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WATER MANAGEMENT OF MIKOŁAJKI CITY AND COMMUNE

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Abstract

Using the example of the city and commune of Mikołajki, the state of water and sewage management as well as the management of groundwater resources available in the commune has been characterized for a typical tourist town and commune located in Mrągowo County, Warmian-Masurian Voivodeship. The town and commune of Mikołajki, located in the Warmian-Masurian Voivodeship, has about 7 457 inhabitants. Over 83% of the commune's inhabitants are covered by the water supply network. The Mikołajki commune has four water intakes (one of which is out of use) and three water treatment plants. The water used by the inhabitants of the commune meets all sanitary requirements.

Introduction

Water plays a special role in the processes occurring in ecosystems, constituting an essential abiotic element of the environment for their functioning. It is a renewable raw material with resources that vary over time and fulfills many basic functions in the economy. These special functions make it necessary not only to protect it against pollution, but also to manage its resources rationally and economically. Qualitative and quantitative protection of water resources is an integral element of environmental protection. Many tourist destinations struggle with the problem of maintaining the appropriate condition of water and sewage management. The main reason is their sudden development and changes in the population in the commune, which varies depending on the season.

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The urban-rural commune of Mikołajki is located in the Warmian-Masurian Voivodeship, in the Mrągowo poviat. The area of the commune is 256. 41 km^2 and the headquaters is the city of Mikołajki, with the area of 8.85 km^2 (The Central Statistical Office. 2022). The entire commune occupies 24.07% of the area of the Mrągowo poviat. Mikołajki is located near Lakes Tałty and Mikołajskie, and the north-eastern part of the city borders with Łuknajno Lake.

Water and Sewage Company limited liability company (Zakład Wodociągów i Kanalizacji w Mikołajkach sp. z o.o. – later referred to as ZWiK Mikołajki) in Mikołajki conducts activities related to the collection, treatment and distribution of water for the needs of the residents and other recipients, collection of sanitary sewage to the sewage system and its treatment, renovation and investment works of water and sewage equipment, delivery of services to other business entities in the field of construction and operation of water intakes, sewage networks, water supply systems, sewage treatment plants, drilling works, preparation of documentation for investments and repairs in the field of water and sewage management, conduct of research in the field of water and sewage systems equipment efficiency, conduct of drilling works of deep wells and their renovation.

The paper characterizes the state of water management in the city and commune of Mikołajki and analyzes the operation of water intakes and water treatment plants to determine actions aimed at improving this condition.

Materials and Methods

This work was carried out based on the documentation from the Mikołajki Town and Commune Office, analysis of documents provided by the Water and Sewage Plant in Mikołajki, Polish legal acts, results of laboratory tests of water and sewage, data from the Central Statistical Office and the on-site inspections of the facilities.

Water supply

Water supply to the commune and the city of Mikołajki is provided by four water intakes and three water treatment plants belonging to ZWiK Mikołajki (Water and Sewage Company in Mikołajki). They are located in Mikołajki, Tałty and Cudnochy. ZWiK also owns the water intake in Prawdów, however it is out of use. Additional Hotel Gołębiewski water

intake is a separate intake providing water only for the hotel needs (The City Council in Mikołajki. 2020).

Water intakes

Figure 1 shows the localisation of intakes belonging to ZWiK in Mikołajki.

Fig. 1. Water intakes belonging to Water and Sewage Company sp. z. o.o. in Mikołajki
Source: Geoportal.gov.pl

Water intake – Mikołajki

The intake in 'Mikołajki' has three active wells: No. 1A, No. 2A and No. 4, which draw from the Quaternary aquifer. The intake is located approx. 250 m north-east of Lake Mikołajskie, in the southern part of the city. The Quaternary aquifer drawn by the wells of the 'Mikołajki' intake does not belong to the main groundwater reservoir. The towns included in

the service of this intake include: Mikołajki, Stawek, Kolonia Mikołajki, Woźnice, Lelek, Olszewo, Górkło, Grabówek and Grabówka, Grabnik, Pszczółki.

All wells have Lange-type casings and consist of a pressure pipeline, a check valve, a manometer, a shut-off damper, a depression pipe, a tap and a water meter. Water is extracted by means of three submersible pumps with a capacity of 75 m^3/h, which are suspended at a depth of 23 m in well No. 1A, 21 m in well No. 2A and 27 m in well No. 4 respectively. Basic data concerning the well are presented in the table below (Table 1).

Table 1

Basic data of active wells for 'Mikołajki' water intake [3]

Parameter	Well No. 1A	Well No. 2A	Well No. 4
State and function of well	active	active	active
Year of creation	1972	1972	2007
Terrain elevation [m] a.s.l. (above sea level)	128.3	131.0	130.0
Depth of the hole [m]	38.0	45.5	60.0
Operational efficiency – Qe [m^3/h]	15.45	63.0	135.0
Operationa depression – Se [m] (at Qe)	3.15	3.1	6.5
Unit capacity – q [m^3/h/1mS] (m^3/h/1m depression)	1.53	20.32	20.77
Filtrartion coefficient – *k* [m/d]	15.64	34.99	22.98
Static water level from the period of well construction – depth [m b.g.l.] (below ground level) – ordinate [m a.s.l.] (above sea level)	 10.6 117.7	 14.54 116.46	 13.4 116.6
Active part of the filter: – length of the active part of the filter [m] – diameter [mm] – foundation depth [m b.g.l.] (below ground level)	 5 200 38	 8.8 230 44.8	 20 250 59.5

The characteristics of water consumption at the 'Mikołajki' intake presented below was based on data on monthly intakes from 2015–2021. A detailed summary of the amount of monthly consumption is presented in Table 2.

Table 2

Total water intake [m^3] in wells of the 'Mikołajki' intake in years 2015–2020 (Water and Sewage Company in Mikołajki. 2022)

Month/year	2015	2016	2017	2018	2019	2020
I	23 198	25 222	28 301	27 941	35 876	37 971
II	17 187	21 748	24 595	25 421	35 779	30 939
III	19 636	24 968	26 425	29 438	42 109	31 252
IV	22 317	26 981	28 471	32 086	38 629	37 955
V	26 041	36 052	36 966	39 357	43 584	41 379
VI	30 523	33 194	42 090	39 760	49 208	50 899
VII	42 995	43 528	50 608	52 574	60 383	61 430
VIII	46 229	47 591	49 938	55 715	68 186	74 806
IX	30 081	37 027	32 541	38 133	44 307	49 179
X	25 544	33 374	28 955	34 235	38 966	40 591
XI	23 896	31 538	26 059	32 341	36 952	35 994
XII	24 303	28 478	28 900	34 240	40 351	37 631

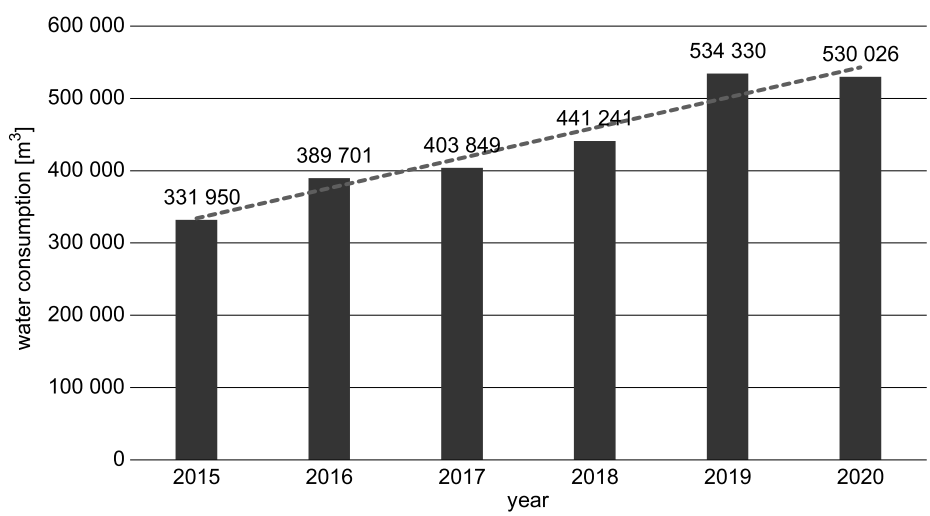

Fig. 2. The variability of the total annual water consumption (in m^3) at the 'Mikołajki' intake in 2015–2020 (Water and Sewage Company in Mikołajki. 2022)

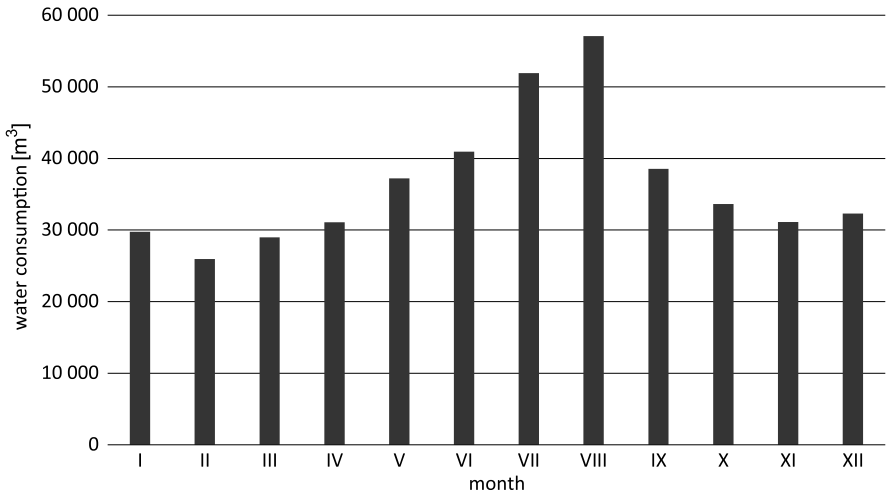

Fig. 3 Average monthly water consumption at the 'Mikołajki' intake in 2015–2020 (Water and Sewage Company in Mikołajki. 2022)

According to the data presented in Table 2 and the graphs above, the following were observed:

– current, total water consumption from the intake in 2020 with a value of 530 026 m^3 (i.e. on average 1 452.1 m^3/day), which is approx. 33.2% of the permissible value set in the water law permit;
– an increase in water consumption at the 'Mikołajki' intake in 2015–2019;
– the highest water consumption in the summer months – this is related to the tourist character of the area of Mikołajki;
– lower water consumption in 2020 compared to 2019 – the reason was a smaller number of tourists visiting the city of Mikołajki due to the pandemic situation caused by COVID-19 (Water and Sewage Company in Mikołajki. 2022).

Water intake – Tałty

The intake consists of two wells: No. 1 and No. 2, which draw from the Quaternary aquifer. Currently, only one well (No. 2) is in operation. The intake is in the southern part of the village of Tałty, about 350 m east of the shore of Lake Tałty and about 4 km north of the center of Mikołajki. The towns included in this intake are: Tałty, Kolonia Tałty, Kolonia Mikołajki. Wells No. 1 and No. 2 are enclosed with reinforced concrete rings with a diameter of 1 500 mm placed on a concrete bottom slab. Inside the housing there is a depression pipe, a power cable supplying the pump, a latch, a water meter, a discharge pipe, a check valve and a tap for water intake. Well No. 1 is intended for closing, as it has not been used for many years. Basic data on wells are presented in the table below (Table 3).

Table 3

Basic data of wells for 'Tałty' intake
(Water and Sewage Company in Mikołajki. 2022)

Parameter	Well No. 1	Well No. 2
State and function of well	inactive	active
Year of creation	1962	1973
Terrain elevation [m] a.s.l. (above sea level)	128.3	126.0
Depth of the hole [m]	38.0	42.0
Operational efficiency – Qe [m^3/h]	15.5	60.0
Operationa depression – Se [m] (at Qe)	3.1	12.0
Unit capacity – q [m^3/h/1 mS] (m^3/h/1 m depression)	4.9	5.0
Filtrartion coefficient – *k* [m/d]	15.6	6.0
Static water level from the period of well construction – depth – [m b.g.l.] (below ground level) – ordinate – [m a.s.l.] (above sea level)	 10.6 117.7	 10.2 115.8
Active part of the filter: – length of the active part of the filter [m] – diameter [mm] – foundation depth [m b.g.l.] (below ground level)	 5 8 38	 7.5 $11\frac{3}{4}$ 42

Table 4

Total water intake (in m^3) in wells of the 'Tałty' intake in years 2015–2020
(Water and Sewage Company in Mikołajki. 2022)

Month/year	2015	2016	2017	2018	2019	2020
I	840	834	1 333	992	1 177	1 088
II	821	974	1 169	997	1 062	900
III	955	759	1 800	1 101	1 231	1 121
IV	1 030	1 008	1 834	1 252	1 408	1 419
V	1 120	1 512	1 968	1 977	1 549	1 418
VI	1 250	1 693	2 563	2 202	2 099	1 943
VII	2 060	2 794	3 035	2 599	2 860	3 291
VIII	2 250	2 426	2 925	2 676	2 826	2 995
IX	1 425	1 331	1 395	1 398	1 565	1 631
X	1 520	950	962	1 257	1 212	1 124
XI	1 213	789	1 090	1 107	925	983
XII	1 450	1 015	1 058	1 177	1 079	995

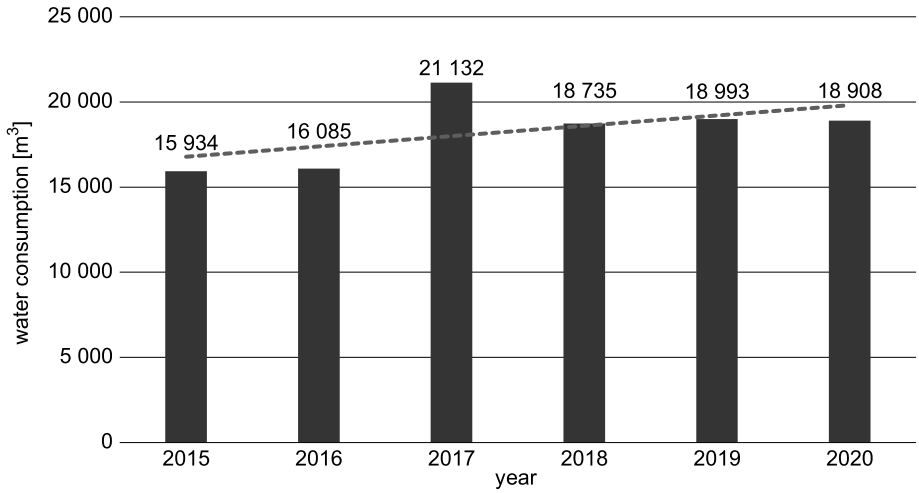

Fig. 4. The variability of the total annual water consumption (in m^3) at the 'Tałty' intake in years 2015–2020 (Water and Sewage Company in Mikołajki. 2022)

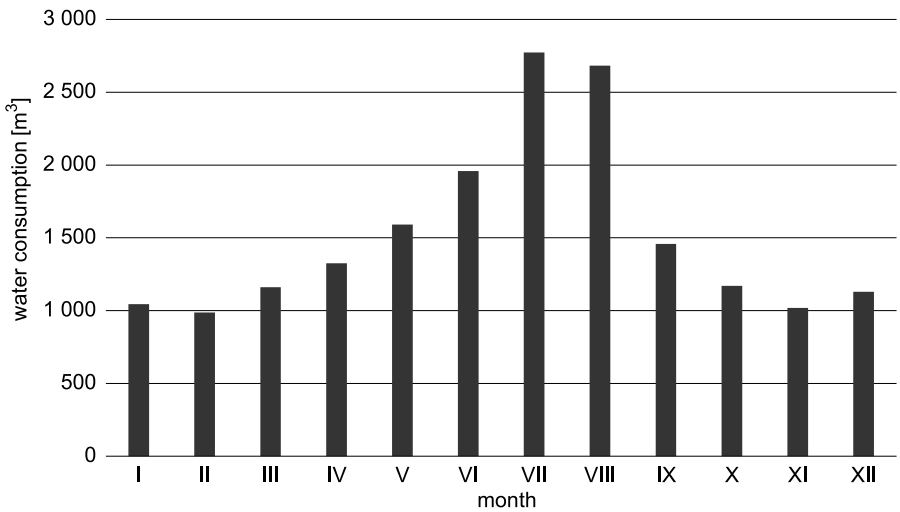

Fig. 5. Average monthly water consumption at the 'Tałty' intake in years 2017–2020 (Water and Sewage Company in Mikołajki. 2022)

According to the data presented in Table 4 and the charts, the following were observed:

– current, total water consumption from the intake in 2020 with a value of 18 908 m^3 (i.e. an average of 51.8 m^3/day), which is approx. 26.4% of the permissible value set in the water law permit;
– annual water consumption ranging from 2015 – 15 934 m^3 (i.e. 43.7 m^3/day) to 2017 – 21 132 m^3 (i.e. 57.9 m^3/day);

– in the last three years, the amount of water intake at a constant level;
– the highest water intake in the summer months from June to August – this may be due to the agricultural character of the intake area (Water and Sewage Company in Mikołajki. 2022).

Water intake – Cudnochy

The intake consists of two wells: one active, drawing from the Quaternary aquifer (well No. 1) and one not exploited (well No. 2). The intake is located in the central part of the village of Cudnochy, at the intersection of the road Faszcze – Jora Wielka with a local country road. The towns included in the service of this intake are: Cudnochy, Baranowo, Faszcze, Jora, Inulec, Śmietki, Nowe Sady, Stare Sady, Zełwągi, Lubiewo. The wells are enclosed with reinforced concrete rings with an internal diameter of 1 200 mm and two reinforced concrete slabs – bottom and ceiling. A PVC drainage pipe ø 160 mm is built into the bottom of the casing.

Water intake process is carried out by a GC.2.05 submersible pump with a capacity of Q = 15–35 m^3/h, lift of H = 11.8–6.5 bar, engine power of 11 kW, installed at a depth of 12 m below the head. Basic data on wells are presented in the table below (Table 5).

Table 5

Basic data of wells for 'Cudnochy' intake (Water and Sewage Company in Mikołajki. 2022)

Parameter	Well No. 1	Well No. 2
State and function of well	active	inactive
Year of creation	1995	2010
Terrain elevation [m] a.s.l. (above sea level)	123.15	122.85
Depth of the hole [m]	40.0	38.0
Operational efficiency – Qe [m^3/h]	40.0	68.0
Operationa depression Se [m] (at Qe)	2.4	–
Unit capacity – q [m^3/h/1 mS] (m^3/h/1 m depression)	16.67	15.1
Filtrartion coefficient – k [m/d]	23.15	17.07
Static water level from the period of well construction – depth [m b.g.l.] (below ground level) – ordinate [m a.s.l.] (above sea level)	 +1.73 124.88	 +2.1 124.95
Active part of the filter: – length of the active part of the filter [m] – diameter [mm] – foundation depth [m b.g.l.] (below ground level)	 15.5 273.05 40.0	 19.0 250/280 37.0

Table 6

Total water intake (in m^3) in wells of the 'Cudnochy' intake in years 2015–2020 (Water and Sewage Company in Mikołajki. 2022)

Month/year	2015	2016	2017	2018	2019	2020
I	4 723	5 832	9 272	6 142	5 862	5 528
II	4 017	5 397	11 407	4 228	5 604	5 779
III	4 567	6 394	9 685	5256	5 453	5 232
IV	5 307	8 020	9 268	6 147	7 685	5 900
V	5 479	7 764	12 090	8 653	7 456	6 021
VI	7 237	8 508	13 969	10 187	8 931	8 201
VII	11 010	11 272	13 457	11 250	11 535	11 603
VIII	12 844	10 140	13 246	10 970	12 757	13 862
IX	7 436	6 827	6 729	6 979	7 362	8 656
X	5 031	5 268	5 496	6 150	5 400	5 916
XI	4 447	5 147	4 765	4 717	4 681	4 892
XII	5 080	7 495	4 609	5 587	5 085	5 820

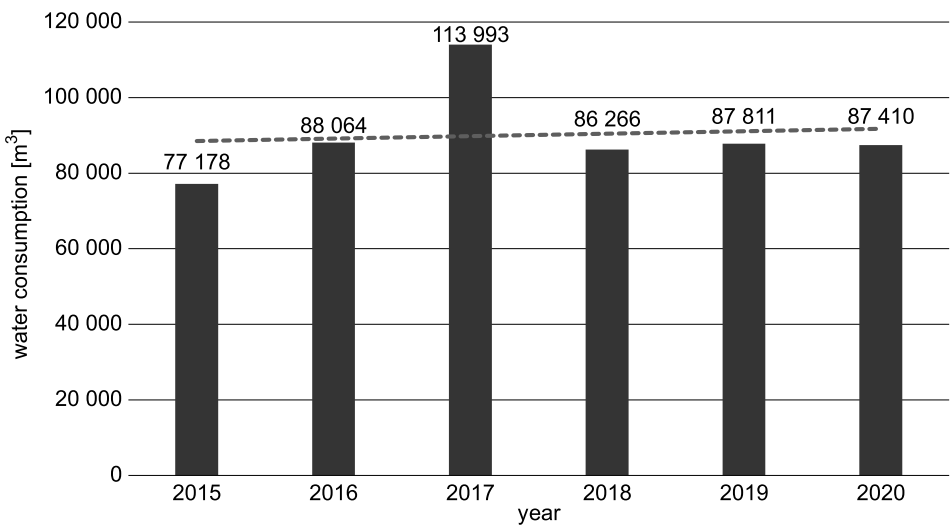

Fig. 6. The variability of the total annual water consumption (in m^3) at the 'Cudnochy' intake in years 2015–2020 (Water and Sewage Company in Mikołajki. 2022)

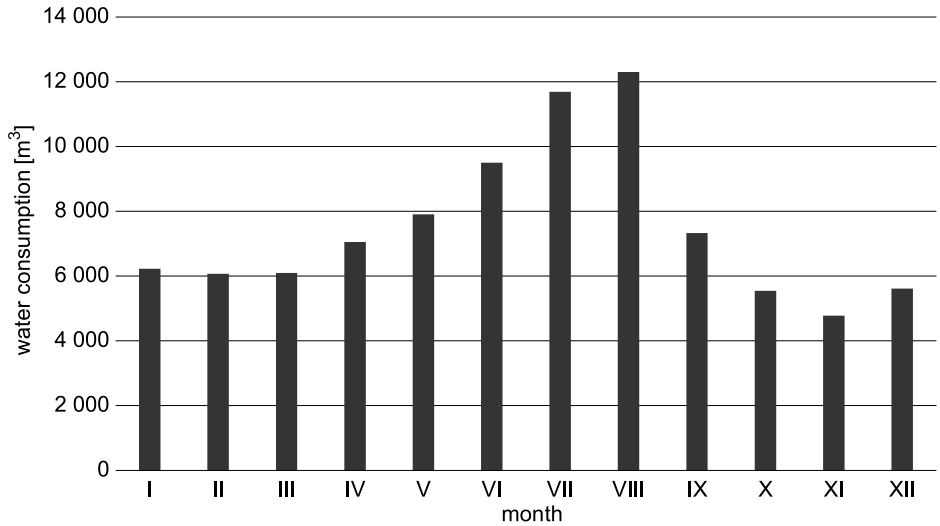

Fig. 7. Average monthly water consumption at the 'Cudnochy' intake in years 2017–2020 (Water and Sewage Company in Mikołajki. 2022)

According to the data presented in Table 6 and in the charts, the following were observed:

– current, total water consumption from the intake in 2020 with the value of 87 410 m^3 (i.e. on average 239.5 m^3/day), which is approx. 41.6% of the permissible value set in the water law permit;
– annual water consumption ranging from 2015 – 77 178 m^3 (i.e., 211.4 m^3/day) to 2017 – 113 993 m^3 (i.e., 312 3 m^3/day);
– the highest water consumption in the summer months and the lowest in the winter. In August, the consumption exceeds 13 000 m^3 (i.e., 420 m^3/day) – this is the value allowed in the water law permit (480 m^3/d); in November, water intake drops to as little as 5 000 m^3 – in this month the lowest value of water consumption is read (Water and Sewage Company in Mikołajki 2022).

Water treatment

In 2019, a total of 508 412 m^3 of treated water was fed into the network. In 2020, the consumption of treated water was lower by 7 582 m^3 and amounted to 500 830 m^3. For 2021, a value of 506 596 m^3 was recorded. Water treated in those years came from three intakes. Tables 7, 8 and 9 show the monthly water production for three water treatment plants (WTP).

Table 7

Water production in 2019 for each WTP in the Mikołajki commune
(Water and Sewage Company in Mikołajki. 2022)

Water production – 2019										
Specification	WTP Mikołajki				WTP Cudnochy			WTP Tałty		
	raw water [m^3]	treated water [m^3]	washings [m^3]	ZH Woźnice [m^3]	raw water [m^3]	treated water [m^3]	washings [m^3]	raw water [m^3]	treated water [m^3]	washings [m^3]
January	35 876	24 518	3 140	4 702	5 862	5 444	282	1 177	899	279
February	35 779	21 380	2 910	–	5 604	5 402	285	1 062	881	181
March	42 109	26 799	3 180	–	5453	4960	249	1 231	944	287
April	38 629	31 670	3 020	–	7 685	7 625	261	1 408	1213	195
May	43 584	33 881	3 171	6 137	7 456	7 207	249	1 549	1 305	235
Juni	49 208	42 220	281	7 350	8 931	8 650	281	2 099	1 754	345
Juli	60 383	53 655	3 130	7 624	11 353	11 072	281	2 860	2 582	287
August	68 186	56 719	3190	7 860	12 757	12 466	291	2 826	2 575	251
September	44 307	34 335	2 980	6 206	7 362	7 093	269	1 565	1 317	248
October	38 966	29 196	3 130	6 270	5 400	5 122	294	1 212	733	419
November	36 952	26 170	3 070	4 075	4 681	4 412	269	925	612	313
December	40 351	28 100	3 100	7 427	5 085	4 790	295	1 079	711	368
Total	534 330	408 643	34 302	57 651	87 629	84 243	3 306	18 993	15 526	3 408

Table 8

Water production in 2020 for each WTP in the Mikołajki commune
(Water and Sewage Company in Mikołajki. 2022)

Water production – 2020										
Specification	WTP Mikołajki				WTP Cudnochy			WTP Tałty		
	raw water [m^3]	treated water [m^3]	washings [m^3]	ZH Woźnice [m^3]	raw water [m^3]	treated water [m^3]	washings [m^3]	raw water [m^3]	treated water [m^3]	washings [m^3]
January	37 971	25 974	3 100	5 663	5 528	5 234	294	1 088	825	263
February	30 939	24 808	3 000	5 110	5 779	5 764	261	900	673	227
March	31 252	25713	3080	5 788	5232	4917	315	1 121	878	243
April	37 955	28 987	3 020	6 549	5 900	5 831	318	1 419	1120	299
May	41 379	31 244	3 060	5 699	6 021	5 895	315	1 418	1 085	333
Juni	50 899	37897	2 960	7 866	8 201	7 900	301	1 943	1 714	229
Juli	61 430	52 820	3 090	8 273	11 603	11 306	297	3 291	3 236	55
August	74 806	57 326	3040	8 581	13 862	13 589	273	2 995	2 964	31
September	49 179	36 790	3 010	6 645	8 656	8 037	280	1 631	1 561	70
October	40 591	28 465	3 070	5 983	5 916	5 646	270	1 124	998	126
November	35 994	24 509	3 070	6 053	4 892	4 740	272	983	947	36
December	37 631	25 171	2 960	6 000	5 820	5 307	284	995	959	36
Total	530 026	399 704	36 460	78 210	87 410	84 166	3 480	18 908	16 960	1 948

Table 9

Water production in 2021 for each WTP in the Mikołajki commune (Water and Sewage Company in Mikołajki. 2022)

Specification	Water production – 2021									
	WTP Mikołajki				WTP Cudnochy			WTP Tałty		
	raw water [m^3]	treated water [m^3]	washings [m^3]	ZH Woźnice [m^3]	raw water [m^3]	treated water [m^3]	washings [m^3]	raw water [m^3]	treated water [m^3]	washings [m^3]
January	34 076	24 304	3 110	5 815	5 486	5 212	274	988	984	4
February	34 148	24 300	2 750	5 815	5 068	4 825	243	904	890	14
March	37 350	26 696	2 970	0	6 103	5 569	325	1 122	1 043	79
April	26 989	25 838	1 970	6 048	5 497	5 324	277	5 497	5 324	277
May	33 356	33 356	2 030	6 689	7 038	6 727	311	1 290	1 235	55
Juni	47 958	47048	1 900	0	8 584	8 328	256	2 097	2 072	25
Juli	57 819	56 499	1 910	0	10 284	10 266	267	2 498	2 484	14
August	54 961	54 733	2020	6 738	8 554	8 242	278	2 325	2 247	78
September	39 707	36 930	1 880	7 574	5 314	4 990	256	1 125	1 049	76
October	33 798	31 507	1 970	0	3 831	3 233	272	853	653	200
November	32 432	28 655	1 850	7 027	2 955	2 591	271	749	600	149
December	32 537	29 472	1 950	59 993	3 792	2 785	277	792	585	207
Total	465 131	419 338	26 310	105 699	72 506	68 092	3 307	20 240	19 166	1 178

Water treatment plant – Mikołajki

The „Mikołajki" intake has a Water Treatment Plant (WTP) localized at Wawrzyńca Prusa Street. Water taken from the well is pumped through an aerator to 5 filters arranged in parallel and responsible for manganese and iron removal. The treated water goes to a reinforced concrete tank with a capacity of 175 m^3. It is placed on top of the water tower. Then, the water is gravitationally fed into the municipal water supply system.

The filters are rinsed every day at night, each rinsing lasts 1.5 hours. The amount of water used to rinse the filters is 100 m^3. Washing waters are discharged to the rainwater sewage settling tanks, and then through the connection to the sewage system. From the system, they go to the Municipal Wastewater Treatment Plant in Mikołajki (Water and Sewage Company in Mikołajki. 2022).

The water intake in Mikołajki has a permit for the abstraction of underground water in the amount of Q_{dav} = 2400 m^3/day and maximum hourly Qh_{max} = 182 m^3/h and supplies the town of Mikołajki with water (The City Council in Mikołajki. 2020).

The expansion and modernization of the water treatment system in Mikołajki was aimed at ensuring good quality drinking water for residents and increasing the efficiency of the intake to Qh_{max} = 200 m^3/h.

Based on the analysis of raw water, on-site inspection and information on the treatment processes used so far, a technology was designed to improve the quality of water, consisting of two-stage filtration through a multi-layer bed and water disinfection with the use of sodium hypochlorite and UV rays.

The works included the construction of water tanks with inter-facility networks, construction of a new technological building; selection, production and assembly of new technological devices, e.g., pressure aerators, filters, hydrophore set, rinsing pump, blower or compressors, and new stainless-steel piping for the plant. The operation of all devices is managed by a new PLC controller, which implements a prepared individual control algorithm, thanks to which the water treatment plant is fully automatic. All implementation works were completed in 2011. Since then, the quality of water supplied by the water treatment plant to the residents meets all the standards required by law, which confirms the effectiveness of the treatment technologies offered by Instalcompact.

Water treatment plant – Tałty

The "Tałty" intake has a Water Treatment Plant (WTP) located on the same plot as the intake wells. Water taken from the well is pumped to two raw water tanks with a capacity of 4.0 m^3 each. These tanks are equipped with compressors to aerate the water, which oxidizes the iron and manganese compounds before filtration. Then the water is directed to the iron and manganese removal filter with a diameter of 1400 mm. It is responsible for the removal of iron and manganese compounds and for the reduction of the turbidity of water. The next step in water treatment is its disinfection with sodium hypochlorite.

The treated water goes to the clean water tank, and then to the water supply system (Water and Sewage Company in Mikołajki. 2022).

The water intake in Tałty has a decision to withdraw underground water in the amount of Q_{dav} = 140 m^3/day and the maximum hourly Qh_{max} = 20 m^3/h and supplies the town of Tałty with water (The City Council in Mikołajki. 2020).

Water treatment plant – Cudnochy

The "Cudnochy" intake has a Water Treatment Plant (WTP) located on the same plot as the intake wells. Water drawn from the well is pumped

to aerators. To remove the excess of manganese and iron compounds from it, it is passed through the iron and manganese remover. The treated water is directed to two clean water tanks, and then to the hydrophore with a capacity of 6.3 m^3. From there it is fed into the water supply system.

The filters are rinsed twice a week. Washing waters are discharged to the pond through PVC pipes with a diameter of 160 mm through 6 settling tanks, where sludge from washings is collected (Water and Sewage Company in Mikołajki. 2022).

The water intake in Cudnochy has a decision for the intake of underground water in the amount of Q_{dav} = 480 m^3/day and maximum hourly Qh_{max} = 24 m^3/h and supplies the towns of Cudnochy, Śmietki, Stare Sady, Baranowo, Jora Wielka and Inulec with water (THE CITY COUNCIL IN MIKOŁAJKI. 2020).

Table 10 presents compare of the test results of treated water from the Mikołajki, Tałty and Cudnochy water treatment plants.

Table 10

Compare of the test results of treated water from the Mikołajki, Tałty and Cudnochy water treatment plants

Parameter	Unit	Maximum allowable parameter values	Test result		
			Mikołajki	Tałty	Cudnochy
Colour	mg Pt/l	15 mg Pt/l; acceptable by consumers and without incorrect changes	<5	<5	<5
Turbidity	NTU	1.0; acceptable by consumers and without incorrect changes	0.21	0.22	0.22
Smell	–	acceptable by consumers and without incorrect changes	<1	<1	<1
pH	–	6.5–9.5	7	7.2	7.1
General hardness	mg $CaCO_3$/l	60–500	389	379	332
Specific electrical conductivity (SEC) in temp. 25°C	µS/cm	2500	600	600	610
Manganese (Mn)	µg/l	50	15	18	13.8
Iron (Fe)	µg/l	200	82	102	< 60
Ammonium Ion	mg/l	0.5	0.05	0.05	0.1
Nitrates $(NO_3)^-$	mg/l	50	0.75	0.95	1.2
Nitrites $(NO_2)^-$	mg/l	0.5	<0.03	<0.03	<0.03
Fluorides	mg/l	1.5	0.22	0.22	0.23
Oxidisability with $KMnO_4$ (Permanganate index)	mg/l	5	0.56	0.66	0.73

The results of laboratory tests presented above meet the sanitary requirements for water intended for human consumption and do not exceed the permissible values of indicators (Regulation of the Minister of Health. 2017). Therefore, the State Poviat Sanitary Inspector in Mrągowo approved the suitability of water in Mikołajki for consumption.

Water Supply Network

The water supply network of the Mikołajki commune belongs to the Water and Sewage Department in Mikołajki. The length of the water supply network is 135.3 km of the distribution network, 30 km of which are in urban areas and 105.3 km in rural areas. The number of water supply connections at the end of 2020 was 1753. As part of maintenance and repair works, 11 failures were removed, which in relation to 16 failures in 2019 means progress resulting from the replacement of the most worn sections (Water and Sewage Company in Mikołajki. 2022).

Conclusions

The paper presents the state of water management in the city and commune of Mikołajki, located in the Warmian-Masurian Voivodship, in the Mrągowo poviat. The commune belongs to the Land of the Great Masurian Lakes, has significant landscape, natural and tourist values.

In 2022, the commune was inhabited by 7457 people. There are four water intakes in the commune, including three belonging to ZWiK in Mikołajki. They are in Mikołajki, Tałty and Cudnochy. There is also a water treatment plant in each of aforementioned towns. The results of laboratory tests of the treated water in each of the plants meet the requirements for water intended for human consumption and do not exceed the permissible values of indicators. The water is fit for consumption by the inhabitants of the commune and tourists.

From the information provided in the work, the largest water intake and the largest amount of sewage were recorded in the summer seasons. The COVID-19 epidemic, including the closure of the economy and a smaller number of tourists, resulted in lower water consumption and a decrease in the amount of sewage supplied to the treatment plant in 2020.

The closing of hotels and boarding houses, which are the main "producer" of sewage in Mikołajki, also played a decisive role.

The increasing number of hotels, motels and bed places causes a large irregularity of hours, to which the existing system was not adapted.

Unfortunately, the main problem in the commune and the whole country are septic tanks, which largely pollute the environment. If society does not accept the fact, that the tanks pose an enormous threat to the environment as soon as possible the entire natural environment will suffer.

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