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Updated insights into the Isonzo River (NE Italy) flow rate in the 1998-2022 period

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ABSTRACT This study investigates the seasonal and inter-annual flow rate variability of the lower course of the Isonzo River during the 1998-2022 period. Expanding upon a previous study focused on the gauging stations of Solkan (Slovenia) and Turriaco (Italy) spanning from 1998 to 2005, data of the 2006-2022 period are added and the gauging station network is broadened to include those of Gorizia, Gradisca d'Isonzo, and Pieris with data from 1998 to 2022. The investigation further incorporates Acoustic Doppler Current Profiler data from near the river mouth (2015-2022). Flow rates were calculated from hydrometric heights downstream of Solkan and were studied to provide a comprehensive spatio-temporal overview of the river flow and novel insights into flow propagation between stations. This integrated information will potentially be useful for the calibration and validation of models and could orient future research in this study area.

Key words: flow rate calculation, flow propagation time, Gulf of Trieste, rating curve, Soča River.

1. Introduction

Among the water courses that flow into the northern Adriatic Sea, the Isonzo River (Soča in Slovenian) represents the major source of freshwater and land-borne nutrients for the Gulf of Trieste (Cozzi *et al.*, 2012), giving it a pivotal role in the circulation, geomorphology, biogeochemistry, and ecological processes of the gulf. Actually, the plume of the Isonzo influences and drives the circulation of the Gulf of Trieste with its extremely-fresh water in the upper layer and it can expand up to 12 km from the river mouth during autumn (Querin *et al.*, 2006; Malačič and Petelin, 2009; Cosoli *et al.*, 2013; Lombardo *et al.*, 2025). In addition, the sedimentation pattern of the solid transport carried by the Isonzo significantly modulates the morphology of the gulf's northern sandy coast (Cozzi *et al.*, 2012). Moreover, the discharge of land-borne nutrients considerably influences the biogeochemical cycles of the Gulf of Trieste (e.g. Tamše *et al.*, 2015; Klun *et al.*, 2019), constituting its main source of dissolved and particulate heavy metals (Covelli *et al.*, 2004, 2006; Turritto *et al.*, 2018; Pavoni *et al.*, 2020). For instance, since one of the main tributaries of the Isonzo, the Idrijca, drains mercury-containing soils, the Gulf of Trieste results as one of the most mercury-contaminated coastal areas of the Mediterranean Sea (Horvat *et al.*, 1999). Besides, the river sustains the northernmost wetland of the Mediterranean Sea, a particularly sensitive and ecologically relevant environment (Stoch, 1994), and its discharge affects the productivity of the gulf (Mozetič *et al.*, 2012).

Past studies have provided assessments and estimates of the Isonzo River flow rate along its course and discharge into the gulf (e.g. Mosetti, 1983; Olivotti *et al.*, 1986; Raicich, 1994; Širca *et al.*, 1999; Zavatarelli and Pinardi, 2003; Comici and Bussani, 2007), but works with recent data are scarce. Among past studies, the work by Comici and Bussani (2007) focused on the seasonal and inter-annual variability of the Isonzo River flow in the 1998-2005 period, considering the gauging stations of Solkan (Slovenia) and Turriaco (Italy). The present paper aims at updating that work by adding data of the 2006-2022 period and extending the number of gauging stations to include those of Gorizia, Gradisca d'Isonzo, and Pieris with data from 1998 to 2022. This information is combined with Acoustic Doppler Current Profiler (ADCP) data collected near the river mouth from 2015 to 2022. The Isonzo River flow rates were calculated from hourly hydrometric height values, and enabled us to provide an overview on the spatio-temporal variability of the Isonzo River flow in the 1998-2022 period as well as to present novel insights into the flow propagation between stations downstream of the Solkan gauging station.

Considering the crucial importance that the Isonzo River's discharge plays in shaping the environmental dynamics of the Gulf of Trieste, the updated and integrated information provided in this work will be potentially useful for the calibration and validation of hydrodynamic and ecological models, and could represent a starting point for orienting future research in this study area.

2. Materials and methods

2.1. Hydro-geological setting

The Isonzo River, a transboundary watercourse, originates in the Julian Alps, in the Trenta Valley in Slovenia at 935 m above sea level (a.s.l.) and flows into the Adriatic Sea in Italy (Fig. 1). The Isonzo is 136 km long and its basin covers 3452 km^2, of which 1115 km^2 in Italian territory (Autorità di Bacino dei fiumi Isonzo, Tagliamento, Livenza, Piave, Brenta-Bacchiglione, 2004). The basin, primarily mountainous with an average elevation of 599 m a.s.l., has a characteristic Alpine flow, particularly in the upper part of the river course. The main Slovenian tributaries are the Koritnica, Idrijca, and Vipava (Vipacco in Italian) rivers, while those flowing in Italian territory are the Torre, Malina, Natisone, Judrio, and Versa rivers (Fig. 1). Similar to the other watercourses in the region (except for those fed by springs in the Friulian Lowlands), the Isonzo exhibits a torrential regime.

Geologically, the basin's northern section is dominated by permeable limestone and dolomite formations due to karstification (Gabrovec, 1995; Szeramek *et al.*, 2011), while the area around Gorizia is characterised by flysch, marly-arenaceous rocks (Carulli *et al.*, 2011). Additionally, one of the tributaries of the Isonzo River located in its eastern mountain section, i.e. the Idrijca, drains water from the Idrija mines, where cinnabar was mined since the 16th century and which ceased operations in 1996. For this reason, the Isonzo River has been shown to be a continuous point source of mercury in the Gulf of Trieste (Faganelj *et al.*, 2003; Turritto *et al.*, 2018; Autorità di Bacino di Isonzo, Tagliamento, Livenza, Piave e Brenta-Bacchiglione e Autorità di Bacino dell'Adige, 2014). In addition to this, the river flow is influenced by extensive underground water circulation, especially in the Karst areas, which results in the riverbed being made up of permeable gravelly alluvium. After merging with the Vipava River, the Isonzo traverses the Karst Plateau and continues through the alluvial plain before discharging into the northern Adriatic Sea.

2.2. Data analysis

We collected the data of five gauging stations in the terminal part of the river course (Fig. 1):

- Solkan: this station is located at the closure of the mountain basin of the Isonzo River, in close proximity to the border between Slovenia and Italy. The hydrometer is located downstream

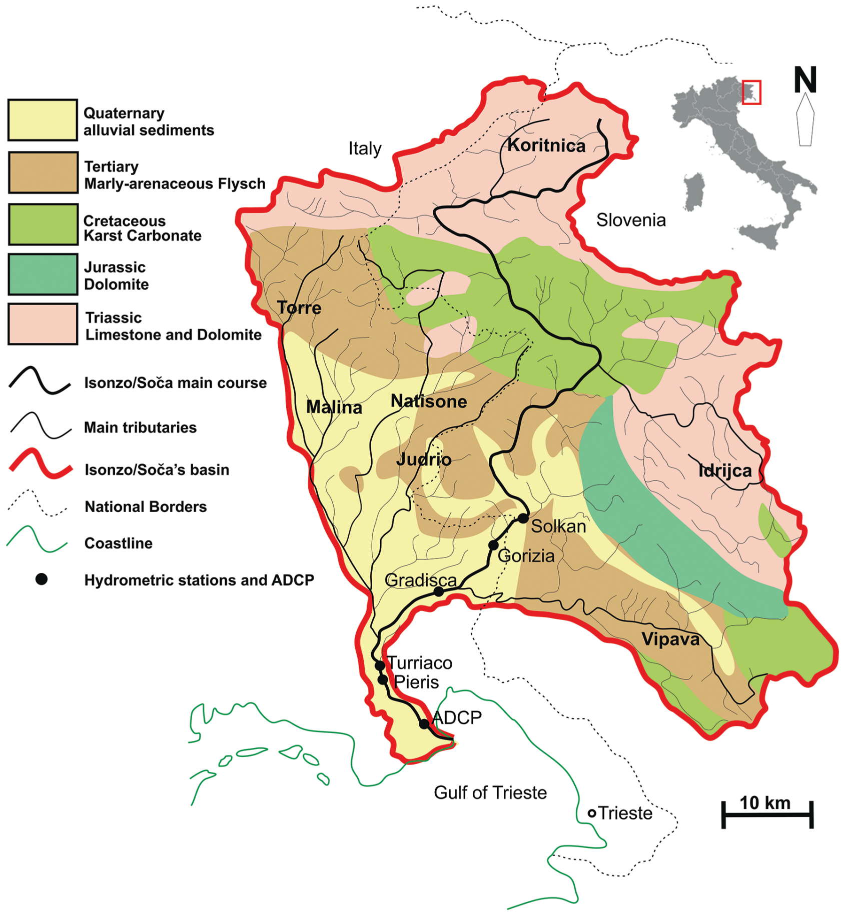

Fig. 1 - Schematic hydrogeological map of the Isonzo River basin, with the gauging and ADCP stations considered in the study [modified from Comici and Bussani (2007); schematic geological map of the Slovenian portion from Szeramek *et al.* (2011), schematic geological map of the Italian portion from Fontana *et al.* (2019)]. The hydrographic network was adapted from the EU-Hydro River Network Database 2006-2012 (vector), Europe – Shapefile (doi: 10.2909/393359a7-7ebd-4a52-80ac-1a18d5f3db9c), downloaded from https://land.copernicus.eu/en/map-viewer. The basin boundaries were adapted from those reported in Autorità di Bacino di Isonzo, Tagliamento, Livenza, Piave e Brenta-Bacchiglione e Autorità di Bacino dell'Adige (2014).

to the dam system, which was built in the 1980s for hydroelectric power production. The presence of the dams does not affect the annual average flow rates of the Isonzo River, as the water returns to the riverbed after generating hydropower (Mosetti, 1983; Comici and Bussani, 2007). Transnational regulations determine that a flow rate of 25 m^3/s should be guaranteed, although this value may oscillate between 12.5 and 120 m^3/s (Cozzarini, 2017);

- Gorizia (ARPA[1] code N021): this station is located on the Ponte di Piuma, a bridge in the northern part of the town of Gorizia. Upstream, it receives the waters of the Piumizza Torrent;
- Gradisca (ARPA code N027): this station is located on the bridge at the beginning of the town of Gradisca d'Isonzo, and upstream it receives the tributary Vipava River and two

[1] ARPA = Agenzia regionale per la protezione dell'ambiente del Friuli Venezia Giulia, i.e. the Regional Agency for Environmental Prevention and Protection

minor canals. A little downstream lies the Canale de Dottori, a catchment used for irrigation purposes;
- Turriaco (ARPA code N040): this station is located at about half a kilometre upstream the confluence with the Torre River tributary;
- Pieris (ARPA code N041): this station is located at about 1 km downstream the confluence with the Torre River tributary, at the natural end of the whole Isonzo basin, at 11 km from the mouth.

For the Slovenian gauging station of Solkan, the mean daily flow rate in the 2006-2022 period (Fig. 2) was retrieved from the Agencija Republike Slovenije Za Okolje - ARSO (i.e. the Slovenian Environmental Agency).

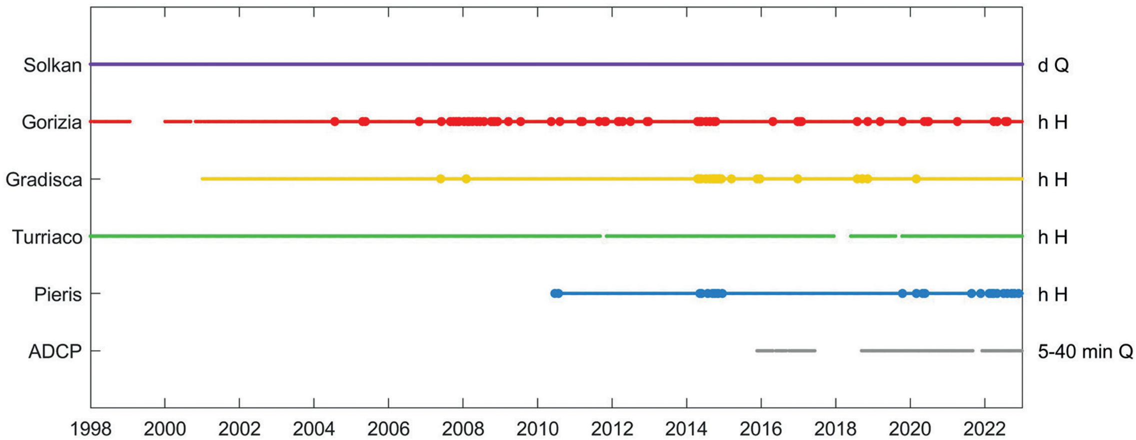

Fig. 2 - Dataset time chart. The dots over the lines represent the dates on which the Water Resource Management Service of the Friuli-Venezia Giulia Region measured the pairs of hydrometric height and flow rate for extrapolating the rating curves. On the right, the information on the temporal frequency of the data (d = daily; h = hourly; 5-40 min = every 5 to 40 minutes) and the original available variable (Q = flow rate; H = hydrometric height).

For each Italian station, the data were retrieved upon request to the Direzioni Centrali dell'Amministrazione Regionale - Direzione Centrale Difesa dell'Ambiente, Energia e Sviluppo Sostenibile - Servizio Gestione Risorse Idriche of Regione Friuli-Venezia Giulia (namely, the Central Directorates of the Regional Administration - Central Directorate for Environmental Protection, Energy, and Sustainable Development - Water Resource Management Service of the Friuli-Venezia Giulia Region). For the Turriaco station, the hourly hydrometric height in the 2006-2022 period was requested, while for the other stations data were collected from 1998 to 2022 to homogenise the dataset (Fig. 2).

In addition, we calculated the flow rates in the Italian gauging stations. For the Turriaco station, we used two rating curve formulae made available by Water Resource Management Service of the Friuli-Venezia Giulia Region: one for data before 1 May 2016 and one for data from this date on. As for the other three Italian gauging stations (Gorizia, Gradisca, and Pieris), we derived the equation of the rating curves from sporadic pairs of direct hydrometric height and flow rate measurements. The measurements were collected by the same agency in a scattered manner over a period of several years (coloured dots in Fig. 2) and included cases ranging from drought up to high-flow conditions. The rating curves were fitted by minimising the root-mean-square residuals with respect to Eq. (1):

$$Q = a(H - offset)^b \quad (1)$$

where *Q* is the flow rate, *H* the hydrometric height, and *a*, *b* and *offset* (corresponding to a cease-to-flow reference level) are the fitting parameters to be minimised (Le Coz *et al.*, 2014). This formula was, then, applied to all the available hourly data to obtain flow rate values for the various stations.

Next, the dataset was integrated with flow rate data from the 2015-2022 period, measured by the ADCP at the Isonzo River mouth (Fig. 2). This sensor (model Nortek Aquadopp Profiler 1 MHz) is located 7 km from the river mouth (Fig. 1) and lies at a mean depth of 12 m below the average river surface level. It provides flow rate, direction, and intensity data of the current, by exploiting the acoustic Doppler effect every 5 minutes. Since the ADCP is positioned on the riverbed facing upwards, it measures the flow rates throughout the entire water column. Specifically, the instrument transmits an acoustic pulse after dividing the above water column into 14 vertical cells, each 50 cm in height. For each individual cell, the flow rate - including both intensity and direction - is calculated separately. Starting from the bathymetric survey of the river section at the location of the current profiler, the flow rate is estimated by multiplying the measured current in each cell by the cross-sectional area and, then, summing the contributions from all cells. The instrument is connected via an underwater cable to a telemetry unit installed on a piling near the actual deployment site and equipped with a 4G modem for the transmission of the data to a main server. The ADCP data that are unsent due to occasional failures in modem transmission are not stored in the unit and, thus, are lost, causing different data frequencies over time (ranging from 5 to 40 minutes). Hence, the ADCP data were interpolated hourly prior to analysis. Additionally,

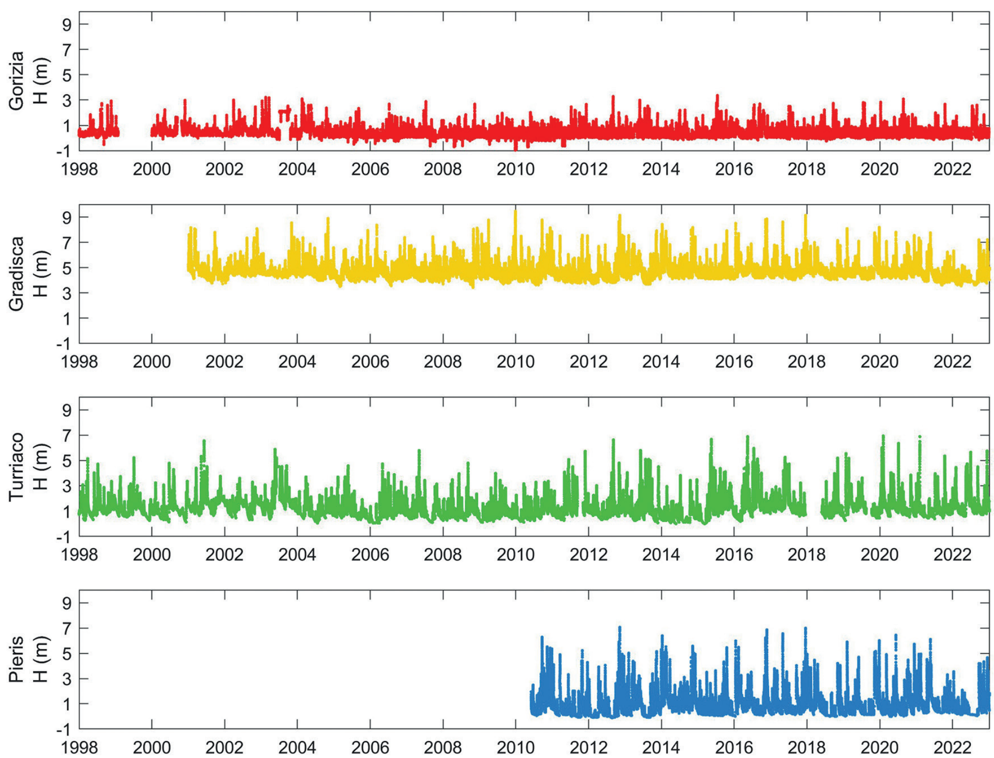

Fig. 3 - Time series of hydrometric height values recorded at Gorizia, Gradisca, Turriaco, and Pieris.

due to the torrential behaviour of the river, several floods damaged the instrument consequently causing missing data in the instrument record (Fig. 2).

Lastly, to gather all data at the same sampling frequency, the mean daily hydrometric height and flow rate were calculated from the hourly values. Days with less than 75% of data were excluded for the daily mean calculation.

Owing to the availability of hourly data for the Italian stations, it was possible to analyse the following spatial-temporal dynamics of the 1998-2022 period in detail:

1. the possible presence of daily and sub-daily signals of the Solkan dam. For each station, a spectral analysis based on a fast Fourier transform (FFT) was performed to determine the frequency content of the time series (Fleming *et al.*, 2002); hourly flow rate data of the 1998-2022 period were analysed considering seven-day non-overlapping time windows. Before the computation, the mean value was subtracted from the entire dataset and the log transformation was applied to reduce the variance. The amplitudes corresponding to the same frequencies computed for each window were, then, averaged;
2. the delay in flow propagation between the stations downstream Gorizia. The correlation between the Gorizia station and the Gradisca, Turriaco, Pieris, and ADCP stations, respectively, delaying them with one-hour steps from 0 to 24 hours, was investigated. The computations were performed after removing values lower than the 25% of the maximum flow rate value, so as to avoid lower values that could hide the signal.

Additionally, descriptive statistics of daily data (mean ± standard deviation, median, minima, maxima), aggregated by month and year for the different gauging stations, were summarised in tables and boxplots. All computations and visualisations were performed using the Matlab (version R2017b) and R (RStudio, version 4.4.1) software.

3. Results and discussion

The results of fitting the hydrometric height against flow rate data of the Gorizia, Gradisca, and Pieris gauging stations with the power function are shown in Fig. 4. The respective coefficients of the power function and the coefficient of determination of the fit (R^2) are reported in Table 1. In

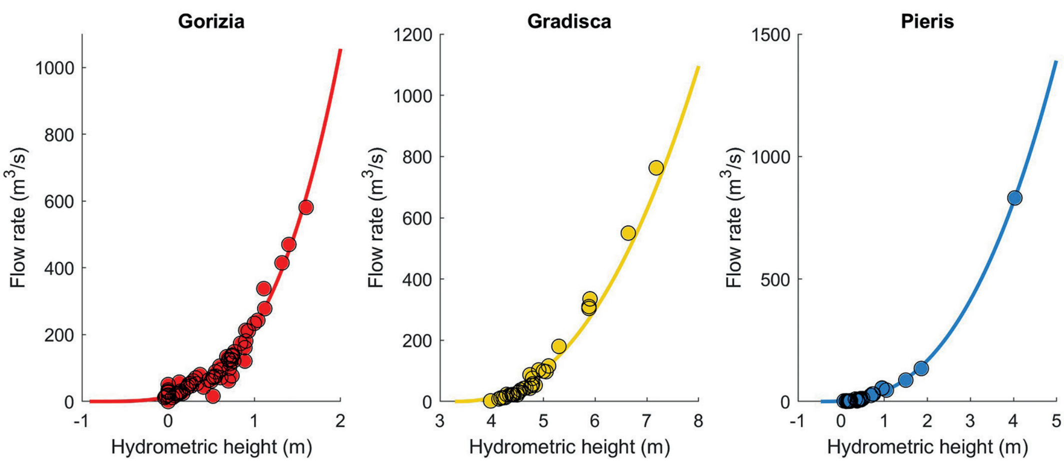

Fig. 4 - Hydrometric height and flow rate data fitted by the function $Q = a\ (H\text{-}offset)^b$ for the gauging stations of Gorizia, Gradisca, and Pieris.

all cases, the value of R^2 is very high, confirming the goodness of the fit, as much as the trustability of the obtained formula. As for the Turriaco station, the Water Resource Management Service of the Friuli-Venezia Giulia Region provided two flow rate formulae to be used with the data before and from 1 May 2016. The parameters of the flow rate formulae provided by the Water Resource Management Service of the Friuli-Venezia Giulia Region are also summarised in Table 1. The offsets determined by the fit are quite close to the minimum value of the hydrometric height recorded over the entire time series for each station (Gorizia: -1.00 m; Gradisca: 3.39 m; Pieris: -0.13 m; Fig. 3). This indicates that the available hydrometric height and flow rate pairs describe well the relationship at the minimum values (i.e. drought).

The analysis of hourly flow rate data by means of the FFT enabled the identification, for all stations, of clear peaks at 24 and 12 hours, and weaker peaks at 8 and 6 hours (Fig. 5). These peaks are most likely driven by the opening of the Solkan dam, which we can infer to occur once or twice a day, but in case of higher flows could be set to occur at shorter time intervals, i.e. every 6 or 8 hours. Besides, it could not be excluded that such peaks could also represent the harmonics of either the 24-hour signal (8 hours and 6 hours) or the 12-hour signal (6 hours). The power of the signal decreases downstream the Solkan dam. This aspect had already been

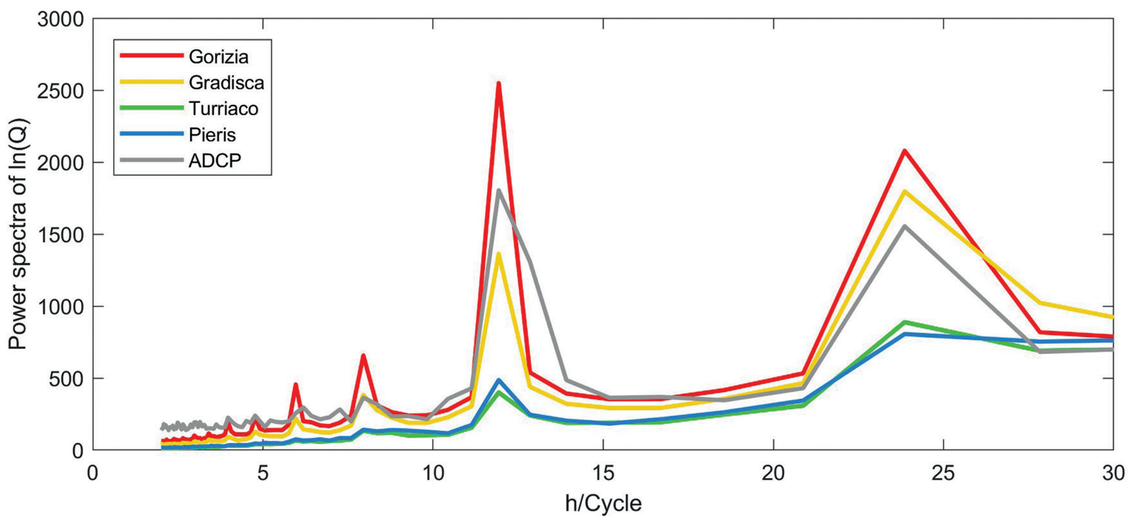

Fig. 5 - Power spectra of the natural logarithm of the flow rate data of the different gauging stations. Peaks denote frequencies that are present in, and make a significant contribution to, the signal. The *x*-axis is shown up to 30 h/cycle for better visualisation.

Table 1 - Parameters obtained from the minimisation of the residuals in the fitting of hydrometric height against flow rate data with the formula $Q = a(H\text{-}offset)^b$, with Q = flow rate, and H = hydrometric height, for the different stations. Coefficients of determination (R^2) of the fit are also reported.

Station	***a***	***b***	***offset* (*m*)**	**R^2**
Gorizia	20.4324	3.6930	-0.9109	0.96
Gradisca	29.0852	2.3415	3.2899	0.98
Turriaco (before May 1st, 2016)	31.7793	2.4697	0.00	NA
Turriaco (from May 1st, 2016)	53.8702	2.0174	0.00	NA
Pieris	15.0227	2.6677	-0.4699	1.00

reported in Comici and Bussani (2007) on the flow rate recorded at the Turriaco station, although it was not analysed in such detail. The signal at the river mouth (ADCP) again shows these peaks and is more energetic than at the gauging stations upstream, but this may be due mostly to the tidal periodicity, clearly strong in close proximity to the coastline.

The availability of hourly flow rate data also enabled the calculation of the hourly correlation between the different stations downstream of Gorizia (Fig. 6). The graph suggests that the greatest correlation occurs between Gorizia and Gradisca (87%) with a delay of 2 hours, and indicates that a hypothetical water parcel starting from Gorizia arrives in Gradisca after about 2 hours, while in Turriaco and Pieris it arrives after 4 hours, and at the river mouth after 6 hours. These times can, in a way, be assimilated to flow propagation times and are close to the upper range of the flood peak propagation times reported in SIMIS (2008) for some exceptional events (i.e. the 1998, 2000, and 2004 events). Indeed, SIMIS (2008) reports time gaps of 5 to 10 minutes between Solkan and Gorizia, 1 hour and 10 to 15 minutes between Gorizia and Gradisca, and between 45 minutes and 3 hours and 25 minutes between Gradisca and Pieris. The differences observed could be explained by the fact that the SIMIS (2008) values refer to floods, and, thus, exceptional events, while those of this study are related to the entire dataset cleared of data with values less than 25% of the maximum value.

Table 2 summarises the flow rate characteristics over the 2006-2022 period. In general, by considering the median (an indicator more robust than the mean in the case of values that do not follow a normal distribution), there is good agreement with what is expected, i.e. dissipation of the flow along the course of the river. The slightly higher value observed in Gradisca, compared to Gorizia, could be explained by the confluence of the Vipava upstream of the Gradisca gauging station. Besides, the median value at Turriaco, 49.1 m^3/s, is comparable to the 44.4 m^3/s obtained by Comici and Bussani (2007). Taking into account the mean flow rate, the value of 99.3 m^3/s at Solkan is comparable with the value reported by Širca *et al.* (1999), i.e. 94 m^3/s. Similarly, the 71.6 m^3/s estimated at the ADCP station are just slightly lower than the approximately 80-110 m^3/s presented in Olivotti *et al.* (1986). The inconsistencies observed in flow rate maxima (Table 2) are likely due to the scarce availability of pairs of hydrometric height and flow rate for calibrating the rating curves in their upper range (Figs. 2 and 4) that may often produce systematic errors in flow rate extrapolation (Le Coz *et al.*, 2014). The minima recorded at the mouth with the ADCP show negative values, typical of an area where the tide plays a crucial role and can invert the flow direction.

Figs. 7 and 8 illustrate the distribution of flow rates during the 2006-2022 period, in each station aggregated by month (left panels) and by year (right panels), while tables in Supplementary

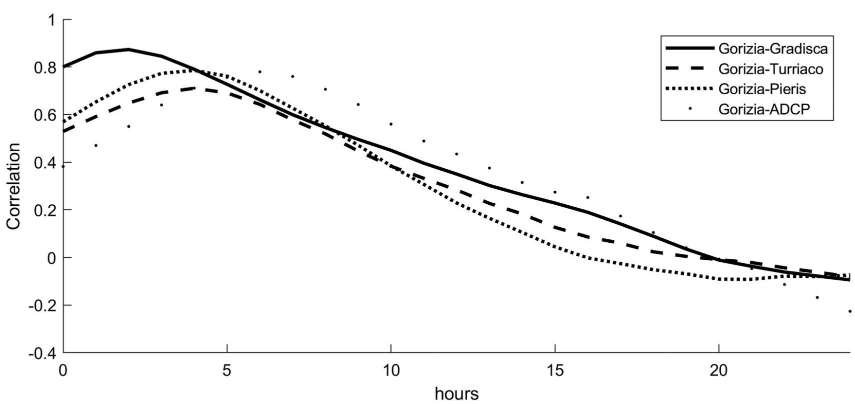

Fig. 6 - Variation of the correlation coefficient between Gorizia and the stations downstream, as a function of the time delay. The flow rate values lower than the 25% of the maximum value were discarded *a priori*.

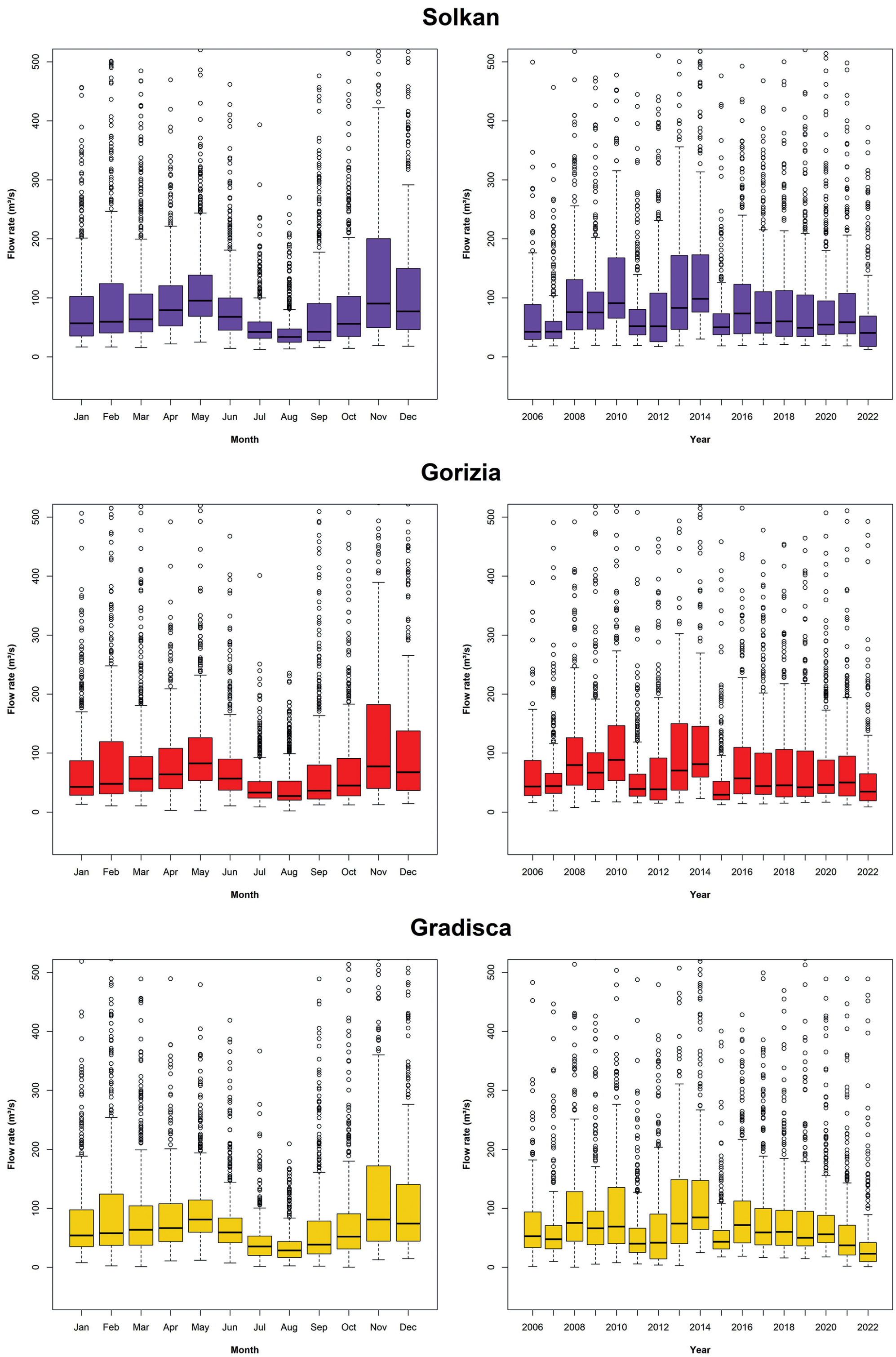

Fig. 7 - Boxplots of the flow rate at Solkan, Gorizia, and Gradisca in the 2006-2022 period, aggregated by month and year. The lower and upper boundaries of the boxes indicate the 25th and 75th percentiles, the line within the box the median, the lower and upper whiskers the 10th and 90th percentiles, and the circles the data outside the 10th and 90th percentiles. The *y*-axis is shown between -50 and 500 m^3/s for better visualisation.

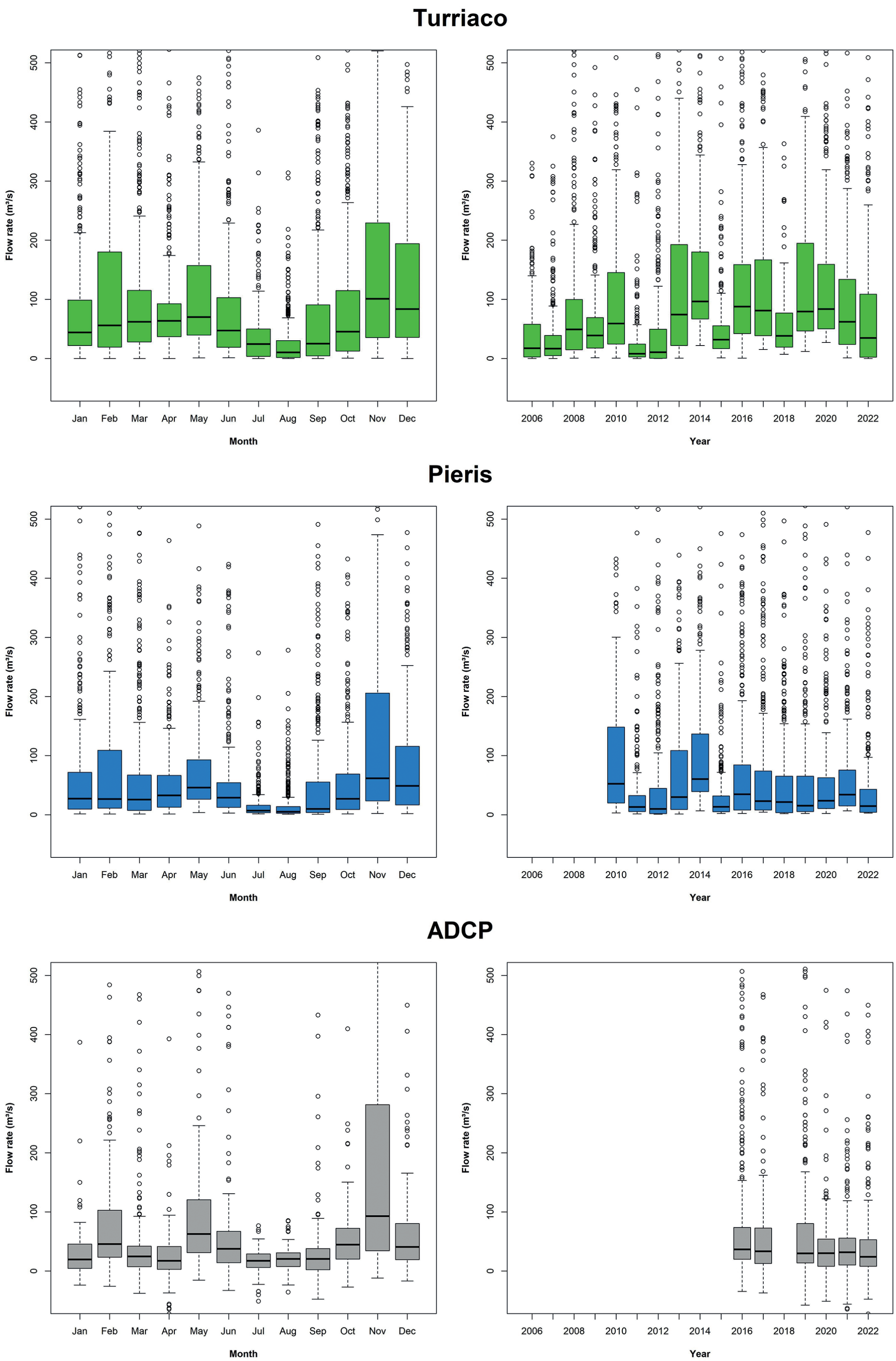

Fig. 8 - Same as Fig. 7 for the Turriaco, Pieris, and ADCP stations. The ADCP data for 2015 and 2018 are not displayed as there was too little data.

Table 2 - Minimum, median, mean, and maximum flow rate (m^3/s) in the 2006-2002 period at the various stations.

Station	Minimum (m^3/s)	Median (m^3/s)	Mean (m^3/s)	Maximum (m^3/s)
Solkan	12.8	61.3	99.3	1870.8
Gorizia	2.2	51.0	92.7	3005.5
Gradisca	0.6	55.7	88.2	1709.1
Turriaco	0.0	49.1	106.2	2782.9
Pieris	1.1	25.6	80.0	2437.9
ADCP	-72.5	30.0	71.6	2032.3

Material provide mean ± standard deviation (Tables S1-S6), median (Tables S7-S12), minimum (Tables S13-S18), and maximum values (Tables S19-S24) in the 2006-2022 or 1998-2022 periods (the period depending on the station). Without considering the absolute values, the monthly and annual values show a consistent pattern between the stations. Looking at the medians, the lowest values are observed in January and in summer, i.e. in July and especially in August (particularly for Pieris), while the maximum values are found in May and November-December. This partly confirms the well-known annual cycle which consists in two maxima (spring, autumn) and two minima (summer, winter), reflecting the Alpine sub-littoral rainfall and snowmelt regime typical of this geographical area. Besides, greater monthly variability is observed in February and November-December. By comparing these results with those of Covelli *et al.* (2004), Comici and Bussani (2007), and Cozzi *et al.* (2012), August is confirmed as the driest month, but there seems to be a slight anticipation for the other minimum (January instead of February) and a delay for the maxima (May and November-December instead of March-May and September-November).

As for the inter-annual variability, all stations except for the ADCP one show lower median values in 2006 and 2007, 2011 and 2012, 2015 and 2022, and higher median flow rates in 2010 and 2014. The years 2010 and 2013 also show greater annual variability. Turriaco and Pieris showed a greater monthly and annual variability, as reported also in Comici and Bussani (2007) for Turriaco. This considerable variability and altered flow rate balance is most likely due to the fact that the final area of the river course is characterised by a complex interplay of factors. First of all, the confluence of the Torre and Vipava tributaries introduces fluctuating flow rates based on independent precipitation patterns in their respective basins. Then, the catchment of the Canale de Dottori upstream the Turriaco station and other minor canals divert water for irrigation purposes, particularly during peak agricultural demand (Autorità di Bacino di Isonzo, Tagliamento, Livenza, Piave e Brenta-Bacchiglione e Autorità di Bacino dell'Adige, 2014). Besides, during low flow periods, the river can appear dry because the water percolates in the highly permeable gravel that characterises the area around Turriaco and Pieris. Finally, the spring line, which is also located in the area, can add spring water to the river in Pieris.

The observed intra- and inter-annual variability is pronounced and is due to the fact that the Isonzo has a torrential regime, with significant flow fluctuations (long periods of low-medium discharge and short peaks of intense river flow coupled with high suspended sediment load) primarily driven by rainfall in its upper course (Covelli *et al.*, 2004; Comici and Bussani, 2007; Cozzi *et al.*, 2012). Indeed, in the upper portion of the Isonzo basin, characterised by climate conditions ranging from Alpine to sub-Mediterranean (Cegnar, 1996; Ogrin, 1998), the total annual precipitation can vary from 1200 mm up to 3500 mm (Koblencen and Pristov, 1998; Janža, 2013), thus introducing large variations in the flow rate of the river.

As for the ADCP, data were available for fewer years than in the other stations. Nonetheless, it is possible to notice that, although flow rate values are quite similar between 2016 and 2022 (2015 and 2018 are not shown because of too little data), the median flow rate is slightly lower in 2022 compared to the other years, as noticeable for the other gauging stations. Additionally, in all cases, negative values are present in the boxplots: this is the signal of seawater entering the river. Actually, the upstream movement of seawater, opposite to the river flow, contributes negatively to the overall flow rate calculation, resulting in these negative values, as also highlighted in Table 2.

4. Conclusions

Building on Comici and Bussani (2007), this paper addresses the knowledge gap regarding recent Isonzo River flow rates (2006-2022) in its lower course and presents detailed flow rate information (1998-2022), incorporating previously unanalysed gauging stations.

This work compiles all available open-access flow rate and hydrometric height data for the final section of the river, and highlights the importance of manipulating such data to derive scientifically-sound information. Official rating curve formulae were, in fact, available only for Turriaco and, moreover, they had not been regularly verified and updated. The flow rate was calculated using hydrometric height-flow rate pairs for the regression via rating curve, but, notably, the limited availability of pairs and the need to establish site-specific formulae required a significant effort. The dynamic riverbed conditions [e.g. accumulation of debris and sediment or scour over time, growth or accumulation of seasonal vegetation, variation in downstream boundary conditions, hysteresis due to the effects of unsteady flow (World Meteorological Organization, 2010)], combined with the river network complexity (catchments, tributaries, geology), account for inconsistencies in the flow rate decrease towards the mouth. However, still recognising the inherent and largely variable uncertainties in flow rate estimations, mostly given by the scarcity of direct measurements at extremely high or low discharge, this study represents a significant starting point for the calibration of hydrological and ecological models of the Isonzo River basin and the Gulf of Trieste, fostering integrated overview across Slovenian and Italian territories, an often challenging task in the case of transboundary watercourses.

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Additional electronic material: Tables with the mean ± standard deviation, median, minimum, and maximum values of flow rate in the 2006-2022 or 1998-2022 periods (depending on the station) are available at the BGO webpage.

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