

RECORD-BREAKING SEA LEVELS IN THE NORTHERN ADRIATIC ON 1 DECEMBER 2008

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Abstract

Exceptionally strong storm surge that occurred on 1 December 2008, when record-breaking sea level was recorded in the Northern Adriatic, is analysed using sea-level data from tide gauges along the eastern Adriatic coast. The event was a result of fine tuning between the storm surge brought about by a series of synoptic atmospheric disturbances, the tide and the preexisting Adriatic basin-wide seiche, all superimposed on a significant sea level rise due to the low-frequency atmospheric disturbance related to planetary waves, whereupon the local seiche activity additionally increased the sea level.

Keywords: *Adriatic Sea, Sea Level*

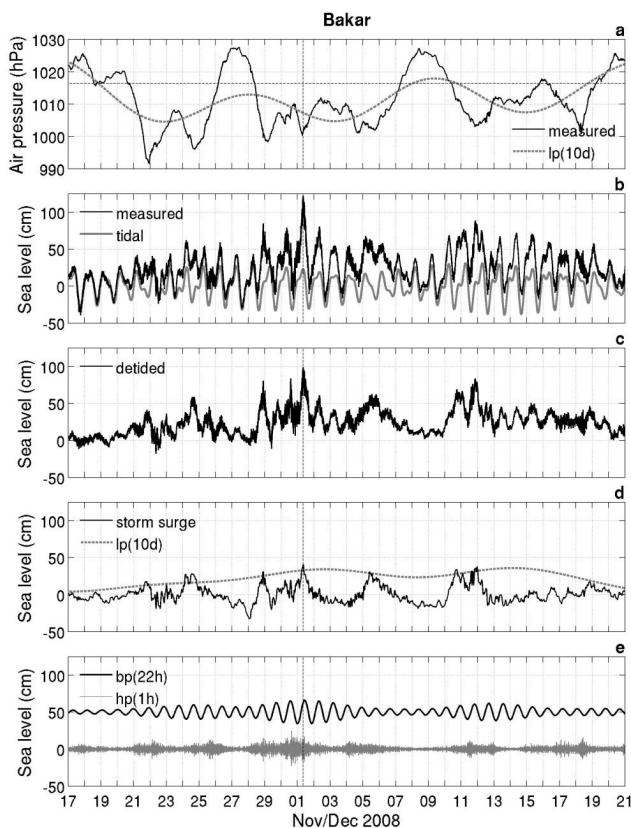


Fig. 1. The episode of exceptionally high sea level recorded at Bakar: (a) original air-pressure time series and the data low-pass filtered at 10 days; (b) the recorded time series of 1-minute sea-level data and the tidal prediction; (c) the sea level upon removal of the tidal signal; (d) the sea-level time series, low-pass filtered at 10 days and the storm-surge activity related to synoptic atmospheric disturbances; (e) sea level, band pass filtered around 22 hours, which corresponds to the principal mode of the Adriatic basin-wide seiche and high-pass filtered (at 1 hour) time series representing the local seiche activity.

During late autumn and winter the coastal area of the Northern Adriatic is occasionally exposed to extremely high sea level (*acqua alta*), which floods the towns and brings great damage to urban infrastructure. Venice is most vulnerable to this phenomenon, but other towns in the region are sometimes also severely affected. One exceptional occurrence took place on 1 December 2008. On this occasion not only the Northern Adriatic coast was flooded, but the sea level rose high above its usual values along the greater part of the Dalmatian coast north of Split. The towns of Trogir, Šibenik, Zadar, Rijeka and many other were flooded while in some harbors ships were damaged. At Bakar the sea level reached 121 cm which is absolutely the highest value recorded at the longest operating Croatian tide gauge in use since 1929, with a 10-year break around Second World War. Exceptionally high sea level was also registered on the Italian coast of the Adriatic.

In Venice the sea level reached 156 cm [1], which is the fourth highest value since 1923.

The event was well documented by tide gauges of the Croatian network of permanent stations. The network was modernized in 2003 with digital instruments and GSM modems for the data transmission, thus providing real-time data and enabling the prompt and detailed analysis of the event. The peak event occurred at Bakar at 08:15 CET, with sea level reaching 121 cm; at Rovinj the highest instantaneous sea level (95 cm) was recorded at 11:36 CET, at Zadar the maximum (83 cm) occurred at 08:39 CET, at Split it was 71 cm at 07:02, while at Dubrovnik sea level maximum was considerably lower (50 cm). The beginning of the episode can be tracked two weeks before - a large-scale air-pressure disturbance, related to passage of planetary atmospheric waves, caused sea level to slowly rise (Figure 1) thus securing preconditions for the occurrence of extreme sea levels [2]. This intensified in the next days when a series of weather fronts passed over the Adriatic, each time triggering off the Adriatic seiche. Three days prior to the peak event a very strong sirocco started to blow, piling up water in the shallow Northern Adriatic. On the morning of 1 December 2008 yet another front passed over the Adriatic - the air pressure at Bakar reached its minimum value at 07:30 CET, just shortly before the tide reached its daily maximum and the preexisting Adriatic seiche was heading towards its maximum. Hence, when the tide reached its maximum at 08:15 CET sea level at Bakar went up to its highest level since the start of the uninterrupted measurements in 1949 and also likely since the start of the tide gauge 79 years ago. This record-breaking level was a result of fine tuning between the storm surge (~40 cm) brought about by a series of synoptic atmospheric disturbances, the tide (23 cm) and the preexisting Adriatic basin-wide seiche (13 cm), all superimposed on a 33 cm sea level rise due to low-frequency atmospheric disturbance related to planetary waves, whereupon the local seiche activity within the Bakar Bay contributed with additional 10 cm.

References

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