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Meteorological determinants of bicycle traffic volume in Toruń

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Abstract. This paper presents the results of research on the correlation between bicycle traffic volume (number of bicycles per day detected by counters) in Toruń and a selection of meteorological elements. The analysis covered the years 2019–2021 and the data was sourced from the Municipal Roads Authority in Toruń and meteomodel.pl. Using IBM SPSS Statistics, models were developed to illustrate the influence of weather conditions on bicycle traffic volume in different periods of the year. The volume of bicycle traffic in Toruń was lowest in January (on average N=709 bikes recorded per day) and highest in July (N=4533). The period from June until September, during which the number of recorded bicycle passes was more than 2.5 times greater than in the remaining months of the year, was referred to as the 'high season'. Amongst the analysed variables the strongest determinant of bicycle traffic was decidedly air temperature. However, in individual months, especially in summer, other weather elements also played a major part in affecting the so-called apparent temperature. This allowed for the identification of the weather-related preferences of cyclists in such months.

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1. Introduction

The bicycle is gaining in popularity as a means of transport all over the world; it offers a sustainable and cheap mobility solution. The advantages of this means of transport are particularly relevant in urban areas, because bicycles emit no pollution, take up little space, reduce traffic density and are good for health (Sośnicki, 2012; Yan et al., 2019). Regular cycling reduces the risk of developing chronic diseases, improves cardiorespiratory fitness and prevents obesity and other lifestyle diseases (Oja et al., 2011; Posłuszny, 2011). It is also beneficial for mental health and well-being and supports the treatment of depression (Garrard et al., 2012). Cycling is also a free-time activity, and cycling tourism makes for both good entertainment and adventure, while improving orientation and enriching the knowledge and skills of the participants (Kurek, 2007). Besides being a leisure activity, cycling is also used to commute to work. In recent years, electric bikes have emerged, but large numbers of people remain unconvinced by this form of transport for various reasons.

In principle, cycling is an activity for good weather, especially in the case of leisure rides. Good weather is usually perceived as such if it is sunny with few clouds, no precipitation and the temperature is above 5°C (Brandenburg et al., 2007; Sabir, 2011). Cyclists, as road users, are more susceptible to weather than, for example, drivers, so the decision to ride a bike depends on observed or predicted weather conditions.

Air temperature, precipitation, insolation, cloud cover, air humidity and wind strength all have significant influences on bicycle use, but the influence varies in different groups of cyclists depending on their motivation to ride, experience, age and sex. For example, the cycling activity of women and young persons is more sensitive to weather conditions than that of men (Noland & Ishaque, 2006; Saneinejad et al., 2012; Ahmed et al., 2013; Gebhart & Noland, 2014; An et al., 2019). More than half of cyclists consider weather outlooks when deciding to use this means of transport (Gallop et al., 2012). Survey results show that weather conditions largely determine bicycle traffic volumes and their importance can even reach 80% (Thomas et al., 2013).

This paper undertakes to determine the relationship between meteorological conditions and bicycle traffic volume in Toruń with the following research objectives:

- Establishing general determinants of bicycle traffic volume in Toruń and identifying the so-called ‘bike season’
- Developing models and analysing the correlation between daily volume of bicycle traffic and selected weather parameters, as well as defining reference weather conditions for the highest bicycle traffic volume
- Identifying the weather preferences of cyclists in different periods of the year, on weekdays (commuting), weekends and public holidays (leisure use)

2. Research area

Toruń is one of two capitals of the Kujawsko-Pomorskie province. The city is situated on the River Vistula in the Toruń Basin and is partially surrounded by forest areas. With a population of 197,812 it is the sixteenth city in Poland in terms of number of residents (as at 30 June 2021). The area of the city is 115.75 km^2. Toruń is a major economic and business centre, as well as an important road and railway junction. As a result of restructuring and transformation, the city has limited its industrial function and developed higher-tier services, such as higher education, culture and tourism. The location of Toruń in proximity to Bydgoszcz (45 km) and Włocławek (56 km) affects the development of a functional urban region (Hołowiecka & Szymańska, 2008). The city’s most iconic symbols include primarily gingerbread and Nicolaus Copernicus.

Residents of Toruń are increasingly willing to shift from cars to bicycles. In the city, according to the data contained in a report of Stowarzyszenie Rowerowy Toruń (Cycling Toruń Association), there are about 130 km of designated bike routes. The cycling infrastructure, which varies in standards, comprises bike paths, multi-use paths, bike lanes and contraflow bike lanes. It also includes bike racks, stands, shelters and self-service repair stations. Their number is hard to establish, as they are provided by city authorities and private entities alike. The number of bicycle parking spaces can be estimated at 5,000–6,000 (Jaroszyńska, 2020). Since April 2014 (with a break in 2018), both residents and tourists can use a bike-sharing scheme called Toruński Rower Miejski Torvelo. It is an automated system of public bike rental offering 400 bikes and 40 stations (as at 14.02.2022) located in different parts of the city to enable users to get around quickly and efficiently. Bicycle-sharing systems are an essential element of sustainable urban mobility in the 21st century. They were conceived mainly to improve city transport in congested conurbation centres. Over time, the authorities have adopted this solution for the whole city and have extended its geographical reach (Kwiatkowski & Szymańska, 2020; Kwiatkowski, 2021a; 2021b). In Toruń, there are also bicycle counting stations, the issue being addressed further in the article.

3. Materials and methods

In this article, the meteorological determinants of bicycle traffic volume in Toruń have been established on the basis of 24-hour data for the years 2019–2022.

3.1. Materials

The information on bicycle traffic was sourced from bicycle counting stations of the Municipal Roads Authority in Toruń. There are five such counting stations in Toruń, and their location is shown in Figure 1.

The device that measures bicycle traffic is embedded in the bike path and uses the principle of electromagnetic induction. In a few places there are also displays showing daily and annual counts in the location (Fig. 2).

It should be pointed out that, due to the method of measurement applied, the counter does not differentiate between bikes, e-bikes and electric scooters, and it might not detect a bike that is not made of metal. Therefore, the traffic recorded by the counters actually reflects only a portion of the total traffic volume in the bike paths, and it includes other personal transportation devices as well.

Problems encountered at the initial selection of data from the above-mentioned counting stations were connected with breakdowns. Most often, these were caused by power failures. On days when at least one of the five counters was out of order, the total bicycle traffic volume was burdened with an error. This applied to about 16 per cent of all daily data sets. Thus, in order to obtain comparable results for individual months, it was decided to use – instead of the total number of all records – the parameter N (bicycle passes/24 h), which represents a mean monthly traffic volume calculated for each month as the arithmetic mean only of days when all the counters were fully operational.

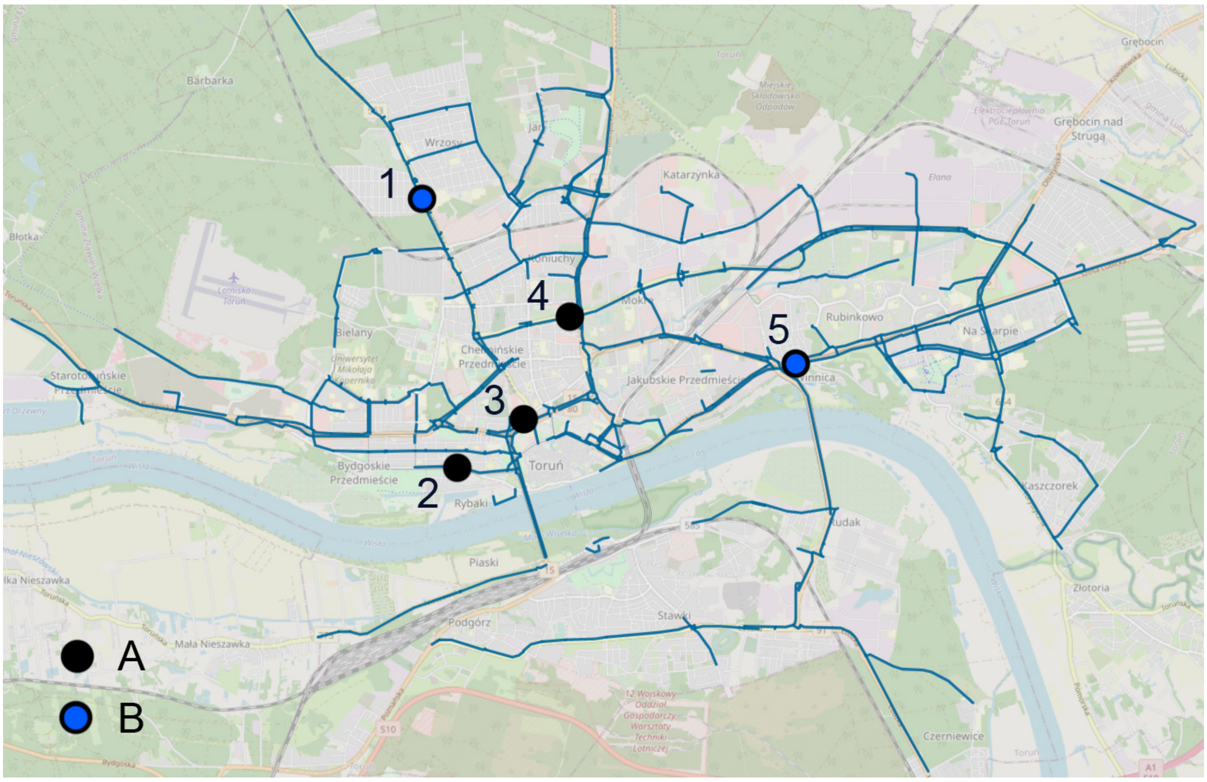

Fig. 1. Bike paths in Toruń and the location of traffic volume counting points
Explanation: A – counter, B – counter and display. 1 – Chełmińska Street, 2 – Bydgoska Street, 3 – NOT Square, 4 – Northern Thoroughfare, 5 – Daszyńskiego Square
Source: https://torun.onthe.bike/ accessed: 14.03.2022, revised

Fig. 2. Counter at the Northern Thoroughfare (A) and the counter display unit on Chełmińska Street (B)
Source: photo B. Pawłowski

The data concerning meteorological elements was taken from the online weather service Meteomodel.pl (https://meteomodel.pl/ accessed: 15.03.2022). Ultimately, the following parameters were selected:

- Temperature (T_{max}, °C) – in this case it was decided to use the maximum diurnal value, assuming that most bicycle traffic occurs during the day,
- Mean diurnal wind speed (W, m/s),
- Precipitation total (P, mm) – only data concerning precipitation during the day was used, ignoring nocturnal precipitation,
- Insolation (I, h), acknowledging the fact that maximum possible diurnal insolation is much greater in summer months than in winter. Therefore, the value of this parameter included seasonal changes in length of day,
- Snow cover thickness (S, cm).

3.2. Methods

The main part of the analysis was done using PS IMAGO PRO, which is a part of the IBM SPSS Statistics software package, which is licensed for use by the academic staff and students of the Nicolaus Copernicus University (UMK). The tool uses multiple linear regression to create models for evaluating relationships between a target variable and independent variables, perhaps removing those found to be irrelevant (backward elimination method). What we obtain are predicted values and their comparison with the actual value (data strings called 'residuals') and all information about the models created by the program, comprising:

- the value of the coefficient of correlation/determination of a given goodness of fit,
- information on which parameters were used in each case, and which were rejected as not statistically significant, in order to develop an optimum model,
- values of the coefficients for independent variables, allowing for a presentation of the model in the form of a mathematical equation.

In total, as many as 18 such models were created, including models for the entire period of three years, models for the high and low seasons and for off-season periods, 12 models for individual months, and separate models presenting determinants of bicycle traffic volume on weekdays and at weekends.

4. Results

4.1. Seasonality of bicycle traffic

Bicycle traffic in Toruń is clearly seasonal. By far the highest traffic volume is recorded in the summer months, and it is four times as high as in winter (Fig. 3). Its minimum in each year of the analysed period was observed in January. Maximum values

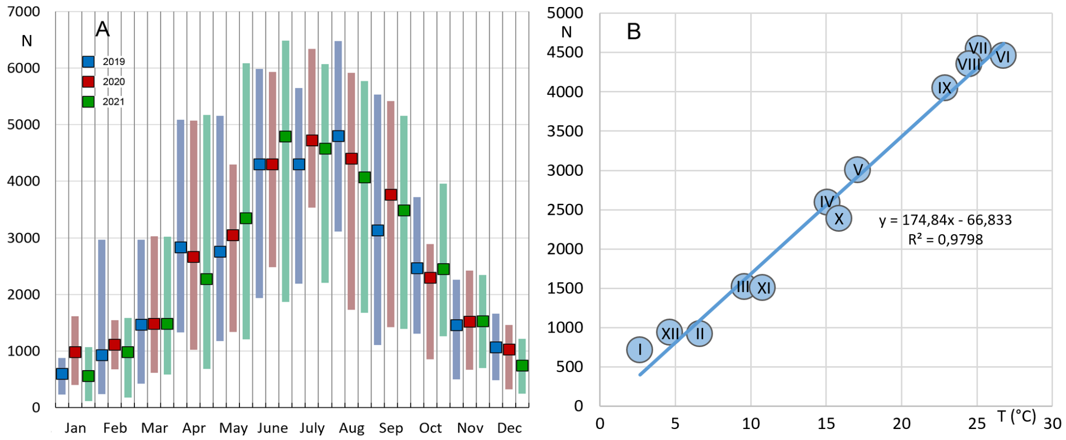

Fig. 3. Changes in mean, maximum and minimum value of bicycle traffic volume (A), and its correlation with mean maximum monthly air temperature (B)

Source: authors' own elaboration based on data from the Municipal Roads Authority in Toruń and www.meteomodel.pl, accessed: 15.03.2022

of mean traffic were recorded in August for 2019, in July for 2020, and in June for 2021 (Fig. 3A).

A strong correlation was found between monthly bicycle traffic volume and the mean value of T_{max} in individual months. Figure 3B, showing the distribution, provided the basis for identifying the following characteristic periods, in which the N-parameter evidently differed:

- the off season: the months from November until March,
- the low seasons: April and May and October,
- the high season: the months from June until September.

It was also found that the bicycle traffic volume in Toruń was slightly higher on weekdays than at weekends (N=2528 and N=2205, respectively), which certainly indicates that many residents use a bike to commute to work or school. The mean values of annual bicycle traffic in the analysed years were similar (Table 1), though it slightly decreased (by approx. 5%) at some point, which might have been due to the Covid-19 pandemic and the ensuing temporary restrictions on movement having reduced bicycle trips, and due to some residents having either isolated/quarantined or having worked remotely, which did not require commuting.

The mean bicycle traffic volume on weekdays was also compared against a period before the pandemic (04.2019–03.2020) and against the pandemic itself (04.2020–03.2021). The apparent drop in volume between the two periods reached 7%. However, as the weather in the second period was colder, it is difficult to unequivocally attribute this result to the impact of the Covid-19 pandemic. The greatest differences in 2020 with regard to the preceding year concerned traffic in August and September (Fig. 3A).

4.2. Meteorological determinants of daily traffic volume

In all developed models covering days with snow cover, the parameter was disregarded as irrelevant. Therefore, it appears that on days with snow cover and considering the already low bicycle traffic volume in winter, the bike is used by people who do not mind how thick the snow cover is. This is surely a result of the fact that the bike paths with traffic counters are usually cleared of snow and

Table 1. Mean bicycle traffic volume in Toruń, 2019–2021

Period	2019	2020	2021	2019–2021
N	2635	2596	2509	2580

Source: authors' own elaboration based on data from the Municipal Roads Authority in Toruń

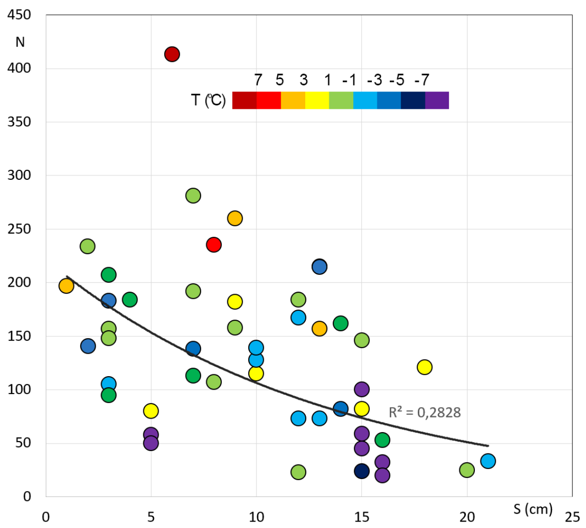

Fig. 4. Correlation between bicycle traffic volume and snow cover thickness.

Explanation: Colour scale represents maximum diurnal temperature

Source: authors' own elaboration based on data from the Municipal Roads Authority in Toruń and www.meteomodel.pl, accessed: 15.03.2022

any snow layer is firmly compacted. People riding bikes in winter are well prepared for this and tend to use MTBs or trekking bikes (with thicker tyres than road bikes have). Figure 4 shows a correlation between bicycle traffic volume and snow cover thickness in the years 2019–2021.

The value of the coefficient of correlation shows a moderate relationship between the data series. At the same time, an additional analysis for the same periods indicated a greater correlation between bicycle traffic and maximum air temperature (R^2=0.34).

4.2.1. Models: Year, Off season, Low Season, High Season, Weekdays, Weekends

In this section, results of the analyses conducted using IBM SPSS Statistics are presented. The results for the entire period of 2019–2021 (main model) and for a number of separate periods are presented in Table 2. It is noteworthy that these models (anticipating a total number of bicycles recorded by city counters, Fig. 1) were developed using all or nearly all independent variables fed into the program. For example, the model for 916 days from the years 2019–2021 with complete data sets from the five counting stations looked like this:

$$N=130.5T_{max}-139W-65P_d+44.4I+741$$

The greatest coefficient of correlation (i.e. the best model fit) was obtained for the main model, comprising data for the three years; the smallest was obtained for the Low Season and Off Season. In those months (from October until March), the bicycle traffic volume is the least determined by the meteorological parameters considered in the analysis. At the same time, as the observations show, cyclists are less sensitive to unfavourable weather conditions then: in the case of the Low Season, the wind speed proved irrelevant, and in the Off Season the model rejected insolation as such.

Similarly, in the case of the Weekend model, only certain parameters were significant; the value of precipitation was not considered (Table 2). This could be because people cycling at weekends only, having no time for such activities during the week, are usually prepared for possible rain. However, it should be noted that rainfall lasting at least a few hours, where the precipitation total P is 10 mm, can considerably reduce bicycle traffic in the city, cutting it by half. For example, during three days with such rainfall in August (8.6 mm, 12.4 mm and 14.8 mm) the observed mean bicycle traffic was N=1635, whereas the mean value for that month reached N=4354.

4.2.2. Meteorological determinants of monthly traffic volume

In a similar analysis carried out for individual months, the results were much more varied and the models developed by IBM SPSS Statistics frequently rejected two or even three of the four independent variables. Furthermore, in none of the 12 cases was the model based on all four parameters. In January and February only the air temperature turned out to be significant. In March and April, the situation was a little different (Table 3).

In May, for the first time in the monthly model, insolation was taken into account and – interestingly – it was considered also in subsequent months. October was the third and last month in which the model was based only on temperature. It should be noted that the only month in which the model did not consider air temperature was July, and for June the dependence of traffic volume recorded by the counters on temperature was inversely proportional (the cooler, the higher the N value). The bicycle traffic volume on days with T_{max}>30 °C in Toruń was not higher than with T_{max} reaching 20–25 °C (Fig. 5A) and, for the June data, the traffic volume was lower when the temperature was highest (Fig. 5B).

Table 2. Results of analysis by multiple linear regression for individual periods within the years 2019–2021

	Year	High Season VI–IX	Low Season IV–V, X	Off Season XI–III	Weekdays	Weekends
T_{max} (°C)	130.5	28.9	108.4	58.2	135.9	113.5
W (m/s)	-139.0	-228.9		-60.2	-148.8	-160.3
P_d (mm/12h)	-65.0	-86.9	-49.7	-57.3	-72.4	
I (h)	44.4	97.9	25.9		41.0	60.4
constant	741.0	3330.0	810.6	936.7	820.2	643.1
R	0.855	0.617	0.577	0.588	0.757	0.835

Source: authors' own elaboration

Table 3. Results of multiple linear regression analysis for individual months

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
T_{max} (°C)	38.0	40.3	72.6	136.0	82.1	-55.9		44.8	34.8	40.0	51.4	27.3
W (m/s)			-173.1	-300.2			-322.0		-258.9		-120.7	
P_d (mm/12h)			-107.3			-76.9	-67.2	-179.1				-75.2
I (h)					117.8	85.5	125.0	106.8	128.8			
constant	608.6	671.3	1384.0	1423.5	1014.4	5312.4	4470.0	2695.5	3909.9	1753.2	1472.0	858.1
R	0.446	0.483	0.613	0.682	0.696	0.629	0.734	0.857	0.516	0.246	0.478	0.396

Source: authors' own elaboration

An interesting situation was observed when identifying the correlation for November. The first version of the model (not presented here) did not consider air temperature as a significant parameter. A detailed analysis of the course of temperature value in that period indicated that, in 2019, the mean value of the parameter was exceptionally high (15 °C) and more than 6°C higher than in the other two years in question. The irregularly high air temperature was not matched by a high volume of bicycle traffic. Once the 2019 data was removed from the model, the temperature parameter was taken into consideration.

The most interesting and relevant outcome of this part of analysis of the results was the possibility to identify the preferences and behaviour of cyclists. In months with the lowest apparent temperature while cycling, this means of transport is used exclusively by people who are adequately equipped for low temperatures, for whom – at the same time – the other meteorological elements are negligible. As air temperature and the number of cyclists on bike paths increase, so does the share of people more susceptible to weather conditions – those who would like to travel in comfortable and favourable conditions. This is demonstrated in the shaded fields (May–September) of Table 2, creating a symmetrical pattern to July (when the bicycle traffic volume is highest, Fig. 3B).

5. Discussion

The volume of bicycle traffic was similarly monitored and analysed in the years 2012–2016 in Tczew (https://rower.tczew.pl/dane-pogodowe-a-ruch-rowerowy-2012-2016/, accessed: 14.03.2022). The town is situated north of Toruń, also on the Vistula River, 40 km from its mouth at the Baltic Sea. The structure of traffic in the high season (56%), low season (24%) and off season (20%) was very much like the patterns observed in Toruń (56%, 26% and 18%, respectively). The slight differences may have been caused by the climate in Toruń being more continental (colder winters).

The value of the coefficient of determination for the main model (2019–21), R2=0.73, indicates that, on an annual basis, the bicycle traffic volume depends by nearly 30% on variables other than those analysed. As was already demonstrated, the correlation between traffic volume and air temperature is not linear, which is also confirmed in various other studies (Richardson, 2000; Phung & Rose, 2007; Miranda-Moreno & Nosal, 2011; Lewin, 2011; Corcoran et al., 2014). In high temperatures, above a certain temperature the volume of bicycle traffic decreased; the value ranged from 25 to 32 °C, depending on region. Above the upper limit of that range, traffic has always been observed to decrease (Buehler & Pucher, 2012). A temperature of about 25 °C is considered optimal for cycling (Richardson, 2000). Similar conclusions can be drawn from the results of the analyses carried out for this paper. Some authors point out that mean diurnal temperature is a better parameter to determine the correlation, as a lot of cyclists get on their bikes in the morning when the temperature is close to the said optimum (Thomas et al., 2009). However, considering a mean diurnal temperature in a model instead of a maximum would not make it possible to observe a decline in bicycle traffic on very hot days.

Other similar works have noted that the linear model is not the best one to predict bicycle traffic volumes. For instance, in very hot weather, a little wind could be perceived as pleasant (Thomas et al., 2009). As in the case of air temperature, so too precipitation does not show a linear correlation with bicycle traffic volume (Richardson, 2000; Phung & Rose, 2007). Detailed research has demonstrated that hourly traffic volume depends not only on the size of current rainfall, but also on the rainfall recorded in the previous three hours or earlier in the morning (Miranda-Moreno & Nosal, 2011). Daily rainfalls of about 8 mm caused a 50% decrease in bicycle traffic, which was similar to the case of Toruń (Richardson, 2000). Detailed changes (expressed in percentages) in the bicycle traffic volumes in situations where the mentioned parameters varied, were the subject of research by A. Ermagun et al. (2018) and J. Wessel (2020). Also, T. Thomas et al. (2009) concluded that adding further meteorological parameters does not improve the goodness of fit or reliability of a model.

There are also works confirming that cycling in summer and for pleasure is much more sensitive to weather than the kind undertaken to commute to work (Thomas et al., 2009; Ahmed et al., 2013). In the first study, bicycle traffic was essentially correlated with the same four parameters (the only difference being mean diurnal temperature instead of maximum). As expected, high temperature and

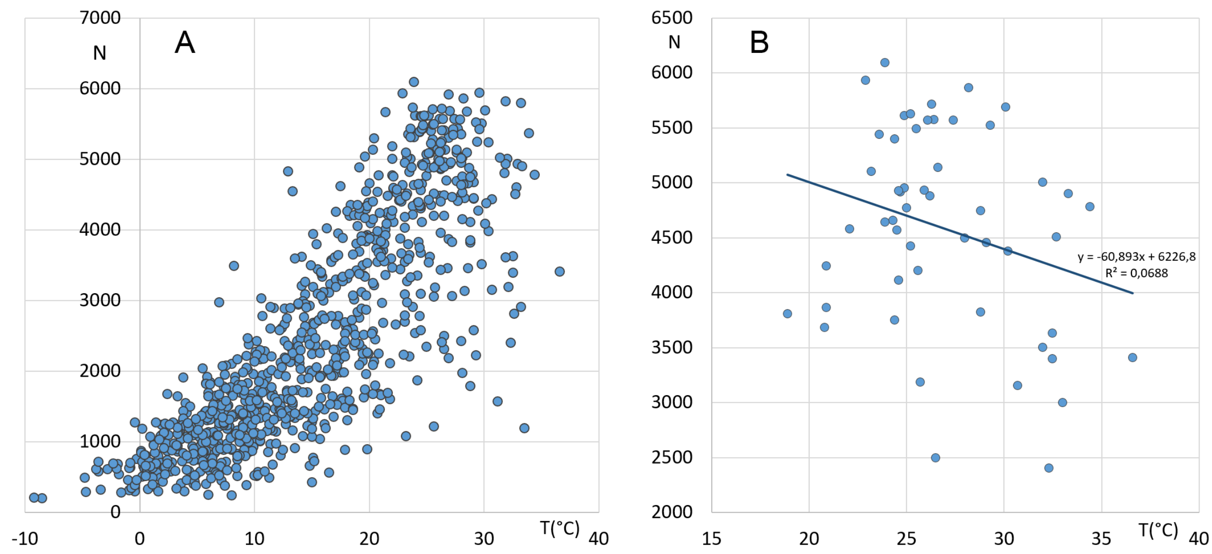

Fig. 5. Correlation between bicycle traffic volume and maximum diurnal air temperature for the entire analysed data from 12 months (A), and for June data (B)

Source: authors' own elaboration based on data from the Municipal Roads Authority in Toruń and www.meteomodel.pl, accessed: 15.03.2022

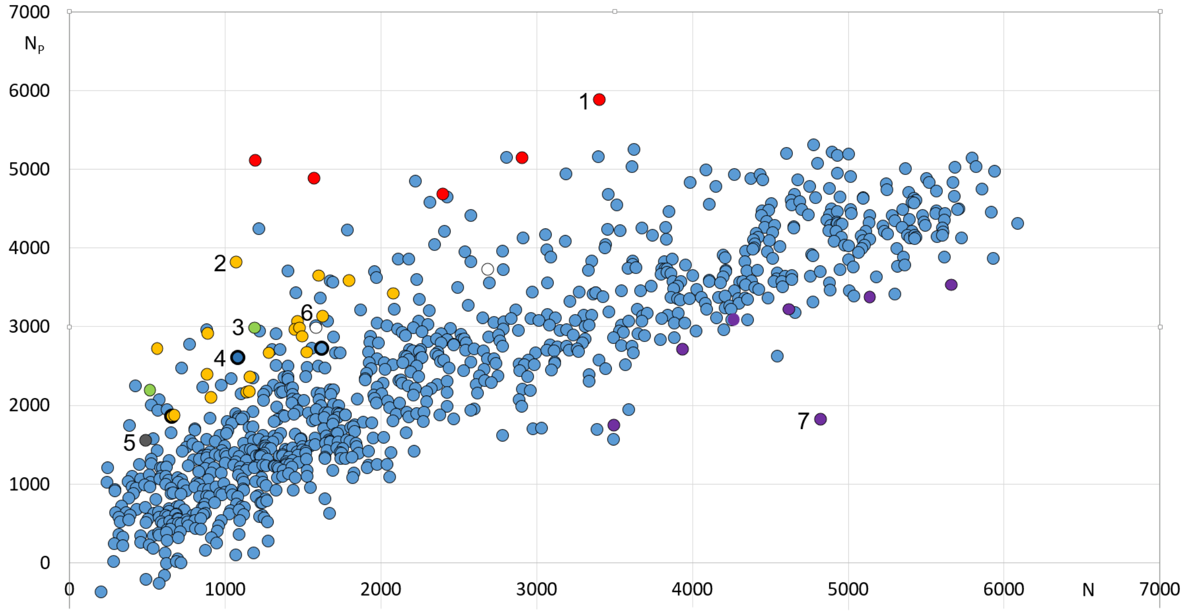

Fig. 6. Comparison of actual values of bicycle traffic volume in the years 2019–2021 (N) with the results of a forecast obtained by means of a multiple regression model (NP).
Explanation: 1 (red) – high temperature, above 30 °C in summer, 2 (orange) – abnormally warm November 2019, 3 (green) – February 2021, above 10 °C, 4 (bold circle) – All Saints' Day, 5 (grey) – warm New Year's Eve 2021, 6 (white) – Easter, 7 (violet) – public holidays at the beginning of the season
Source: authors' own elaboration based on data from the Municipal Roads Authority in Toruń and www.meteomodel.pl, accessed: 15.03.2022

insolation favoured cycling, whereas rainfall and high winds had a negative impact. Brandenburg et al. (2007) also observed decreased bicycle traffic at high temperatures on very hot days. They found that people cycling mainly for pleasure and only in summer are more susceptible to unfavourable weather changes (a high correlation with temperature, R^2=0.71). They also do not usually ride the bike in the rain, because they find out about local weather and its possible changes beforehand. And as far as commuting cyclists are concerned, weather seems to be less important, although temperature conditions are still a valid factor (R^2=0.52).

Figure 6 is a graphical comparison of actual traffic volume and that predicted by the main model for the year; selected situations were analysed in cases where the differences (i.e. residual values) were exceptionally high.

All in all, in 176 out of 916 cases, the absolute residual value was >1000. A slightly greater number of situations (91 in total) concerned the model overestimating the number of cyclists. Particularly evident discrepancies with regard to the actual value of N were noted during very hot summer days (as mentioned earlier, the number of cyclists increases with air temperature but only to a certain point), and in the case of strong positive temperature anomalies (e.g. in November 2019).

Bicycle traffic was also lower than predicted on certain holidays that – due to various customs and traditions – meant that fewer people used bikes, and the model did not predict that; for example, on 1 November, All Saints' Day (which incidentally marks the beginning of the off season, during which some cyclists consider weather conditions to be no longer favourable despite the observed climate warming), on New Year's Eve or at Easter. The most underestimated values concerned the warm half of the year, especially the early part (April and May), in which, if favourable weather conditions occurred – and especially on public holidays – bicycle traffic suddenly increased. On such occasions, whole families were observed riding on bike paths. An instance of the most evident underestimate took place on 1 May 2019: the actual number of cyclists was over 1,300 more than forecast. Thomas et al. (2009) also concluded that bicycle traffic at weekends in spring is characterised by much greater intensity than predicted based on meteorological parameters, and in autumn the volume is lower.

Nor too can the influence of erroneous weather forecasts on the results shown in Fig. 6 be excluded. If rain is predicted, some cyclists might change their plans for public holidays, and on weekdays they might use other means of transport. This follows from the analyses carried out by J. Wessel (2020), in which rain that had been forecast for the morning but did not occur substantially reduced bicycle traffic. Other elements resulting in substantial differences between actual bicycle traffic recorded by counters and values predicted by a model (especially as regards underestimated volumes) are changes in the availability and operation of public transport (Pazdan, 2020), which also includes the construction of new bike paths making some cyclists choose different routes.

6. Summary

Bicycle traffic in Toruń is characterised by a distinct seasonality and is mostly correlated with temperature conditions; thus, its highest volumes are observed from June to August. In that period, bicycle traffic counters registered on average about 4,500 bicycle passes per day. At the same time, there was slightly more bicycle traffic on weekdays than at weekends.

In Toruń, the optimal conditions for cycling are sunny days without expected precipitation, with little wind (up to 2 m/s) and a maximum diurnal air temperature around 25 °C. As demonstrated by the situations observed in summer months, like in other regions of Europe and all over the world, a very high air temperature causes bicycle traffic to decrease. However, even very favourable temperature conditions in the months outside the high season do not necessarily result in the values of N>4000, unless these occur in spring (particularly in May).

On a whole-year basis, the meteorological elements analysed here determined 73% of bicycle traffic volume. The actual bicycle traffic on certain holidays (All Saints' Day, New Year's Eve, New Year's Day and Easter) was much smaller than predicted. In most cases, the holidays fell between Monday and Friday, so commuting to work or school was not undertaken on such weekdays. Furthermore, various traditions and family gatherings prevented cycling for pleasure.

One of the objectives of this paper was to identify the weather preferences of cyclists travelling in different periods of the year, on weekdays and at weekends. The significance of the influence of different meteorological elements on bicycle traffic varied from one month to another. People riding bikes only in summer were much more likely to take other weather elements (besides temperature) into account than those who use the bike throughout the year. For people riding bikes outside the high season (i.e. from November until March), insolation did not matter. Interestingly, and certainly unusually, weekend traffic was influenced by rainfall (snowfall) less than by any other meteorological element analysed here.

The period of the Covid-19 pandemic was marked by slightly lower bicycle traffic volumes (mainly due to restrictions and remote-learning and -working schemes). Yet, weekday cycling did not decrease as much as weekend cycling did when compared with the corresponding period before the pandemic. Perhaps some people who were used to cycling to work switched to leisure cycling during the pandemic.

Cycling as a form of transportation is becoming increasingly popular in Toruń, and every year it gains more and more supporters. It should be treated by city authorities as a priority due to the advantages it offers to residents. On the one hand, the cycling infrastructure ought to be thoughtfully developed based on the highest standards available, and – on the other – this method of transport should be promoted among residents. However, more investment in infrastructure is required to improve the capacity and comfort of getting around the city by bike, especially in summer.

The results of this study will certainly allow the forecasting of a further increase in bicycle traffic in the city, which will also be a consequence of global warming in the coming decades.

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