sea



Source: (Pirooznia, et al., 2016).

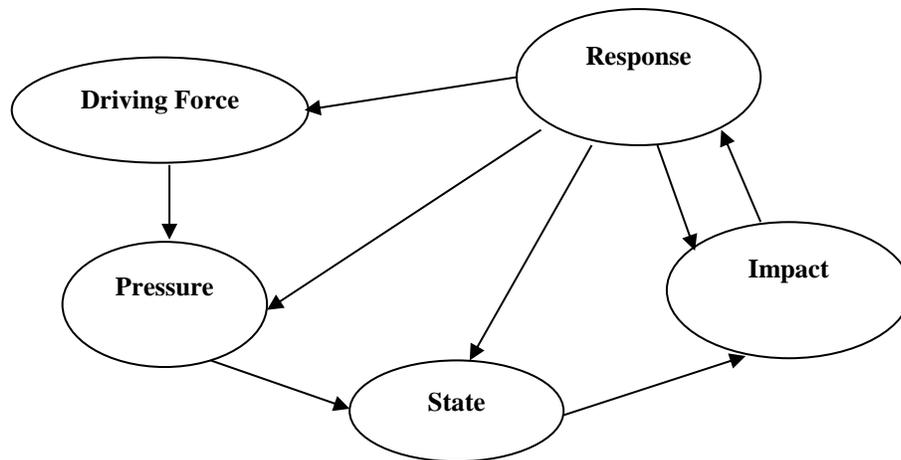
Beside the climate change, which has affected the coastlines, human factors such as dam construction, irrigation systems, as well as the establishment of various industries have affected the quantity and quality of the entering surface waters and its environmental conditions (Efendiyeva, 2000). The Caspian Sea has a vast drainage basin located between Europe and Asia, which is 3,625,000 square km in total. In addition to the five littoral countries (Azerbaijan, Iran, Kazakhstan, Russia

and Turkmenistan), the three non- littoral states of Armenia, Georgia and Turkey are located inside the basin (Refer to Figure 1).

Methodology

For a detailed analysis and assessment of the Caspian Sea's environmental situation and its causes and consequences, the DPSIR model is applied, because it is a functional framework that illustrates the cause-effect relationships associated with the environmental problems (Ness et al., 2010). It is a helpful mechanism for integrating socio-economic and natural environment in a structured manner in order to provide a rational basis for a detailed analysis (Bidone and Lacerda, 2004). Through presenting information in an organized and purposeful manner, this framework is very helpful in determining influential relations and developing an overview and understanding of an environmental problem (Ness et al., 2010).

Figure 2- The DPSIR Framework



Source: (Smeets and Weterings, 1999).

The model consists of five elements that construct a causal chain. Driving forces are mainly human related socio-economic factors that cause an environmental problem. The sequential exploitation of natural resources

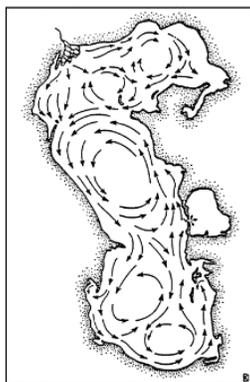
and production of wastes put pressure on the environment and as a result, the status of environmental parameters will change. These changes bring about unfavorable consequences on humans' welfare and ecosystem and will cause the society to respond in order to solve them (Svarstad et al., 2008) (See, Figure 2).

The responses may address different sections of the DPSIR framework. Those that address initial components, (i.e., driving forces and pressures) are more fundamental and long-term solutions. Those responses that address final components of this framework are short-term and temporary. It is important to note that both long-term and short-term solutions are required in order to obtain more successful, rational and sustainable strategies.

Analyzing the Environmental Issues of the Caspian Sea

With the approximate area of 371,000 km², the Caspian Sea is the largest lake of the world (Levchenko et al., 2014). The characteristic of being a non-tidal and confined body of water leads to the ability to absorb pollution less than an open ocean (Jafari, 2010), and therefore the various contaminants stay longer in the environment (Mohammadi Galangash and Ebrahimi Sirizi, 2017).

Figure 3- The Surface Currents of the Caspian Sea



Source: (Zenkevitch, 1957).

As illustrated in Figure 3, the currents of water in the southern part of the Caspian Sea are in a way that the contaminants move towards the Iranian coast. In these areas, the Caspian Sea is adjacent to various industrial installations, and agricultural lands that are constantly exposed to water erosion due to extreme exploitation, causing the high volume of pollutants to enter the rivers and ultimately pollute the sea (Mohammadi Galangash and Ebrahimi Sirizi, 2017). Other sources of contamination include the discharge of ballast water of ships, untreated industrial sewage, and offshore oil extraction (Mohammadi, 2017).

The intense exploitation of the biological resources is another serious threat which not only endangers biological life, but also the livelihood of the local people that are dependent on fishing. According to the Caspian Environmental Program (CEP), the major environmental issues of this fragile ecosystem include: decline in the commercial fish stock, threats to the biodiversity, degradation of coastal habitats and landscapes, decline in environmental quality and human health, and damage to vital coastal infrastructures.

The Volga river which is regarded as the longest river in Europe and a vital national river of Russia flows into the Caspian Sea. In fact, nearly 130 rivers provide the inflow to the Caspian Sea, and among them are the shared rivers that cross international border such as the Atrek River which flows between Iran and Turkmenistan or Kura River with is shared by Armenia, Azerbaijan, Georgia, Iran and Turkey.

An important percentage of the Caspian Sea' pollution is related to petroleum hydrocarbons (See, Table 1). These poisonous materials accumulate in the food chain and have significant environmental impacts in other places far from where they are emitted in the aquatic ecosystem. Because of the direction of water flows of the Caspian Sea, the extraction and exploitation of oil in the other littoral states have led to the presence of such hydrocarbons in Iran's Caspian coast (Shirneshan et al., 2018). Most of the sources of pollution in the Caspian Sea is related to onshore industrial activities and installations (Refer to Table 1). Therefore, industrial development without adequate and effective environmental protection and supervision is the most important cause of the problem which is rooted in the absence of an effective legal regime determined by the coastal states, which are mostly developing countries with national plans for rapid

economic growth. In addition, in the absence of a strong regional monitoring system, the coastal countries pour a large portion of their untreated domestic and industrial wastewater into the Caspian Sea.

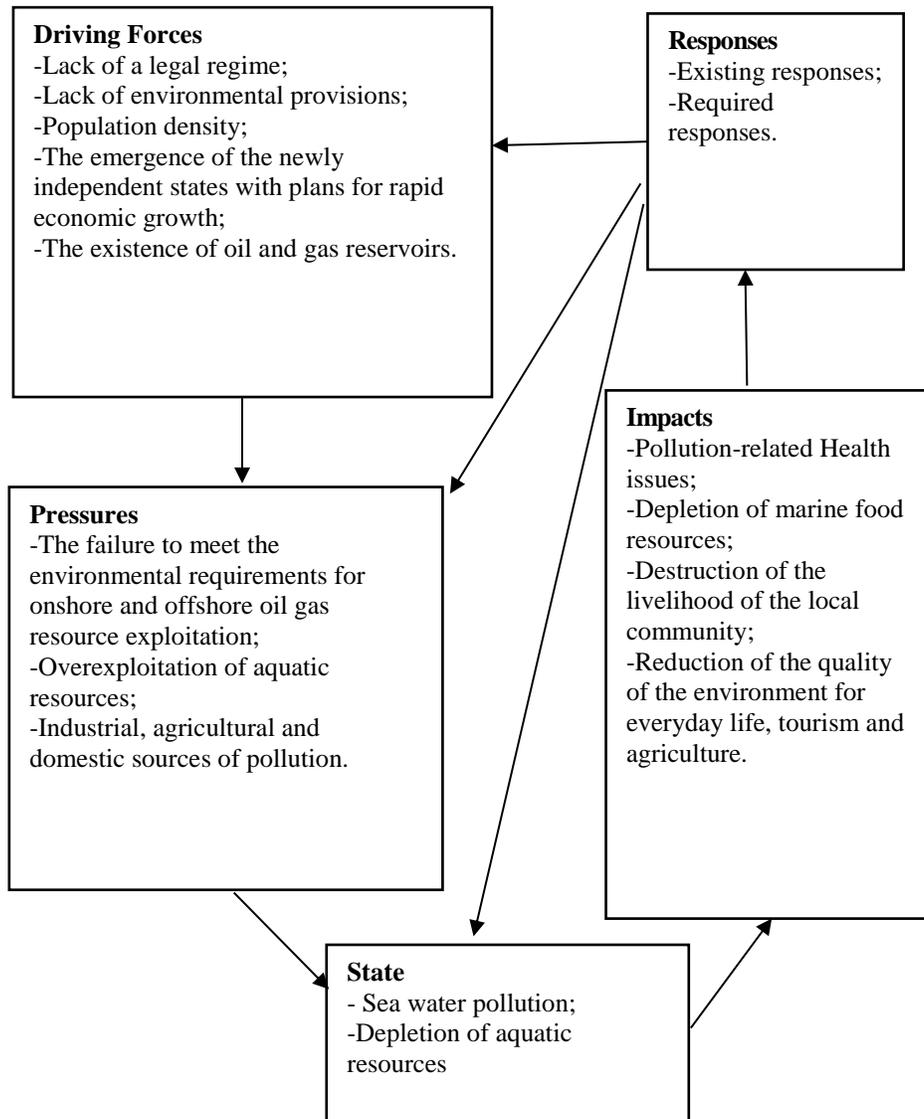
Table 1- The Littoral States' Shares of the Environmental Pollution of the Caspian Sea

<i>Country</i>	<i>Types, Sources and Shares of Pollution</i>
Russia	Around 75% of the pollution of the Caspian Sea is traced back to harmful Russian activities and facilities. Most of this pollution is caused by the land-based installations, waste water disposal from nuclear power plants and other factories. Besides, Russia annually pours more than 13 billion cubic meters of sewage through the Volga river into the Caspian Sea.
Iran	Having the largest population of about 7 million residing in the Caspian coastal cities, Iran is the second most polluting country of the Caspian Sea. The main sources of its pollution are mostly agricultural wastes and domestic wastewater.
Azerbaijan	Azerbaijan is the largest source of oil pollution in the Caspian Sea. Of the five coastal states, only Azerbaijan has not signed the 2003 Additional Protocol to the Tehran Convention. In addition, its construction of 41 artificial islands in the Caspian Sea is a serious environmental predicament. About 40 percent of the population of Azerbaijan lives in the coastal city of Baku, which contributes to the water pollution by dumping pollutants into the Sea.
Kazakhstan	Kazakhstan's largest share of pollution of the Caspian Sea is related to its oil pollution.

Source: (Zarghani and Ahmadi, 2018).

The DPSIR analysis of the causes and consequences of the environmental condition of this body of water is illustrated in Figure 4.

Figure 4- A DPSIR Analysis of the Causes and Consequences of the Environmental Condition of the Caspian Sea



The Existing Legal Responses

Although the Caspian has been called a sea since the first historical accounts in ancient times, and the littoral countries call it a sea in their respective languages, it possesses some unique characteristics that make its identity problematic (Hafeznia et al., 2016). It is an inland body of water that can only be connected to open seas through artificial canals (Zimnitskaya and von Geldern, 2011). The breakup of the Soviet Union created five riparian states and led to increased competition for resource exploitation, which has exposed them to the environmental and biological problems related to the pollutants discharged into the Caspian Sea because they remain trapped within this land-locked system (de Mora and Turner, 2004). The complex nature of the Caspian Sea has resulted in different delimitations by the coastal countries with rights to utilize its resources and has led to the buildup of inter-state tension. The Caspian Sea legal regime, which has been based on the 1921 and 1941 Soviet-Iranian treaties, has amplified the tensions between these countries over the common resources and rights (Hafeznia et al., 2016). The establishment of a new legal regime has always been a challenge, but any new legal system will only be binding if it is accepted by all five Caspian littoral states (Soufi, 2018).

To achieve an acceptable legal framework, several meetings have been held on presidential, ministerial and expert levels between the littoral states in the past two decades (Hafeznia et al., 2016). The existing Convention for the Protection of the Marine Environment of the Caspian Sea can be a positive step in accepting a more integrated agreement by the littoral states (Soufi, 2018).

However, it is difficult and complex to apply policies and instruments that require a change in ecological awareness in order to increase the efficiency of management policies in the coastal areas (Maccarrone et al., 2014). According to the 2010 *Caspian Sea State of Environment*, there are few regional governance structures that can help achieve environmental protection and sustainability in the Caspian region (See, Table 2).

Table 2- The Existing Responses at Regional Level

Legal Tools	Description
The International Commission on Aquatic Resources of the Caspian Sea (1992), signed by four littoral states;	Aimed at regulating fisheries in the Caspian Sea by defining the catch quota for commercial species and coordinating conservation activities.
The Coordinating Committee on Hydrometeorology and Pollution Monitoring of the Caspian Sea (CASPCOM) (1990s);	Aimed at dealing with environmental consequences of sea level rise and rapid economic development in the region.
The Caspian Environment Program (1998), signed by four littoral states;	With the main objective of achieving sustainable economic growth for the people of the region and protecting the environment.
The Tehran Convention (2006), signed by all five littoral states.	With four ancillary Protocols on the Conservation of Biological Diversity, Protection of the Caspian Sea against Pollution from Land-based Sources and Activities, the Protocol Concerning Regional Preparedness, Response and Cooperation in Combating Oil Pollution Incidents, and the Protocol on Environment Impact Assessment in a Transboundary Context (Tehran Convention, 2018; UNEP 2010).

The Proposed Responses

As mentioned previously, the Caspian Sea natural features of being a confined, non-tidal and large basin with transboundary rivers, and surrounded by the five littoral countries with particular socio-economic situation, have led to the complexity of its environmental problems. The main barrier to achieve sustainable development goals in the Caspian region through the existing intergovernmental agreements is that they are not internationally binding. Therefore, an integrated and comprehensive system to monitor the commitments are required; and this system must be capable of covering all aspects of the environmental problems that originate from offshore and onshore sources.

In Table 3, some responses are proposed based on the DPSIR analysis of the causes and consequences of the environmental problems of the Caspian Sea that were previously analyzed in Figure 4. It is obvious that the responses that address the beginning of the DPSIR chain (driving forces and pressures) are more effective and long-lasting. However, they are also harder to achieve and require more efforts aimed at enhancing regional cooperation between the littoral states.

Table 3- The Proposed Responses for the Environmental Problems of the Caspian Sea, based on the DPSIR Framework

DPSIR	Problems	Proposed Responses	Need for Regional Cooperation			Effectiveness		
			H	M	L	H	M	L
Driving Forces	Lack of a legal regime	Establishing a holistic and effective legal regime	✓			✓		
	Lack of environmental provisions	Developing a system for environmental provisions and monitoring		✓		✓		
	Population density in the coastal areas	National land use planning			✓	✓		
	The emergence of the new states with plans for rapid economic growth	Economic development plans based on the use of renewable and sustainable resources			✓	✓		
	The existence of oil and gas reservoirs							
Pressures	The failure to meet the environmental requirements for onshore and offshore oil gas resource exploitation	Extracting fossil reservoirs with lower environmental impacts methods and provisions.	✓			✓		
	Over exploitation of aquatic resources	Reducing the exploitation of aquatic resources	✓			✓		
		Monitoring the population of aquatic species	✓			✓		

DPSIR	Problems	Proposed Responses	Need for Regional Cooperation			Effectiveness		
			H	M	L	H	M	L
Industrial, agricultural and domestic sources of pollution	Industrial, agricultural and domestic sources of pollution	Establishing marine protected areas	✓			✓		
		Meeting environmental requirements by all industries		✓		✓		
		Reduction in the use of chemical fertilizers and pesticides in agricultural sectors		✓		✓		
		Monitoring rivers pollutions		✓				
		Conducting Strategic Environmental Assessment (SEA)		✓		✓		
		Establishing Integrated Coastal Zone Management (ICZM)		✓		✓		
		Establishing an inter-governmental Integrated Watershed Management System	✓			✓		
Stat	The Caspian Sea water pollution	Monitoring the state of water pollution		✓			✓	
	Depletion of aquatic resources	Monitoring the state of aquatic resources		✓			✓	
Impacts	Pollution-related health issues	Providing treatment facilities and medicine			✓			✓
	Depletion of marine food resources	Providing alternative food resources			✓			✓
	Destruction of the livelihood of the local community	Government's assistance for the local communities			✓			✓
	Reduction of the quality of the environment for everyday life, tourism and agriculture	Restoring the environmental quality			✓			✓

Note: H (High), M (Medium), L (Low)

Conclusion

Using the DPSIR framework, the causes and consequences of the environmental issues of the Caspian Sea was investigated; and responses that address each of the DPSIR causal chain components were proposed. One of the most urgent and highly recommended solutions is establishing a holistic and effective legal regime that respects the rights of all nations and the environment. Because of the continuing neglect of the coastal countries and the current trend of extensive exploitation of the resources and the subsequent environmental degradation, the legacy of the people of this region for their future generations will be the depleted natural resources and the dangers of the destruction of the environment

Hydrologically speaking, the Caspian Sea (lake) is located at the lowest level of a closed and large basin. This means that the impacts of any intervention inside the basin will eventually affect the whole Caspian ecosystem with different severity. Since a large portion of the water inflow of the Caspian Sea comes from the transboundary rivers, an integrated system for monitoring the state of the quality and quantity of water inflows and outflows in the Caspian region should be established between the littoral states, and also the countries that are located inside the basin.

Consequently, separated and fragmented efforts made by the littoral countries for the environmental conservation should be replaced with comprehensive, integrated and inter-governmental approaches, such as the Integrated Coastal Zone Management (ICZM), and the Integrated Watershed Management and Strategic Environmental Assessment (SEA) that can be implemented within the context of the existing regional governance structures.

Given the fact that the Caspian Sea is landlocked and considering the impossibility of purifying and diluting its pollutants through natural mechanisms, it is necessary to apply stricter environmental requirements in exploiting the region's oil and gas reserves. Also, the potential sources of risks such as its seismicity and variations in water levels make the industrial accidents more probable (Jafari, 2010). Therefore, the oil industry must recognize its responsibility to play an active role in reducing its environmental impact, by using methods and techniques that cause less pollution and pressure on the ecosystem.

Author's Statement: The author declares that she has fully observed all ethical issues including plagiarism, double publication and/or submission, redundancy, data fabrication and/or falsification, informed consent, misconduct, etc.

References

- Abdi, M. (2011) *Rejime-e hoghoghī-ye daryā -ye khazar (Legal Regime of the Caspian Sea)*. Tehran: Haghgostar Publications. Available at: <http://haghgostar.ir> (accessed 2 June 2018). (In Persian)
- Bidone, E. and L. Lacerda. (2004) "The Use of DPSIR Framework to Evaluate Sustainability in Coastal Areas; Case Study: Guanabara Bay Basin, Rio de Janeiro, Brazil," *Regional Environmental Change* 4: 5–16.
- Efendiyeva, I. (2000, December) "Ecological Problems of Oil Exploitation in the Caspian Sea Area," *Journal of Petroleum Science and Engineering* 28, 4: 227-231.
- Ermolin, I. and L. Svolkinas. (2018, January) "Assessment of the Sturgeon Catches and Seal Bycatches in an IUU Fishery in the Caspian Sea," *Marine Policy* 87: 284-290.
- Hafeznia, M., et al. (2016, July) "An Expert-based Decisionmaking Tool for Enhancing the Consensus on the Caspian Sea Legal Regime," *Journal of Eurasian Studies* 7, 2: 181-194.
- Jacob, C., et al. (2017, September) "Marine Ecosystem Restoration and Biodiversity Offset," *Ecological Engineering* (Article in press, DOI: 10.1016/j.ecoleng.2017.09.007).
- Jafari, N. (2010, February 28) "Review of Pollution Sources and Controls in Caspian Sea Region," *Journal of Ecology and the Natural Environment* 2, 2: 25-29.
- Levchenko, O., et al. (2014, September 10-14) "Contourites in the Middle Caspian Sea?," Paper Presented at 2nd Deep-Water Circulation Congress at Gent University, Ghent, Belgium.

- Maccarrone, V., et al. (2014) "The ICZM Balanced Scorecard: A Tool for Putting Integrated Coastal Zone Management into Action," *Marine Policy* 44: 321-334.
- Mohammadi Galangash, M. and Z. Ebrahimi Sirizi. (2017) "Mansha'yābī va arzya'bī-ye khatar-e (Source Identification and Risk Assessment of Polycyclic Aromatic Hydrocarbons(PAHs) in Coastal Sediment of the Caspian Sea; Guilan Province," *Journal of Mazandaran Univdersity Medical Science* 155, 27: 128-140.
- Mohammadi, M. (2017) "Alodeghī-ye faraghir dar daryā-ye khazar hidrokarbon'hā-ye chand halghe-ye aromatic dar rosobāt-e sāhelī-ye daryā-ye khazar, ostan-e gilān (The Widespread Pollution in the Caspian Sea)," *Donyā-ye- Eghtesād (The World of Economics)* 4191: 29. (In Persian)
- Monfared, H., et al. (2017) "Naghshe modiriāt-e yekpārche-ye manātegh-e sāhelī dar erteghā-ye amniyāt-e jomhourī-ye eslāmī-ye Īrān (The Aim of Integrated Coastal Zone Management (ICZM) in Enhancing the National Safety of Islamic Republic of Iran)," *Faslnāmeḥ-ye joghrāfiā: barnāmeḥ'rizi-ye mantaghe-ye (The Quarterly of Geography: Regional Planning)* 25, 1: 17-32. (In Persian)
- de Mora, S. and T. Turner. (2004) "The Caspian Sea: A Microcosm for Environmental Science and International Cooperation," *Marine Pollution Bulletin* 48: 26–29.
- Naghizadeh, A., et al. (2016) "Environmental Protection of the Caspian Sea by Establishing of Joint Development Zone and Its Effects on Regional and International Security," *Journal of Politics and Law* 9, 9: 155-161.
- Ness, B., et al. (2010) "Structuring Problems in Sustainability Science: The Multi-level DPSIR Framework," *Geoforum* 41: 479–488.
- Pirooznia, M. et al. (2016) "The Caspian Sea Tidal Modelling Using Coastal Tide Gauge Data," *Journal of Geological Research*. Available at: <https://www.hindawi.com/journals/jgr/2016/6416917> (accessed 1 June 2018).
- Shirnesan, G., et al. (2018) "Olgho-ye tozī va mansha-e hidrokarbon'hā-ye naftī dar rosobāt-e omghī-ye sāhel-e jonob-e gharbī-ye khazar, kiāshahr (Identification Distribution Pattern and Origin of Petroleum Hydrocarbons in Core Sediment of Southwest Coast of

- the Caspian Sea, Kiashahr),” *Mohit’shenasi (Journal of Environmental Studies)* 43, 4: 743-755. (In Persian)
- Smeets, E. and R. Weterings. (1999, September) “Environmental Indicators: Typology and Overview,” *European Environmental Agency (EEA) Technical Report No 25*. Copenhagen: EEA. Available at: <https://www.eea.europa.eu/publications/TEC25> (accessed 1 June 2018).
- Soufi, F. (2018) “Tahlil-e hoghogh-e daryā’hā bā neghāhi bar jāyeghāh-e Īrān dar zamīn-e beinolmelal (Analysis of International Law of the Seas by Looking at Iran's Position in International Affairs),” *Faslnāmeḥ-ye elmi-hoghoghi-ye Ghanoonyar (Scientific-Legal Journal of Ghanoonyar)* 4: 265-278. (In Persian)
- Svarstad, H., et al. (2008) “Discursive Biases of the Environmental Research Framework DPSIR,” *Land Use Policy* 25, 1: 116-125.
- Tehran Convention. (2018) *Caspian Sea Region*. Available at: <http://www.tehranconvention.org> (accessed 3 June 2018).
- The UNEP, Caspian Environment Programme. (2010) *Caspian Sea: State of the Environment*. Available at: www.tehranconvention.org/IMG/pdf/Caspian_SoE_Eng_fin.pdf (accessed 3 June 2018).
- Zarghani, S. and E. Ahmadi. (2018) “Tabyin-e jeopolitik-e zīst mohitī-ye daryā-ye khazar: barresī-ye mansha-e ālodegī va elal-e jeopolitikī-e ān (Explaining the Environmental Geopolitics of the Caspian Sea: Checking the Sources of its Contamination and Geopolitical Causes),” *Majles va Rahbord (Majles and Strategy)* 93: 5-420. (In Persian)
- Zenkevitch, L. (1957) “Caspian and Aral Seas,” in J. Hedgpeth, ed. *Treatise on Marine Ecology and Paleoecology*. Boulder, CO: Geological Society of America.
- Zimmitskaya, H. and J. von Geldern. (2011) “Is the Caspian Sea a Sea; and Why does it Matter?,” *Journal of Eurasian Studies* 2:1-14.
- Zverev, V. and I. Kostikova. (2014) “Revisiting the Possible Influence of Subsurface Water on the Caspian,” *Water Resources* 41, 7: 833-838.