BI-MONTHLY CASPIAN SEA DATASET OVERVIEW

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This is the first bi-monthly update by CASPISNET under its new arrangement with IDD to present an overview of existing data sources and databases to understand Caspian Sea level variability under the ongoing impacts of changing climate.

Overview

Inland water bodies constitute essential elements of hydrological and biogeochemical water cycles due to their inherent ability to store, retain, clean, and provide water consistently. Lakes and enclosed inland seas are integrators of environmental and climatic changes that occur within their contributing basins. The factors driving lake conditions vary widely across space and time, and lakes and enclosed inland seas, in turn, play an essential role in local and global climate regulation. As a result, lakes and enclosed inland seas are critical to our understanding of water resource availability and its link to climate change. They serve as sentinels of current and changing conditions, as actors in influencing their surrounding environments, and as integrators of human and environmental activities in their catchments.

The Caspian Sea is the largest inland freshwater basin and is thus a unique natural laboratory to study the impacts of global changes and to localize them at the regional level. At the same time, the Caspian Sea is both an at-risk ecosystem and vital component of the national economies of several of the core states belonging to the Silk Road region. This transboundary water body is shared by five countries: Azerbaijan, Iran, Kazakhstan, Russia, and Turkmenistan. Around 10 million people live along the coastal region of the Caspian Sea Basin (CSB), and over 70 million people live in its vast watershed.

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As a result, the transition that the Caspian Sea is experiencing today is multifaceted and requires a transversal, interdisciplinary, and comprehensive investigation of the local impacts of change across various natural ecosystems and socio-economic systems, in addition to their impact on urban and rural areas. In fact, the Caspian Sea is heavily affected by cyclical sea level fluctuations, which in turn are negatively impacted by natural climate variability and change. These fluctuations induce severe ecological and economic challenges for local ecosystems, communities, and infrastructure.

Observed sea level fluctuations are one of the features of the hydrological regime of the sea. This should be considered one of the main factors limiting all sorts of economic and other activities by the Caspian's riparian states.

Thus, there is a strong need to establish a reliable forecast of sea level fluctuations to reduce future economic, ecological, and other risks to a minimum. First, it is important to note that, in contrast to short-term forecasts, the percentage of self-correction in long-term forecasts is very low. This concerns both meteorological and hydrological forecasts. The reliability of any such forecast depends on the accuracy of spatial-temporal features of appropriate datasets.

One source for these datasets is the Coordinating Committee on Hydrometeorology and Pollution Monitoring of the Caspian Sea (CASPCOM). This institution was established by the five Caspian riparian countries' state hydrometeorological organizations in 1994 with the support of the World Meteorological Organization. The CASPCOM statute mandates the littoral states to coordinate, standardize, cooperate, and improve the fields of hydrometeorology and pollution monitoring of the Caspian Sea.

Initially, CASPCOM presented a monthly mean dataset of sea level data by the water gauge observation stations located within the territories of the five riparian countries. Later, other kinds of data were also included. Later still, remote sensing and model data were added. Compared with in-situ data, the model data mainly consists of data taken from all possible sources: available in-situ, remote sensing, and different equations that help to interpolate the empty paths in the investigated parameter. The datasets from the CASPCOM portal (www.caspcom.com) are sorted by catalogues into different time and spatial distribution formats. They are the following:

1. *General Catalogue of the Caspian Sea Level*. This is provided by all five riparian state hydrometeorology organizations. In total, in-situ data from 23 sea level observation stations is freely distributed on a monthly mean basis. These datasets are updated every three years.

2. *Catalogue of Regional Atmospheric Circulation*. Caspian Sea environment and ecosystem conditions depends on the character of atmospheric circulation

above its water area. This catalogue makes use of the following parameters as indicators of regional atmospheric circulation and their impact on the Caspian Sea ecosystem:

a. Wind speed mean and maximum, standard deviation, wind speed with 10 percent occurrence rate, and accordingly, with occurrence of wind speed > 5m/second.
a. Atmospheric circulation parameters mean, maximum, and minimum, the value of meridional and latitudinal gradients of atmospheric pressure, standard deviation, and the occurrence of different circulation types.
a. This section also stores data on the parameters of regional atmospheric circulation and its impact on water dynamics in the Caspian Sea with appropriate datasets evaluated by eight locations along the coast of the Caspian Sea.

2. *Sea Surface Temperature (SST)*. This has been available on the CASPCOM website since 2013. The catalogue contains data for the coastline zone of the Caspian Sea and provides the SST monthly mean for the whole observation period going back to 1961.

3. *General Catalogue of Caspian Surface Runoff*. This measures the incoming part of the Caspian Sea water balance river input. In total, 130 rivers connect to the sea, but in many cases, the impacts of most of them on the water volume of the Caspian Sea is minimal. The Volga River covers about 78-80 percent of all total water volume coming into the Caspian Sea. Previously, the Kura River provided 6 percent of the total water volume of the Caspian Sea's income water, but that number has decreased for various reasons (for more on this, see Hajar Huseynova's 8 February 2023 IDD Analytical Policy Brief titled "Reviving the Kura River Basin"). The rivers that have a powerful effect on the water balance of the Caspian Sea are the following: Volga, Kura, Terek, Ural, Sulak, Plolrood, Chaloos, Haraz, and Sefidrood. The CASPCOP website provides their monthly mean of water discharge. Additionally, some geographic information is available on this portal, which makes it easy to figure out the location of measurement points.

In addition to four types of data catalogue sets provided by CASPCOM, the website also contains several additional data materials—notably, an internet-based guide on the Caspian's hydrometeorology. This guide contains many types of scale data that provide valuable information on monitoring the sea's hydrology and also information about the data provider. The internet-based guide to hydrometeorology of the Caspian Sea provides data along the following directions:

- Forecasts
- Actual weather information
- Climatic information
- Remote sensing data
- Marine pollution information

Forecasts

Several websites provide forecasting data. The portal titled Unified Information about World Ocean Condition (ESIMO), established in Russia, is one of the main sources of forecast data for the Caspian Sea. The Hydrometeorological Center of Russia maintains ESIMO's operational module and includes marine hydrometeorological forecasts. Alongside wind and wave forecasts, it is possible to obtain other forecasts, as the portal features 5-day forecast lead times and a 12-hour run time that function on the basis of the following parameters:

- Air temperature
- Relative humidity
- Cloudiness
- Precipitation rate
- Underlying surface temperature
- Heat flux at the sea surface
- Freshwater flow at the sea surface

The data may be accessed via this link: http://hmc.meteorf.ru/sea/casp/gfs/menu.php. Data in this module is updated every 6 hours.

The second data source on forecasting given by CASPCOM also belongs to ESIMO—this operational module contains forecasts with 2-day lead times and a time interval of 1 hour. This data is available for the whole sea, or there is an option to view only the North Caspian Sea area. This operational module is available for the following parameters:

- Sea level
- Currents at 2.5-meter and 10.5-meter water level

Another source of data for short-term forecasting with a 5-day lead time and for general data on hydrometeorological and environmental features of the surface area adjacent to Kazakhstan can be found using the following link: https://www.kazhydromet.kz/meteo_db.

Daily updated data on the temperature of the sea water across the Caspian Sea can be found on the ESIMO website via the following link: (http://hmc.meteorf.ru/sea/casp/sst/sst_casp.html).

During the cold period of the year, especially the freeze-up period, Roshydromet distributes short forecasts of ice cover for the northern part of the Caspian Sea on a weekly basis. The data can be found here: http://193.7.160.230/web/esimo/casp/ice/ice_casp.php.

Climate Information

A world ocean and sea electronic atlas established by ESIMO also contains data about the Caspian Sea. This atlas includes data results collected through a long period of data

analysis from coastal in-situ observations and open sea expeditions for air temperature, wind speed and direction, water temperature and salinity, sea level, wave height and direction, among other hydrometeorological parameters. It can be accessed via this link: http://www.esimo.ru/atlas/Kasp/2_watertemp.html.

Yet another source of data on the CASPCOM website is long-term data on the air temperature and atmospheric precipitations along the coastal part of the Caspian Sea. This data can be found on the website of the North-Eurasian Climatic Centre. This entity also distributes a seasonal and annual overview of the state and trends of climate change including the Caspian region. Both can be accessed via the following link: .

Within the framework of ESIMO, a digital reference guide has been produced for the Caspian Sea that provides geographical characteristics, a description of hydrometeorological conditions and the hydrochemical regime, and an overview of marine activities and the natural resources of the sea. The link for the data: http://esimo.oceanography.ru/esp2/index/index/esp_id/2/section_id/9/menu_id/862

Remote Sensing Data

Compared to traditional in-situ observations, remote sensing data has many advantages, particularly regarding the Caspian Sea region, namely the monitoring and maintenance of continuous data collection frequency. Moreover, while in-situ stations are physically limited to a short range of cover along the coastline, remote sensing data can obtain data from the open sea, as this does not require human control. Thus, remote sensing data makes it possible to analyze the state of particular parameters on spatial and temporal scales.

The CASPCOM website provides Caspian Sea level variation maps based on satellite altimetry observations through the ESIMO portal (http://hmc.meteorf.ru/sea/casp/ssh/ssha_casp.html). Satellite altimetry is used to measure the ocean surface height, and observations have been available for the Caspian Sea going back to September 1992. More about satellite altimetry and the datasets available for Caspian Sea level monitoring will be given in subsequent reports.

The U.S. National Oceanic Atmospheric Administration provides another source of remote sensing data: https://www.nnvl.noaa.gov/view/globaldata.html. It is designed to enable the user to select the required parameter(s), capture an image, and crop the required part of the map to get the needed data in visualized form.

Datasets based on remote sensing or model-based data (in-situ, remote sensing, and models) exist in many forms and timeframes. Sources include the RADS DATA, the NASA Goddard data center, NOAA, and several others. To avoid confusion about data types and data sources, especially those related to remote sensing, we will provide additional information about this in our next report.

Finally, regarding information on marine pollution, CASPCOM relies on five partner organizations. Two of these, Kazhydromet and Roshydromet, observe environmental pollution indicators, including the pollution of the Caspian Sea as well as hydrometeorological indicators. On the basis of collected confirmed data, Kazhydromet issues an information bulletin on the state of the environment in Kazakhstan's sector of the Caspian Sea, and Roshydromet issues a *Yearbook of Marine Water Quality by Hydrochemical Parameters*. The link for the data https://www.kazhydromet.kz/en/.