

# Ice monitoring and forecasting practices in the Danube River Basin

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## INTRODUCTION

Within the framework of the DAREFFORT (Danube River Basin Enhanced Flood Forecasting Cooperation) project, an international initiative between the Danube River Basin countries came into being aiming to mitigate flood risk on the catchment level and support knowledge exchange and sharing of best practices within the Danube Basin. E-learning materials were delivered for educational institutes, experts of national and regional authorities and non-professionals to facilitate the knowledge exchange. In the course of this activity an overview of the ice monitoring and forecasting practices in the Danube River Basin has been carried out.

## METHODOLOGY

In the Danube Basin national hydrological services are responsible for monitoring the ice cover along the main flow of the Danube River and its navigable tributaries. Almost all countries provide information on ice to some extent.

HHFS provides river ice condition forecasts for Danube and Tisza rivers for the next 6 days every morning. The forecasting system is based on two methods, the estimated energy balance and the weighted mean temperatures method.

In Slovakia river ice is monitored but not forecasted. Monitoring is done at hydrological stations by hydrological observers once a day in the morning on working days. During the winter period ice formation and ice run are monitored by the Slovak water management enterprise, s. e. Banská Štiavnica (SWME, s. e.) on a daily basis. Type of ice phenomena and ice width are monitored and recorded. Data is stored at the Branch offices, they send information related to ice events to SWME. Every year before winter SWME performs measures on all Branch offices to ensure winter operation.

In Ukraine monitoring of ice phenomena is carried out twice a day by observers at hydrological stations. The type and intensity of ice phenomena and most importantly the presence and formation of ice jam are determined. Forecasting of ice phenomena is carried out in regional hydrometeorological centers of Ukraine for consumers, in the form of background storm warnings for the next 1-2 days. Both long-term and short-term forecasts are performed at the Ukrainian Hydrometeorological Institute (UHMI).



Fig. 1. Icebreakers in Hungary

## DISSEMINATION

In Croatia a possible ice warning, in Slovakia the ice phenomenon is available through the daily hydrological reports and in Hungary along with the current ice conditions the forecasts are also published.

Country	Ice events reports	Information provided on ice events			
		Percentage of surface covered by ice	Thickness of ice cover	Duration of ice cover	Type of ice event
Austria (Lower Austria)	No				
Bosnia and Herzegovina	Yes	x			
Bulgaria	Yes				x
Croatia	Yes		x	x	
Czech Republic	No				
Germany	Yes			x	
Hungary	Yes	x	x	x	x
Moldova	Yes		x	x	x
Romania	Yes	x	x	x	
Serbia	Yes	x	x	x	
Slovakia	Yes	x	x		x
Slovenia	No				
Ukraine	Yes	x	x	x	

In Slovenia the hydrological service does not monitor river ice cover, nor prepares ice forecast. In Bulgaria the type of ice phenomenon is reported daily in case of ice events. Croatia does not collect ice data regularly, observation is only done at hydrological stations, where an observer is available.

In Hungary monitoring and recording of ice phenomena of the main watercourses are carried out for decades by the Regional Directorates of Water Management under the direction of the General Directorate of Water Management. During winter periods the Hungarian Hydrological Forecasting Service (HHFS) receives data about river ice conditions daily from the regional directorates and other European hydrological services. River ice reports for Danube, Tisza, Drava and their tributaries are disseminated every morning. Hungary in addition also operates an icebreaker fleet, which consists of 22 ships.

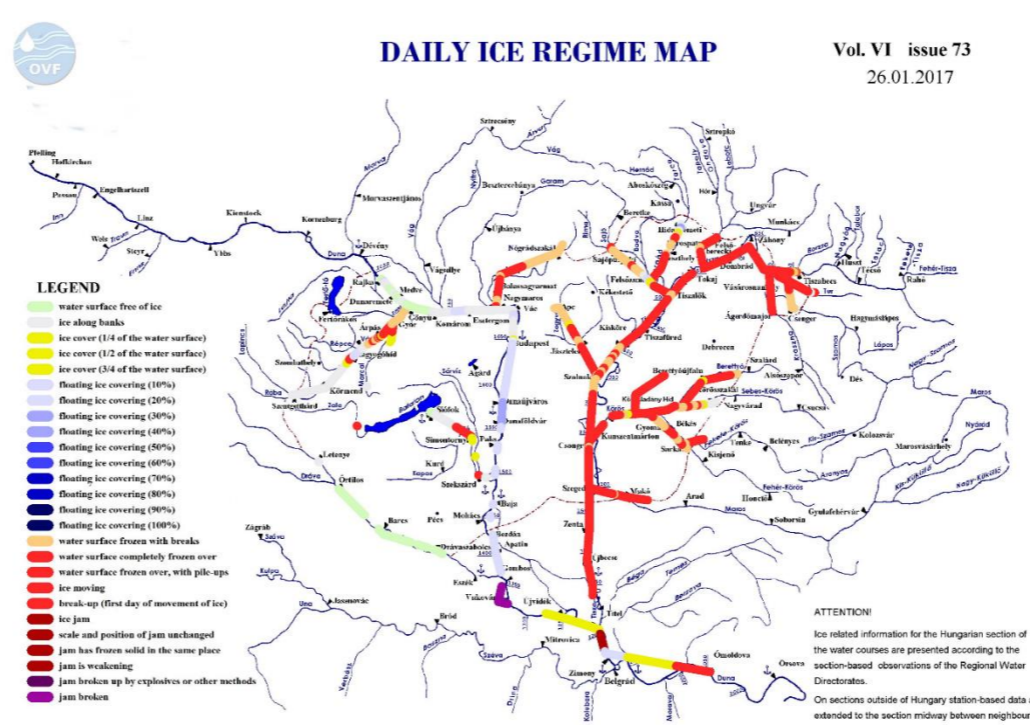


Fig. 2. Daily ice regime map disseminated by Hungary

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**FORECAST**  
ice phenomena on the Ukrainian section of the Danube in the winter of 2018-2019

According to the targeted weather forecast for the cold period, developed by the Ukrainian Meteorological Center, it is expected that in the winter of 2018-19, the average monthly air temperature in the mouth of the Danube will be 1.5-2.0 °C above normal. At the same time, short-term bays of cold air masses are expected during the winter. The appearance of primary forms of ice on the Ukrainian part of the Danube is expected in late January - early February. The total duration of the period with ice phenomena will be no more than 5-10 days.

Long-term characteristics of the ice regime on the Ukrainian part of the Danube (1987 - 2018)			
Date of the first appearance of ice			
early winter (year)	average	late (year)	
12/29 (1996)	15.01	17.02 (2003)	
Date of final ice removal			
early (year)	average	late (year)	
02.01 (1997)	08.02	13.03 (2012)	
Duration (in days) of the ice age			
minimum (year)	average	maximum (year)	
1 (2003)	8	46 (2017)	

Note: when calculating the long-term characteristics of winter without ice phenomena were not taken into account.  
The forecast was made by A. Utkin on November 21, 2018.

Fig. 3. An example for Ukrainian ice forecast

## CONCLUSION

In Croatia, Hungary, Slovakia and Ukraine monitoring of ice phenomena is based on subjective naked eye observations. Observations typically carried out once or twice a day. Complementing these small amount of in situ observed data with satellite based observations could be beneficial. Country reports also show that in the Danube basin very few amount of river ice related information is available online for the public.

## ACKNOWLEDGEMENT

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