COORDINATING COMMITTEE ON HYDROMETEOROLOGY AND POLLUTION MONITORING OF THE CASPIAN SEA (CASPCOM)

Information bulletin on the state of the Caspian Sea level No. 10
05 October 2015

In accordance with the data received from the national hydrometeorological organizations of the Caspian littoral states (NMHSs) and the data published in Bulletin No.36 dated 28 April 2015 issued by Hydrometeorological Center of Russia, the mean level of the Caspian Sea in 2014 fell by 12 cm as compared to 2013 and measured -27.74 m B.S[1].

According to the forecast of the Hydrometeorological Centre of Russia published in that bulletin, it was expected that the average level of the Caspian Sea in the first half of 2015 would be by 22 cm lower than in the same period of the previous year, and the seasonal increase of the mean level from January to June would make 18 cm.

The data received from the NMHSs during the preparation of this Bulletin for 22 observation posts covering all the sea coast show that the mean level [2] in the first half of 2015 fell by 18 cm as compared to the previous year (this difference ranged from 10 to 30 cm at different posts). The seasonal increase of the mean sea level from January to June measured 18 cm, which completely corresponded the forecasted data.

According to the forecast of the Hydrometeorological Centre of Russia the mean level of the Caspian Sea in 2015 will drop by 20-30 cm against 2014, as a result of the low water content in the Volga river in 2014. In fact the volume of water discharge from Volgograd HPS during the flood period (in Q2) amounted to 65.5 cubic km (60% of the normal discharge [3]), down 24% against the previous year.

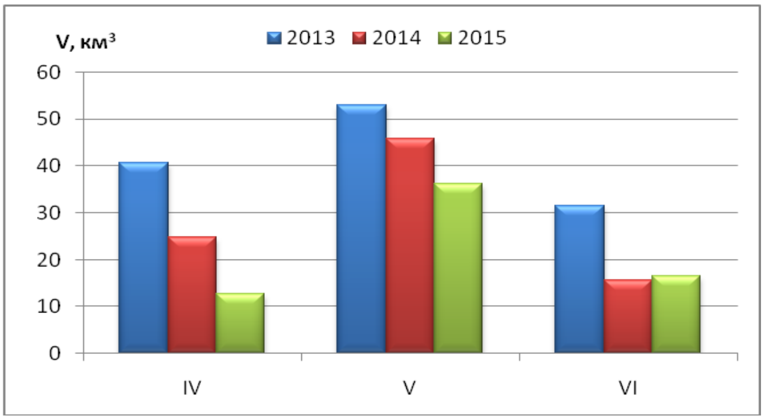

Fig. 1. Water discharges from Volgograd HPS (V, km^3) throughout April - June 2013 - 2015.

[1] To calculate the mean value of the sea level for the whole sea water area we have used observations data at "century" posts: Baku, Neft Dashlary (Oil Rocks), Makhachkala, Fort-Shevchenko, Guvlymayak (Kuuli-Mayak), Turkmenbashi (Krasnovodsk), Garabogaz (Kara-Bogaz-Gol).

[2] To calculate the mean level in this case we have used observations data at 4 "century" posts: Makhachkala, Fort-Shevchenko, Guvlymayak (Kuuli-Mayak), Turkmenbashi (Krasnovodsk)

[3] The normal value was calculated for the period 1960 - 1990.

The trend of the Caspian Sea level fall can be clearly traced starting from 2006[4]. From 2006 to 2014 the rate of sea level fall (cm per month) in the second half of the year ranged from 3-4 cm (years with normal water content) to 6-7 cm (years with low water content). In the past 3 years, the rate of the sea level fall in the second half of the year varied from 3 to 6 cm (Fig. 2).

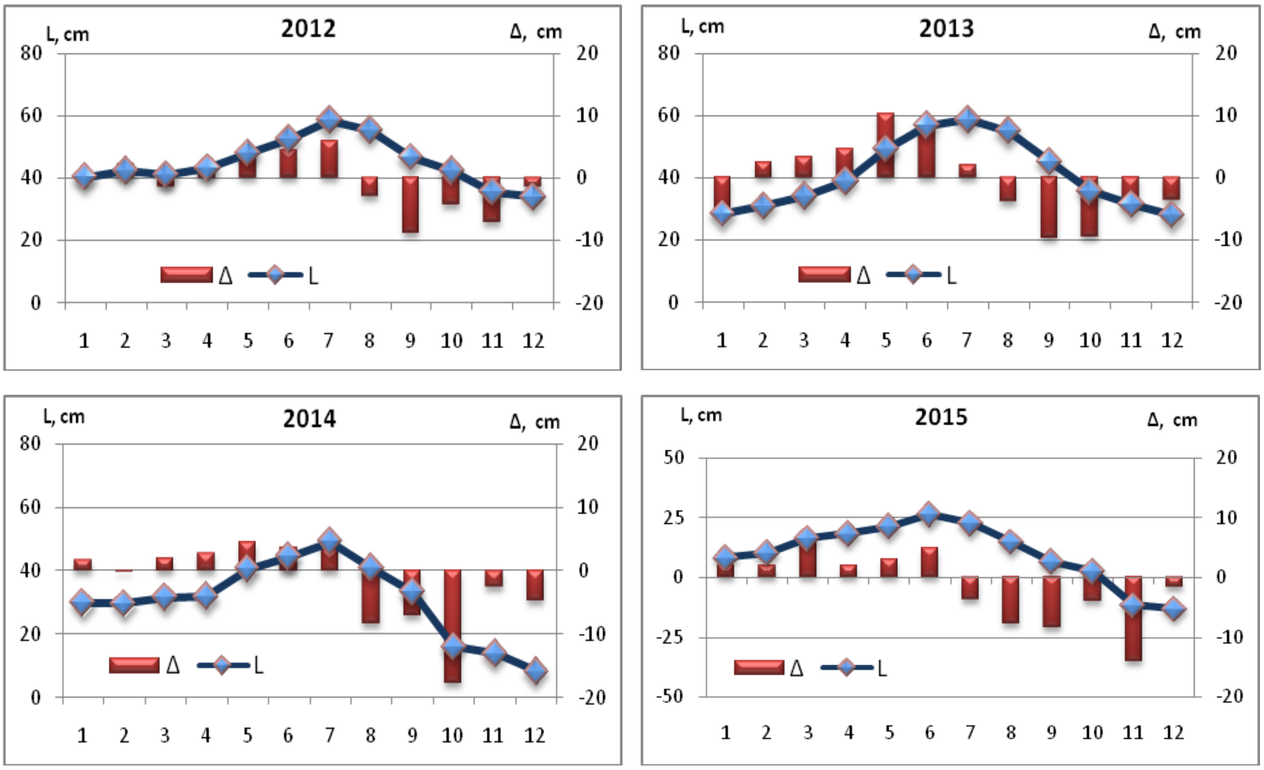

Fig.2. Seasonal changes of the mean Caspian Sea level (L, cm) and its monthly increment (Δ, cm) in 2010 -2013. The expected sea level change for the 2nd half of 2015 is predicted based on the assumption that the average rate of sea level decrease would make 7 cm a month.

If one takes into account the actual water content in the Volga river in the first half of 2015 one could suppose that the rate of seasonal sea level fall in the second half of 2015 will be higher than in 2014 and will make about 7-8 cm a month (Fig. 2). If we base upon these figures, then the mean level of the Caspian Sea in 2015 will fall by 20-25 cm as compared to the previous year and will make -27.95...-28.00 cm B.S.

This bulletin is intended for the authorities, enterprises and organizations and coastal communities as well as for all whose activities are connected with the Caspian Sea. Its preparation became possible only due to the cooperation of hydrometeorological organizations of the Caspian littoral states. The data of the General Catalogue of the Caspian Sea level elaborated under CASPCOM umbrella were used to compile the bulletin

[4] The Annex to this Bulletin gives an experimental forecast of the sea level up to 2025. The forecast is based on the analysis and modelling of the long-term temporal series given in the General Catalogue of the Caspian Sea level. In accordance with this forecast, the sea level changes will shift from being negative to positive in the nearest future.

Experimental forecast of the Caspian Sea level for the period to 2025 made on the basis of the data of CASPCOM General Catalogue

The creation of the General Catalogue of the Caspian Sea level gave new opportunities to develop methods used to forecast long-term sea level fluctuations. It can be easily demonstrated by the periodicity method which is used to predict the Caspian Sea level alongside with the physical-statistical and probability-based methods

The periodicity-based method is based on the assumption that the fluctuations of the sea level are presented as overlaid cycles of different amplitude and time (further referred to as harmonics). The method was first offered by B.Shlyamin who in 1962 predicted the sea level rise in the period from 1975 to 2032 using the combination of 4 harmonics with the periods of 11, 35, 100 and 500 years with the amplitude ratio of 1:2:4:7.

At the moment, numerous harmonics have been extracted in the long-term fluctuations of the Caspian Sea level. The accumulated experience made it possible to list the requirements for the harmonics which have the prognostic significance. These harmonics must:

- have a big contribution to the sea level variability within a time period equal to the forecast lead-time;
- have a significant occurrence in space (at different posts) and time (in different months of the year);
- have coinciding frequencies in the temporal series of the mean, minimal and maximal sea level;
- be to some extent in compliance with the river Volga discharge fluctuations.

To identify the harmonics which meet these requirements, we need the data, which only source is currently the General Catalogue of the Caspian Sea level, created by CASPCOM. The data analysis shows that if the forecast lead time does not exceed 20-25 years, these requirements are met only by the harmonics with the period of 12-13 and 17-19 years.

By means of different combinations of these harmonics we have received 6 prognostic models. By applying them to different posts (Makhachkala, Baku, Krasnovodsk and Aktau) we received the ensemble of 24 prognostic models. Alongside with this, we have identified the only one (solo) harmonic which best reproduces the actual changes of the sea level in 1996 - 2015. To draw up the Caspian Sea level forecast we have used both solo and ensemble models (mean value in the ensemble)

The results of the forecast employing 6 basic ensemble models (mean value for 4 posts) presented in Fig. 1 show that the sea level curves calculated by different models are in close fit to 2025, after that they diverge. Therefore the numerical forecast presented in Table 1 is restricted by this date.

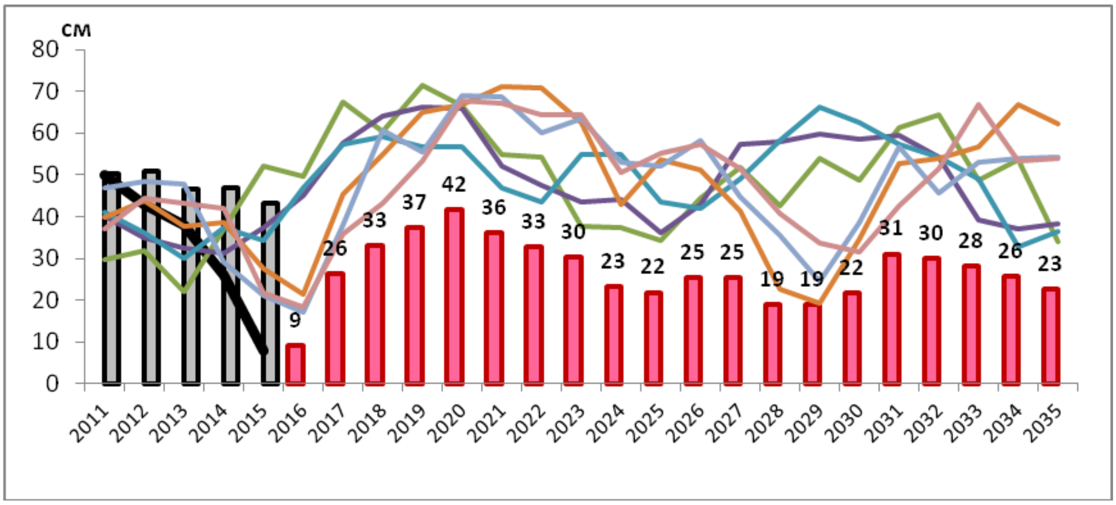

Fig. 1. Actual (black bold line) and calculated by means of a models ensemble (thin lines) sea level in 2011 - 2035. The bar chart shows the mean level for the ensemble reduced to the reference point. The reference point for 2011 - 2015 is the actual sea level in 2011, the reference point for 2016 - 2035 is the actual level in 2015.

Table 1 The forecast of the annual increment of the Caspian Sea level for 2016 - 2025 (cm)

Forecasting method	Years									
	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
Solo	-12	30	10	24	1	-5	-1	-15	-14	-2
Ensemble	1	17	7	4	5	-6	-3	-3	-7	-1

As we can see from Table 1, the sea level changes expected in accordance with the solo and ensemble forecasts in 2016-2025 coincide in some years (2017-2018, 2024-2025) and in 2019-2023 follow each other varying only in fluctuation range.

A considerable difference can be seen in 2016, where the solo forecast predicts a 12-cm level fall, while the ensemble forecast predicts sea level rise by 1 cm as compared to 2015. the identification of the flex point on a prognostic curve is a weak point of all the temporal series models. Therefore this point can shift to 2017.

After the flex point the sea level starts to rise at a fast rate (the rise rate is based on the solo forecast).

As far as the annual sea level increments are closely related to the Volga discharge, their expected values can be used as a reference point to forecast the volume of the Volga discharge. Judging by the figures given in Table 1, a high flood level in the Volga river should be expected in 2017 (± 1 year). Alongside with this, the series of low-water years which started in 2006 can be soon interrupted.