Solutions for supplying meteorological information to inland waterways

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ABSTRACT

Data from general or other specific meteorological networks are usually not representative for waterways' local weather - especially in case of shallow fog patches of river origin, or local low-level wind-channels due to relief – because just few stations are installed by riverbanks and/or not at affected places. As a consequence, neither the weather forecasts consider these local characteristics. Although these phenomena can still be factors in casualties as found by investigations of our Transportation Safety Bureau. Another operative experience from our RIS service that skippers would require such information, furthermore, they would readily share their own reports since it is a common interest.
In this presentation, firstly, we consider these hazardous weather phenomena and their local characteristics according to our investigating experience on the lowland waterway of the Danube.
Secondly, we give more examples what kind of other weather related measurements from different branches of transportation and industry proved useful in reconstructions and can be applied operatively in prevention. We give some solutions as well where to extend them to form a weather monitoring system focusing especially on the demands of inland skippers.
Thirdly, we consider how those observations (or measurements) can be handled by RIS services which crews would give on a common interest base, and what standardisation and regulation background should be set to make it work as in the field of aviation.

Keywords: meteorological information, weather, shallow fog patches, low-level wind jet, casualties, accident investigation

Introduction – experiences from investigation of casualties

First of all, we should raise the question whether the present-day radar equipped and highly powered ships are affected by the weather on inland waterways calmer than seas, and – subsequently – whether the skippers require such information at all? The best answer may be given by accident investigations: if the weather can still be a factor in casualties – no matter in what relation and in how many cases – the answer should be yes.
The Transportation Safety Bureau of Hungary, being the competent accident investigating body on the lowland reaches of the Danube, established in 2006 by extension of the former Civil Aviation Safety Bureau with marine (and railway) departments.[1] The former organisation has had a meteorologist expert ab ovo – the author – who already joins in waterways' investigations as well for four years. According to our experiences two main weather phenomena are significant on inland waterways repeatedly – different from the seas – shallow and occasionally moving fog patches of lowland and/or water surface origin, and local low-level wind-channels due to relief and/or diurnal changes.
As a rough average, there was one casualty per year respectively relating to these phenomena when vessels collided with bridge piers or other water-crafts (pontoon, ferry, etc.), and foundering arose. (On the Hungarian reaches of the Danube only, there were three cases in fog during the period of 2006-2008[2-3], and two in high winds during 2009-2010; and we have just started retrospective weather investigation from the early 2000's, too.) Note, that their consequences cannot be foreseen – from long-period blocking of international waterway due to sinking, up to endangering water supplies of big cities situated by the Danube in case of pouring dangerous material or freight into water (luckily, there was no example of the latter in Hungary.)
According to interviews conducted during the investigations, skippers would require customised forecasts or at least near real-time in-situ information on the presence of such weather conditions on the waterway.

1. Weather phenomena related to casualties on inland waterways

1.1 Shallow and occasionally moving fog patches

We usually learn about fog that it is a calm, slowly changing element of weather, generating from surface of the ground, water, etc. Although fog patches, especially water surface or lowland origin can

have distinct edges while the ambient visibility is still perfect, visibility varies from place to place; and occasionally patches can be moved by light winds.[4] [*see Fig.1*] (The latter ones are ultra low stratus clouds indeed, forming right over the surface when that is warmer than the ambient cooling air thanks to its heat reserve.) Moreover, they usually form around sunset or sunrise when there is an inherent change in visibility anyway.
Casualties can happen with radar equipped vessels too, when there is a loss of time while switching over the habitual visual navigation to radar, and approaching an obstacle at the same time.

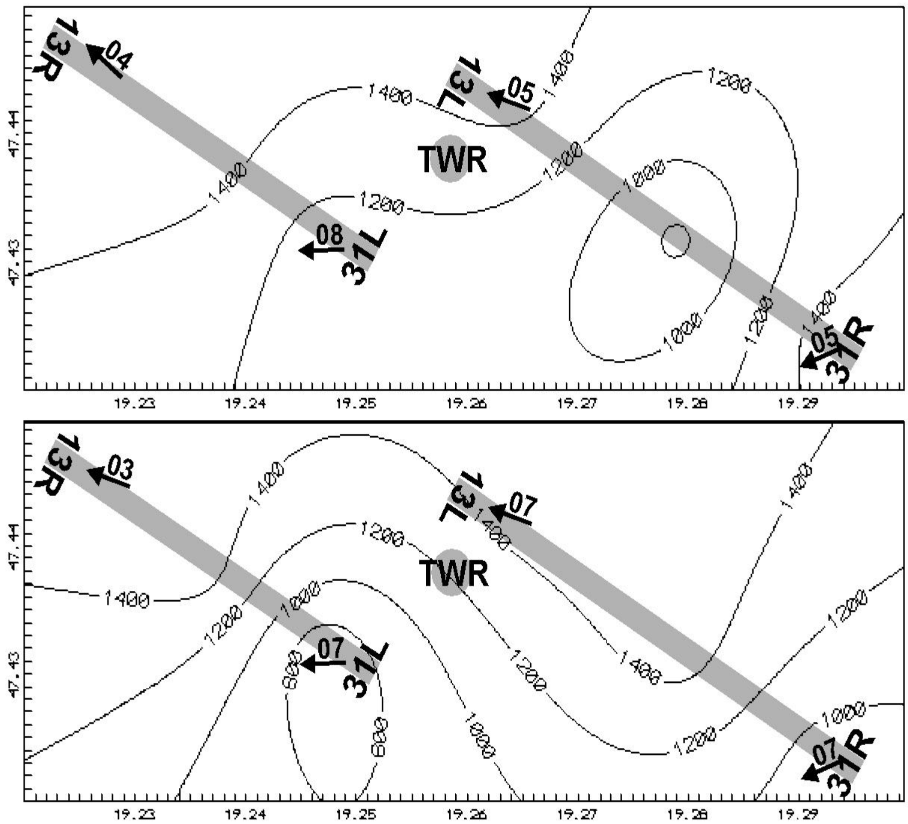

Fig. 1 Movement of a fog patch by wind
as observed by numerous visibility meters at Budapest-Ferihegy International Airport
(the lines are the analysis of visibility in metres)

1.2 Low-level wind-channels and related currents

The existence of low-level wind-channels within the Carpathians is inherent: the air can enter the basin(s) through certain passes from certain directions only, and the inner terrain drives them as well.[5]
More north-westerly wind-channels cross the north-south orientated reaches of the Danube in Hungary. However, local wind-channels or the local amplification of a bigger scale jet can arise due to small, kilometre-size, some 10-metre-high horsebacks – and there are a lot of them along the lowland reaches of the Danube too, from Dunaújváros to Mohács (roughly between 1590 and 1450 rkm). Either a lateral cut in a long riverside forest can generate a crossing wind-channel or among its bordering forests the river surface itself can induce a parallel one as well.[6]
Winds usually affect unloaded vessels (or) with big lateral surface. However, where violent wind blows and a reach of the lowland meanders falls parallel with the wind – and may form a local wind-channel as mentioned before – it can intensify the current line there, results in an indirect effect, not necessarily from the direction of the wind. A complex example of effects mentioned above recurs at Dunaföldvár and its bridge (at 1561 rkm), which is hard to navigate anyway due to its shallow river-bed and narrow meandering fairway (known as the “Danube Triangle”). In case of strong north-westerly air-advection, wind can cross the riverside horseback only laterally, beyond the bridge

(downstream), while parallel winds may intensify the current line heading to the right bank – both results in an anticlockwise turning force under the bridge. [*see Fig.2*]
A very same casualty occurred here this year, like in 2002: a more than 250 meter long, 3-by-3 formation of barges turned sideways while navigating the bridge and pushed against it, as a consequence, the barge-formation broke apart and scattered out by kilometres downstream on an international fairway.

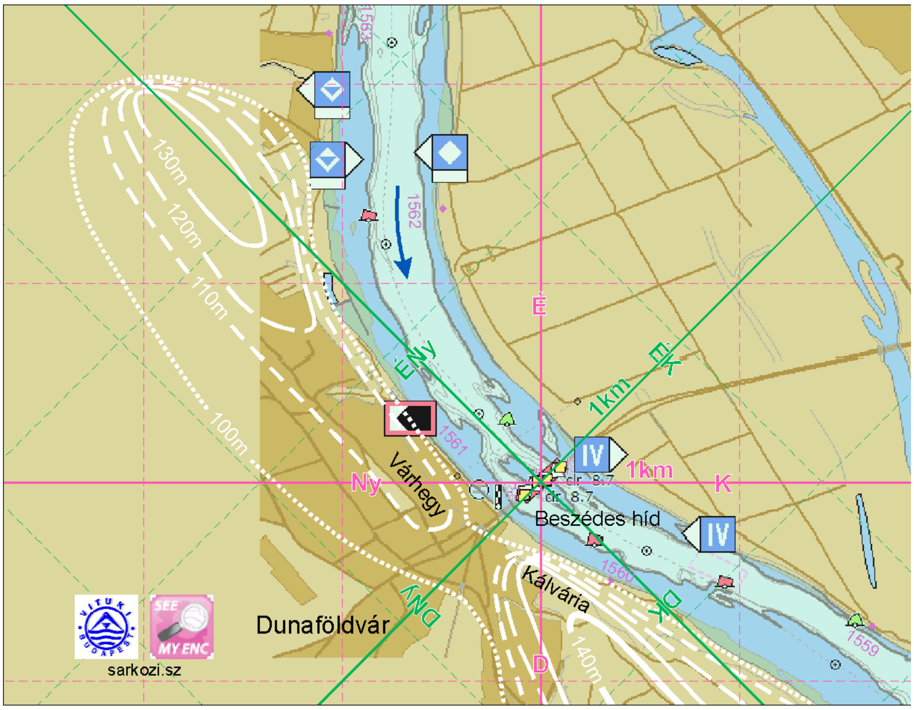

Fig. 2 Map of the Danube's fairway and riverside horseback at Dunaföldvár

2. Lack of representative weather data and customised prognosis – and its possible solutions

2.1 General national meteorological networks

The fundamental problem is providing inland waterways with proper weather information for the skippers' needs as general national meteorological services (NMSs) do not have enough stations being representative to the rivers' microclimate. E.g. in Hungary there are only three stations right at the Danube's bank, all within a 85 rkm-short reach for its 378-rkm-length (at Tát at 1729 rkm and at Budapest at 1656 and 1644 rkm), and all of them are basic automats – not reporting visibility which is one of the two essential elements from the point of marine safety as described above. (Four others near the river are more than 500 m off the bank.)[7] As a consequence, neither the forecasts can focus on rivers' local weather characteristics.

2.2 Solutions from other branches of transportation and industry

One solution may come from the roads: where modern main road bridges cross the river, there are road meteorological sensors on it – right over the waterway including winds and visibility as well. These monitoring measurements are on-line at the competent road engineerings, and can relay to a database of a prospective waterway weather system – such cooperation between two state-owned transportation branches seems obvious. In Hungary there are four such bridges over the north-south orientated reaches of the Danube (the M0 at 1660 and 1633 rkm, the M8 at 1572 rkm and the M9 at 1499 rkm), therefore in every 40 rkms on average. Visibility today is measured only on two bridges but they are currently planning to install such device onto all of them. (We use these data regularly for reconstructing weather conditions in accident investigations.) Involving older bridges for subsequent

installations – at Vámosszabadi at 1806 rkm, Komárom at 1768, Esztergom at 1719, Dunaföldvár at 1561 and Baja at 1480 – this coverage can be extended to the whole Hungarian reach with the same average resolution, not having a gap longer than 60 rkms. [*see Fig.4*]
Another important feature of low-level wind-channels is its awakening: the wind gusts arising on the surface in the morning can be measured at around 100 m height hours before. [*see Fig.3*] Therefore, measuring winds at that height has a forecasting value.[8] Masts of high-voltage lines spanned over rivers are exactly as tall as that, and in Hungary over the Danube they have a similar distribution as bridges: at ten locations, 30-40 rkms from each other on average; actually, they are usually next to bridges to be able measuring upper and surface wind as well at the same location. [*see Fig.4*] (Power suppliers can have an interest to allow wind measurements on their installations since violent winds damaged their lines more times in the recent years.)

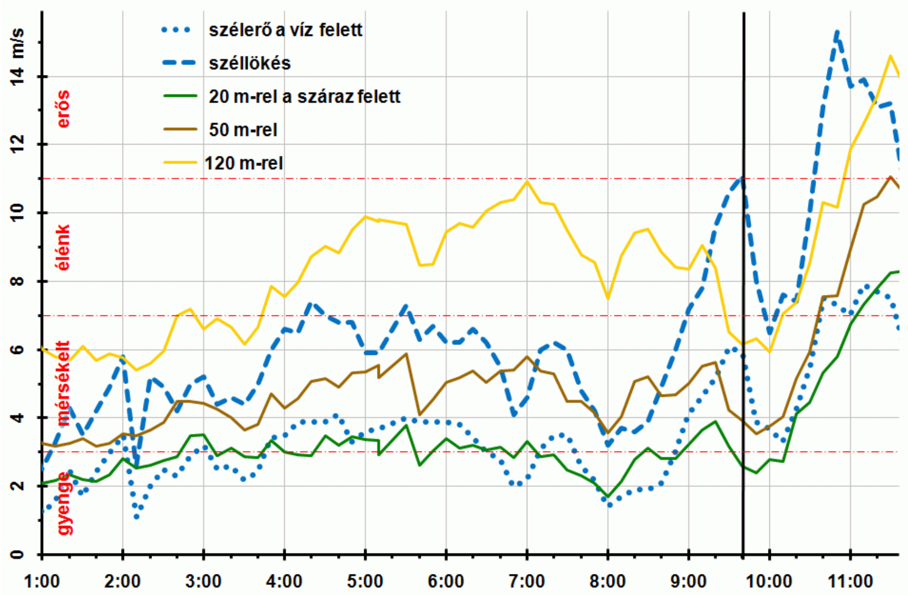

Fig. 3 Winds at the incident of 2nd January 2010 at Dunaföldvár
(green, brown and yellow lines are wind speeds measured at 20, 50 and 100 m heights respectively;
blues are the average and gusts right over the river)

Nuclear power plants (there is one in Hungary near to the Danube at 1526 rkm, 2 kms off the bank) and wind turbines also measure wind at that height – there is plenty of the latter ones by the Danube's west-east orientated reach where less bridges and high-voltage intersections are.
Other industrial sites by the river which are expected to measure meteorological parameters as well (purification plants, oil-refineries or tanks, etc.) are still to be discovered for data integration.

2.3 New installations

Installations of sensors monitoring especially waterways' weather should be considered too, since those 'artificial' locations mentioned above do not necessarily follow the natural distribution of weather phenomena. For surveying these features and to determine the locations for future operative measurements, mobile monitoring measurements of wind and visibility should be carrying out on vessels sailing the same longer passage regularly.
Considering their costs, the price of one easily fits in the budget of a RIS radio relay transmitter which are installed as close as the above mentioned facilities from each other.

3. Sharing observations and measurements on a common interest base

Our discussions with skippers concluded that they would readily share their own observations of significant weather as well or automatic measurements through RIS services in order to receive other vessels' ones. Also RIS dispatchers would happy to handle such information in order to be able answering weather related questions coming from the skippers on air, and developers as well to introduce new service products.

For establishing such a system, the following steps should be worked out:

- a simplified observation scheme of weather phenomena being significant from inland waterway point of view, which can be carried out easily by any skipper;
- reporting protocol how such data to be transmit to RIS services and broadcast to skippers, in order to avoid engaging marine radio channels and to be able to relay automatic real-time measurements as well;
- a skipper friendly visualisation of set of observations and measurements.

Remark, that such an operative system works in the field of aviation where certain weather phenomena hazardous to flights are obligatory to report in every state involved in international aviation.[9]

There are working examples among amateur meteorologists on a voluntary base as well.[10] (The idea above is actually from this methodology...) There are such observers in settlements situated on the banks of the Danube and their activity might be involved; or – conversely – officers of services by the river (dike-reeves, ferry-men, river-policemen, etc.) should join this movement, too. (Notice e.g. how ferry-men would cover the gap in the sometimes windy, sometimes foggy Danube Bend.)

Conclusions

According to accident investigations weather can be a factor in casualties on inland waterways as well. Since general meteorological networks cannot supply representative data and products customised to the skippers' needs, initiative solutions may come from other branches of state-owned transportation and industry by bilateral cooperation; and/or from voluntary activity of marine partners themselves on a common interest base.

To induce such collaborations we suggest establishments of meteorological task forces, both on regional and European levels at organisations responsible for inland waterways, for surveying local potentials and to set international guidelines and standards on the interchange and presentation of river related weather data.

For future improvement investments should be done as well into sample systems and surveying measurements, preferably by RIS providers from development funds, and by leading players of waterway market.

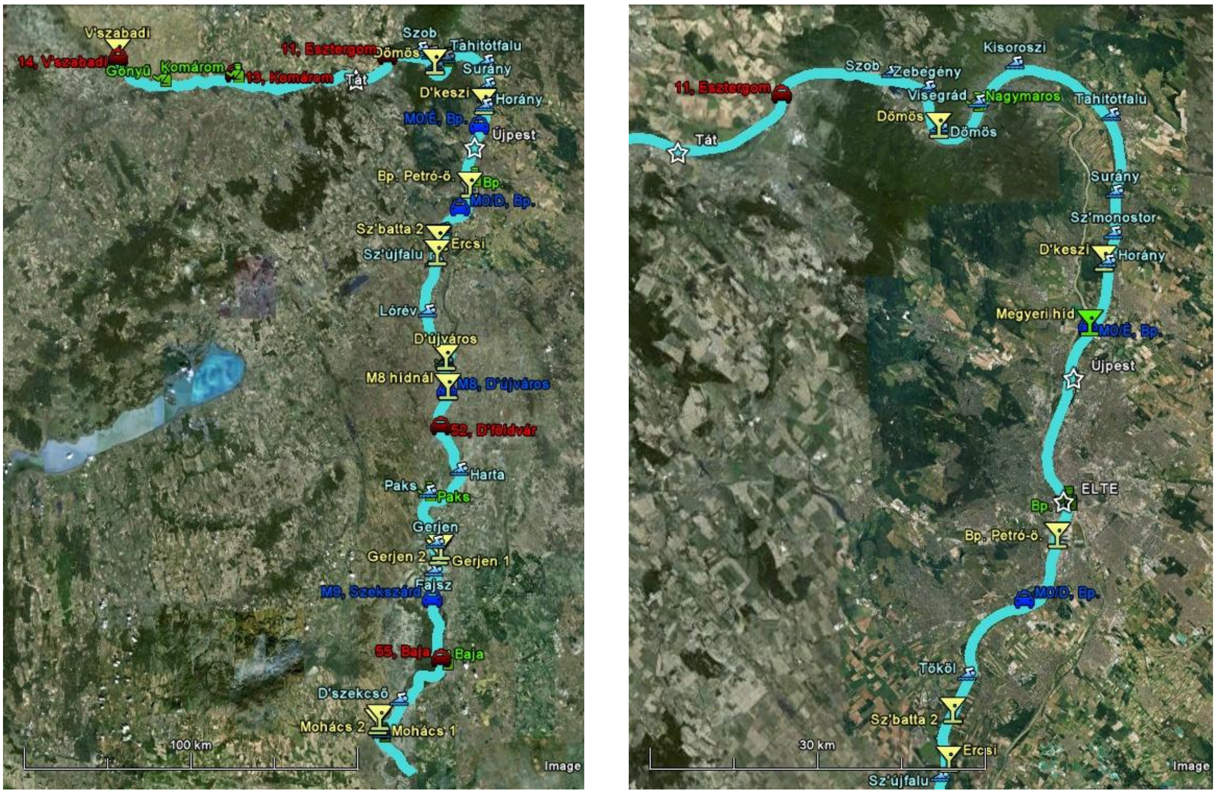

Fig. 4 Services and facilities in Hungary related to or can be involved in meteorological monitoring
(white pentagrams indicate the riverside automats of the NMS,
blue and red cars the bridges of motorways and main roads respectively,
yellow masts the high-voltage line spans,
pale blue swimmers the ferries and green policemen the river-police's stations)

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