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Selected Elements of Technical Infrastructure in Municipalities Territorially Connected with National Parks

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Abstract: The article addresses the problem of selected technical infrastructure elements (e.g., water supply, sewage, gas networks) in municipalities territorially connected with Polish national parks. Therefore, the research refers to the specific areas: both naturally valuable and attractive in terms of tourism. The time range of the research covers the years 2003–2018. The studied networks were characterized based on the statistical analysis using linear ordering methods; synthetic measures of development were applied. It allowed the ranking construction of the examined municipalities in terms of the development level of water supply, sewage, and gas networks. The results show that the period 2003–2018 was characterized by a development of the analyzed networks in the vast majority of municipalities. Thus, the level of anthropopressure caused by the presence of local community and tourists in municipalities showed a decline. It is worth emphasizing that the infrastructure investments are carried out comprehensively. Favoring investments in the development of any of the abovementioned networks was not observed.

Keywords: local development; municipalities; nature protection; national park; technical infrastructure

1. Introduction

National parks represent a widely recognized spatial forms of nature conservation, which cover valuable natural areas [1]. There are 23 of national parks in Poland and their total area is only 315 thousand ha (1% of the country area). However, the values they offer make them interesting not only for the nature specific reasons but also in terms of the development of economic, local, and regional systems.

The pursuit of preserving natural heritage, combined with the physical functioning of human beings in space—and bearing in mind that protected areas are not the closed ones—requires appropriate technical infrastructure, which also minimizes the effects of anthropopressure in both the protected and the adjacent urbanized areas. It is all the more important that, apart from the local residents, tourists take advantage of the described spaces. Anthropopressure is the environmental effects of using natural resources to meet people's needs [2] and results from the impact exerted by both the local community and its visitors. It should be emphasized that the function of tourists in individual municipalities territorially connected with national parks has a different intensity [3] and in the case of parks it has to result from the nature conservation function [4]. It is important to keep in mind that the value streams between the protected area and its surroundings are subject to an ongoing exchange process [5], hence the quality of the broadly approached municipal technical infrastructure has a huge impact on national parks. The fact that nature does not respect administrative boundaries is reflected in Polish legislation. In order to improve the conditions for the protection of fauna, national parks are surrounded by buffer zones within which wild game protection zones are created. Although buffer zones are created by way of regulation issued by the minister competent for the environment, the protection of wild game remains within the responsibility of the director of a given national park [4].

Technical infrastructure consists of many elements (see Section 2). Its basic components have direct impact on reducing environmental pressure and ensure the sanitary safety of its users include the water supply and sewage network. The gas network allows apartment heating to be free from pollution, as the effect of solid fuel combustion is supplementary. Therefore, the long-term characteristics of technical infrastructure aimed at environmental protection (e.g., sewage, water supply networks) and gas network were adopted as the research purpose.

The following research hypothesis was adopted: "In the municipalities territorially connected with national parks, the pursuit towards reducing anthropopressure through the development of water supply, sewage, and gas networks is observed".

The applied statistical methods are described in detail in the methodological notes. It should, however, be noted that the authors decided to apply synthetic development measures (SDMs). These measures allow for the construction of rankings of the analyzed objects (municipalities) and also the performance of subsequent comparative analyzes. The choice of SDMs resulted from a long tradition of their application and high usability level [6–12].

The research was carried out in the period of 2003–2018 and was based on the data provided by Statistics Poland: Local Date Bank (for details, see methodological notes). The research period derives from the statistical data availability.

2. Infrastructure: The Context of Attractive Protected Areas in Terms of Tourism

The concept of technical infrastructure is quite extensive. Traditionally, it covers transport, communication, power engineering, irrigation, drainage, water supply, sewage, telecommunication, and other devices [13,14]. Following the new approach, it also covers the so-called green infrastructure relevant for the adaptation to climate change [15,16]. For the purposes of environment protection, water supply, sewage, and gas networks are still perceived as luxuries in developing countries. Broadly defined technical infrastructure not only provides comfort and safety to people, but it also aims at minimizing anthropopressure, especially in naturally valuable areas, and its design should remain as neutral in terms of the landscape as possible [17,18].

In Polish conditions, infrastructure investments are within the public sector domain; their significant part is implemented directly by the municipalities [19,20]. The majority of Polish national parks are territorially connected with rural municipalities. Hence, it is worth emphasizing that in rural areas the characteristic feature of the discussed investments is the requirement of cooperation involving local authorities and socio-occupational organizations of farmers, individual farmers, advisory services, and local government administration [21].

An important nuance of the research on technical infrastructure is the fact that some national parks and also the municipalities connected with them represent popular tourist destinations, and are thus affected by the phenomenon of mass tourism [22–24] and the related problems characteristic for Poland's most popular places [25]. A growing interest in both education and tourism in national parks has been observed for several years. It is extremely important that in the context of the World Tourism Organization (UNWTO) reports, it is indicated that there is an ongoing increase in tourism-oriented activity and, thus, tourism has become the foundation of local development [26]. A growing number of people that visit a given space automatically translates into a higher burden on infrastructure and demand for resources. The problem of water supply and sewage network efficiency and the available drinking water resources is of the utmost importance. At this point it is worth highlighting that Poland is a very poor country in terms of water [27,28].

3. Methodological Remarks

The research was initiated with a library query. Due to the fact that the term "technical infrastructure" is complex and covers many elements of the conducted research, it was limited to the selected aspects as the most important for environment protection, i.e., water supply, sewage, and gas networks.

During our research, statistical tools were used that allowed us to obtain results useful for presenting conclusions and recommendations. It was decided to apply analytical methods, including the linear ordering method—i.e, synthetic development measures (SDMs). It was adopted that the analyzed municipalities form one set of 117 objects. SDM was developed in three examined areas: the water supply network (SDMwater), the sewage network (SDMsewage), and the gas network (SDMgas).

It should be emphasized that not all municipalities reported the existence of the analyzed infrastructure elements. The following three municipalities reported no sewage network: Giby, Krasnopol, and Kobylin-Borzymy. As many as 17 municipalities reported no gas network: Sosnowica, Stary Brus, Urszulin, Kamienica, Szczawnica, Zawoja, Lutowiska, Bargłów Kościelny, Lipsk, Grajewo, Radziłów, Jedwabne, Wizna, Giby, Krasnopol, Nowy Dwór, and Szczawnica. To maintain SDM comparability in the abovementioned cases, the data were supplemented with zero values. These municipalities were finally assigned the last, equivalent position.

The identification of municipalities territorially connected with national parks was the first step of the conducted research procedure.

The construction of SDM started with determining variables for all three measures. Next, the variables were unified for the entire period simultaneously, i.e., for the years 2003–2018. Using the standardized sum method, SDM was developed with a weight system (a common development pattern was adopted for the entire analyzed period). It allowed us to determine in each analyzed year the ranking positions of municipalities developed for individual SDMs and to compare the changes in terms of the positions taken by the municipalities in these rankings.

The following indicators were defined for the purposes of determining SDMwater:

- accessibility index of social water supply network (DSwater)

$$\text{DSwater} = \frac{length\ of\ water\ supply\ distribution\ network\ in\ km}{number\ of\ municipality\ residents} \tag{1}$$

- adjusted accessibility index of social water supply network (SDSwater)

$$\text{SDSwater} = \frac{length\ of\ water\ sypply\ distribution\ network\ in\ km}{number\ of\ municipality\ residents + (number\ of\ tourists\ using\ accommodation : 365)} \tag{2}$$

- accessibility index of spatial water supply network (DPwater)

$$\text{DPwater} = \frac{length\ of\ water\ supply\ distribution\ network\ in\ km}{municipality\ area\ in\ km2} \tag{3}$$

- index of population using water supply network (Lwater)

$$\text{Lwater} = \frac{number\ of\ people\ using\ water\ supply\ network}{number\ of\ municipality\ residents} * 100 \tag{4}$$

To determine SDMsewage the following indicators were defined:

- accessibility index of social sewage network (DSsewage)

$$\text{DSsewage} = \frac{length\ of\ sewage\ network\ in\ km}{number\ of\ municipality\ residents} \tag{5}$$

- adjusted accessibility index of social sewage network (SDSsewage)

$$\text{SDSsewage} = \frac{length\ of\ sewage\ network\ in\ km}{number\ of\ municipality\ residents + (number\ of\ tourists\ using\ accommodation : 365)} \quad (6)$$

- accessibility index of spatial sewage network (DPsewage)

$$\text{DPsewage} = \frac{length\ of\ sewage\ network\ in\ km}{municipality\ area\ in\ km2} \quad (7)$$

- index of population using sewage network (Lsewage)

$$\text{Lsewage} = \frac{number\ of\ people\ using\ sewage\ network}{number\ of\ municipality\ residents} * 100 \quad (8)$$

It should be clarified that the calculation of the adjusted SDSwater and SDSsewage indexes was intended to capture both water supply and sewage networks' usage by tourists. The authors are aware of the imperfections inherent in the proposed measures, as they do not cover seasonal fluctuations or hikers (i.e., people not using accommodation) [29], but the availability of statistical data and the simultaneous striving to maintain comparability of the research results for all 117 municipalities did not allow for a different construction. Statistics Poland provides the total number of tourists for the entire year. Dividing this value by 365 days allowed us to obtain the average number of tourists each day of the year. The number of residents, according to the Statistics Poland data, is constant for all days of the year. Therefore, adding these values allows showing the adjusted number of people using the networks under study and, hence, presenting the synthetic measure of social accessibility of the analyzed networks.

To determine SDMgas the following indicators were defined:

- index of population using gas network (Lgas)

$$\text{Lgas} = \frac{number\ of\ people\ using\ gas\ network}{number\ of\ municipality\ residents} * 100 \quad (9)$$

- index of population heating the apartment with gas (Ogas)

$$\text{Ogas} = \frac{number\ of\ people\ heating\ the\ apartment\ with\ gas}{number\ of\ municipality\ residents} * 100 \quad (10)$$

Due to the fact that Statistics Poland only provides data regarding the length of the functioning gas network for the years 2003–2006, the calculation of analogical indicators, as in the case of the previous two SDMs, was not possible. The data on the population heating their apartments with gas also needed to be supplemented. Statistics Poland presents data only for the period 2005–2018, so the data covering the years 2003–2004 were adopted at the level of the data for 2005.

For all three SDMs, the Statistics Poland [30] data were used to calculate the listed indicators. All of them were considered stimulants without veto threshold, which means that the municipalities that presented high values of the aforementioned indicators were assessed as the units with the highest-ranking positions.

Unitarization procedure was performed after determining indicators for each SDM [31]. The unitarization covering values of the features adopted for the study was carried out according to the following formula:

$$Z_{jit} = \frac{X_{jit} - minX_{jit}}{\max X_{jit} - minX_{jit}} \quad (11)$$

notes:

x: feature value

j: j variable, where j = (1, . . . , p)

i: object (municipality), where I = (1, . . . , N),
N for each SDM = 117
T: time (year), where t = (2003, 2004, . . . , 2018)

Unitarization resulted in obtaining values in the range [0,1]. There was no need to harmonize variables' character (preference function) as they were all stimulants in each SDM. SDM was calculated using the standardized sum method [32]. The value of SDM for the analyzed municipalities was calculated using Equation (12):

$$SDM_{it} = \frac{1}{p}\sum_{j=1}^{p} z_{ijt}(i = 1, \ldots, N)(t = 2003, \ldots, 2018) \quad (12)$$

notes:

SDM: value of the non-model synthetic measure in an object (municipality) and
p: number of features.

For all four SDMs presented above, the highest value is equivalent to the most favorable situation. In the final phase, ranking positions were assigned to the analyzed municipalities and comparisons were made regarding the position determined by the analyzed SDMs.

It should be emphasized that for the purposes of the presented data readability, the tables present data for the selected years, i.e., 2003 and 2018 (the first and the last year of the study).

4. Level and Transformations of the Selected Technical Infrastructure Elements in the Municipalities Territorially Connected with National Parks

The analysis of the studied areas' location allows stating that national parks include coastal, lake, lowland, upland, and mountain areas (see Figure 1).

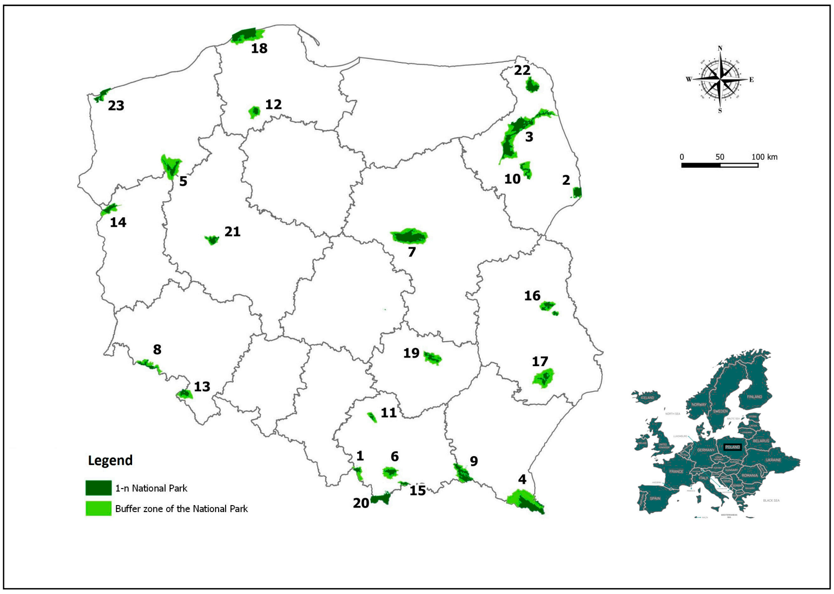

Figure 1. The location of Polish national parks and their buffer zones against the background of the administrative division of the country (voivodship level). Legend: Buffer zone: the area in which protection zones for wild game are created. 1. Babia Góra National Park, 2. Białowieża National Park, 3. Biebrza National Park, 4. Bieszczady National Park, 5. Drawno National Park, 6. Gorce National Park, 7. Kampinos National Park, 8. Karkonosze National Park, 9. Magura National Park, 10. Narew National Park, 11. Ojców National Park, 12. Bory Tucholskie National Park, 13. Stolowe Mountains National Park, 14. Warta Mouth National Park, 15. Pieniny National Park, 16. Polesie National Park, 17. Roztocze National Park, 18. Słowiński National Park, 19. Świętokrzyski National Park, 20. Tatra National Park, 21. Wielkopolska National Park, 22. Wigry National Park, and 23. Wolin National Park.

The administrative division in Poland identifies municipalities, districts, and voivodships. Voivodships correspond to the second level of geocoding in the European Union, the so-called Nomenclature of Territorial Units for Statistics (NUTS). Due to their importance for the correct identification of the detailed location of individual national parks, the boundaries of NUTS 2 are presented in Figure 1.

The identification of municipalities territorially connected with Polish national parks is presented in the table below (Table 1). It should be emphasized that national parks are territorially connected with as many as 117 municipalities (11 of them have the status of an urban municipality, 31 the status of an urban-rural municipality, and 75 the status of a rural municipality).

Table 1. Municipalities territorially connected with national parks in Poland.

No.	National Park	Municipalities Territorially Connected Municipality	No. of Municipalities
1	Babia Góra	Jabłonka (2), Lipnica Wielka (2), Zawoja (2)	3
2	Białowieża	Białowieża (2), Narewka (2)	2
3	Biebrza	Bargłów Kościelny (2), Dąbrowa Białostocka (3), Goniądz (3), Grajewo (2), Jaświły (2), Jedwabne (3), Lipsk (3), Nowy Dwór (2), Radziłów (2), Rajgród (3), Suchowola (3), Sztabin (2), Trzcianne (2), Wizna (2)	14
4	Bieszczady	Cisna (2), Czarna (2), Lutowiska (2), Ustrzyki Dolne (3)	4
5	Tuchola Forest	Brusy (3), Chojnice (2)	2
6	Drawno	Bierzwnik (2), Człopa (3), Dobiegniew (3), Drawno (3), Krzyż Wielkopolski (3), Tuczno (3)	6
7	Gorce	Kamienica (2), Mszana Dolna (2), Niedźwiedź (2), Nowy Targ (2), Ochotnica Dolna (2)	5
8	Stołowe Mountains	Kudowa-Zdrój (1), Lewin Kłodzki (2), Radków (3), Szczytna (3)	4
9	Kampinos	Brochów (2), Czosnów (2), Izabelin (2), Kampinos (2), Leoncin (2), Leszno (2), Łomianki (3), Stare Babice (2)	8
10	Karkonosze	Jelenia Góra (1), Karpacz (1), Kowary (1), Piechowice (1), Podgórzyn (2), Szklarska Poręba (1)	6
11	Magura	Dębowiec (2), Dukla (3), Krempna (2), Lipinki (2), Nowy Żmigród (2), Osiek Jasielski (2), Sękowa (2)	7
12	Narew	Choroszcz (3), Kobylin-Borzymy (2), Łapy (3), Sokoły (2), Suraż (3), Turośń Kościelna (2), Tykocin (3)	7
13	Ojców	Jerzmanowice-Przeginia (2), Skała (3), Sułoszowa (2), Wielka Wieś (2)	4
14	Pieniny	Czorsztyn (2), Krościenko nad Dunajcem (2), Łapsze Niżne (2), Szczawnica (3)	4
15	Polesie	Hańsk (2), Ludwin (2), Sosnowica (2), Stary Brus (2), Urszulin (2), Wierzbica (2)	6
16	Roztocze	Adamów (2), Józefów (3), Zamość (2), Zwierzyniec (3)	4
17	Słowiński	Główczyce (2), Łeba (1), Smołdzino (2), Ustka (2), Wicko (2)	5
18	Świętokrzyski	Bieliny (2), Bodzentyn (3), Górno (2), Łączna (2), Masłów (2), Nowa Słupia (2)	6
19	Tatra	Bukowina Tatrzańska (2), Kościelisko (2), Poronin (2), Zakopane (1)	4
20	Warta Mouth	Górzyca (2), Kostrzyn nad Odrą (1), Słońsk (2), Witnica (3)	4
21	Wielkopolska	Dopiewo (2), Komorniki (2), Mosina (3), Puszczykowo (1), Stęszew (3)	5
22	Wigry	Giby (2), Krasnopol (2), Nowinka (2), Suwałki (2)	4
23	Wolin	Międzyzdroje (3), Świnoujście (1), Wolin (3)	3
		Sum	**117**

Legend: (1) urban municipality, (2), rural municipality, and (3) urban-rural municipality.

As it has been indicated in methodological notes, SDMs were used to describe the analyzed elements of technical infrastructure. The research results for the first and the last year of the study are presented in the table below (Table 2).

Table 2. Synthetic development measures (SDMs) of water supply, sewage, and gas network for the municipalities territorially connected with national parks. Data covers the years 2003 and 2018.

Municipality Name	Water Supply Network				Sewage Network				Gas Network			
	2003		2018		2003		2018		2003		2018	
	SDM	L	SDM	L	SDM	L	SDM	L	SDM	L	SDM	L
Adamów (2)	0.1533	101	0.2779	90	0.0019	110	0.0069	114	0.0497	45	0.1518	42
Bargłów Kościelny (2)	0.7158	1	0.7719	1	0.0511	91	0.0552	111	0.0000	62	0.0000	73
Białowieża (2)	0.3421	53	0.3891	64	0.2672	10	0.4331	12	0.0000	62	0.0140	61
Bieliny (2)	0.2542	76	0.5088	26	0.0817	71	0.3012	44	0.0000	62	0.0198	58
Bierzwnik (2)	0.3653	42	0.3806	69	0.0136	103	0.2781	51	0.0000	62	0.0000	73
Bodzentyn (3)	0.3586	47	0.4461	43	0.0547	89	0.2633	58	0.0000	62	0.0000	73
Brochów (2)	0.3383	57	0.4266	51	0.0878	64	0.2042	75	0.0008	58	0.0204	57
Brusy (3)	0.3506	50	0.4145	56	0.1667	34	0.3389	29	0.0003	61	0.0003	72
Bukowina Tatrzańska (2)	0.1469	102	0.1419	109	0.0833	68	0.2162	72	0.0000	62	0.0004	70
Chojnice (2)	0.5153	7	0.5011	27	0.2461	13	0.3087	39	0.0000	62	0.0775	49
Choroszcz (3)	0.3849	35	0.3991	61	0.1204	52	0.1874	79	0.0175	49	0.0761	50
Cisna (2)	0.0975	112	0.2115	105	0.1278	46	0.2688	56	0.0000	62	0.0000	73
Czarna (2)	0.1618	98	0.2450	97	0.0472	92	0.0822	108	0.0285	48	0.0265	55
Człopa (3)	0.3067	67	0.3766	71	0.1657	35	0.2346	63	0.0000	62	0.0000	73
Czorsztyn (2)	0.2332	81	0.2570	94	0.3132	3	0.3891	18	0.0000	62	0.0000	73
Czosnów (2)	0.1816	93	0.4747	33	0.0444	94	0.3638	24	0.4539	20	0.5986	11
Dąbrowa Białostocka (3)	0.4265	25	0.5338	20	0.1286	45	0.1457	92	0.0000	62	0.0000	73
Dębowiec (2)	0.1750	95	0.2490	95	0.0243	101	0.2089	74	0.5666	9	0.5481	16
Dobiegniew (3)	0.3147	65	0.4100	59	0.2320	17	0.3650	23	0.0000	62	0.0000	73
Dopiewo (2)	0.4325	22	0.4275	50	0.1272	47	0.4025	14	0.2802	30	0.8027	6
Drawno (3)	0.2603	75	0.3695	74	0.1842	25	0.2481	61	0.0876	42	0.1819	41
Dukla (3)	0.2151	86	0.2676	92	0.0792	73	0.2258	68	0.5286	11	0.5271	18
Giby (2)	0.4419	20	0.4871	31	0.0000	112	0.0000	115	0.0000	62	0.0000	73
Główczyce (2)	0.2927	71	0.2997	89	0.1238	49	0.2138	73	0.0000	62	0.0000	73
Goniądz (3)	0.3385	56	0.3705	72	0.0713	78	0.1255	98	0.0000	62	0.0000	73
Górno (2)	0.3789	37	0.4424	44	0.0107	105	0.2654	57	0.0000	62	0.0016	68
Górzyca (2)	0.3748	41	0.3914	63	0.1932	23	0.3666	22	0.0312	47	0.1375	43
Grajewo (2)	0.3776	38	0.6573	5	0.0078	106	0.0073	113	0.0000	62	0.0000	73
Hańsk (2)	0.2707	74	0.4482	42	0.1755	30	0.1649	85	0.0000	62	0.0053	63
Izabelin (2)	0.1893	91	0.3816	68	0.0025	109	0.3375	30	0.8488	3	0.8487	5
Jabłonka (2)	0.3598	45	0.2315	103	0.2114	19	0.5479	5	0.0000	62	0.0000	73
Jaświły (2)	0.4459	19	0.5930	12	0.0691	79	0.1788	83	0.0000	62	0.0000	73
Jedwabne (3)	0.1624	97	0.3310	83	0.0576	86	0.0788	109	0.0000	62	0.0000	73
Jelenia Góra (1)	0.3936	32	0.4846	32	0.3097	4	0.4002	17	0.5540	10	0.5291	17
Jerzmanowice-Przeginia (2)	0.4577	17	0.4903	30	0.0000	112	0.1449	93	0.4597	18	0.5797	12
Józefów (3)	0.3432	52	0.3880	65	0.0227	102	0.1415	95	0.2092	33	0.3169	33
Kamienica (2)	0.1584	99	0.2351	100	0.0898	62	0.3249	32	0.0000	62	0.0000	73
Kampinos (2)	0.5493	3	0.6108	10	0.0827	69	0.2225	70	0.0005	60	0.0191	59
Karpacz (1)	0.3513	49	0.3777	70	0.2203	18	0.5094	7	0.5924	6	0.6000	10
Kobylin-Borzymy (2)	0.5315	5	0.5678	15	0.0000	112	0.0000	115	0.0000	62	0.0000	73
Komorniki (2)	0.4306	23	0.4408	46	0.1841	26	0.3736	20	0.4629	17	0.9347	2
Kostrzyn nad Odrą (1)	0.3216	64	0.3608	78	0.2807	8	0.3030	43	0.5828	7	0.6777	8
Kościelisko (2)	0.1555	100	0.3235	84	0.1806	27	0.2773	52	0.0000	62	0.0004	71
Kowary (1)	0.3234	62	0.3506	80	0.2405	15	0.3111	38	0.5197	12	0.4977	21
Krasnopol (2)	0.2005	89	0.4190	54	0.0000	112	0.0000	115	0.0000	62	0.0000	73
Krempna (2)	0.2295	82	0.2329	101	0.0114	104	0.1885	78	0.0010	57	0.0000	73
Krościenko nad Dunajcem (2)	0.2029	88	0.2416	98	0.1635	37	0.2835	46	0.0000	62	0.0000	73
Krzyż Wielkopolski (3)	0.3487	51	0.4379	47	0.1945	21	0.2433	62	0.0000	62	0.0000	73
Kudowa-Zdrój (1)	0.3059	68	0.3499	81	0.2875	7	0.3197	35	0.4704	16	0.4437	26
Leoncin (2)	0.1199	108	0.3126	87	0.0617	83	0.1178	103	0.0007	59	0.0000	73
Leszno (2)	0.3768	39	0.4205	53	0.0967	60	0.1281	97	0.2855	29	0.3793	31
Lewin Kłodzki (2)	0.2188	84	0.2453	96	0.1736	31	0.3432	27	0.3587	24	0.3167	34
Lipinki (2)	0.0000	117	0.0097	116	0.1485	41	0.4353	11	0.4592	19	0.5662	14
Lipnica Wielka (2)	0.0234	115	0.0000	117	0.1759	29	0.5095	6	0.0000	62	0.0013	69
Lipsk (3)	0.1728	96	0.5606	16	0.1074	55	0.1224	101	0.0000	62	0.0000	73
Ludwin (2)	0.4960	10	0.5926	13	0.0886	63	0.1811	81	0.0526	44	0.1262	45
Lutowiska (2)	0.2061	87	0.1972	106	0.1939	22	0.3167	36	0.0000	62	0.0000	73

Table 2. *Cont.*

Municipality Name	Water Supply Network				Sewage Network				Gas Network			
	2003		2018		2003		2018		2003		2018	
	SDM	L	SDM	L	SDM	L	SDM	L	SDM	L	SDM	L
Łapsze Niżne (2)	0.1009	111	0.1244	110	0.3000	5	0.3112	37	0.0000	62	0.0000	73
Łapy (3)	0.3404	55	0.3624	77	0.2627	11	0.3353	31	0.0110	51	0.0589	53
Łączna (2)	0.3857	34	0.4422	45	0.0062	107	0.1893	77	0.0081	53	0.0215	56
Łeba (1)	0.4872	11	0.5336	21	0.3757	2	0.4014	16	0.0000	62	0.0848	47
Łomianki (3)	0.1271	107	0.4738	34	0.1200	53	0.3629	25	0.9253	2	0.9368	1
Masłów (2)	0.2253	83	0.3834	67	0.0389	96	0.3040	42	0.0046	54	0.0632	52
Międzyzdroje (3)	0.2942	70	0.3082	88	0.2588	12	0.3243	33	0.3557	25	0.6014	9
Mosina (3)	0.3338	58	0.3634	75	0.0844	67	0.3080	40	0.1841	36	0.5079	20
Mszana Dolna (2)	0.0805	113	0.0764	114	0.0572	87	0.2700	55	0.3626	23	0.3882	28
Narewka (2)	0.4584	16	0.6556	6	0.1656	36	0.3800	19	0.0000	62	0.0051	64
Niedźwiedź (2)	0.1149	109	0.2129	104	0.0000	112	0.1810	82	0.3293	26	0.4262	27
Nowa Słupia (2)	0.2453	79	0.4715	35	0.0629	82	0.1997	76	0.0000	62	0.0056	62
Nowinka (2)	0.3410	54	0.6930	3	0.0290	100	0.6646	1	0.0000	62	0.0000	73
Nowy Dwór (2)	0.5759	2	0.7458	2	0.1214	51	0.1237	99	0.0000	62	0.0000	73
Nowy Targ (2)	0.1810	94	0.1240	111	0.0870	65	0.2318	65	0.0460	46	0.0806	48
Nowy Żmigród (2)	0.1295	105	0.0879	113	0.0032	108	0.2825	47	0.4476	21	0.4858	24
Ochotnica Dolna (2)	0.0102	116	0.0122	115	0.0538	90	0.4214	13	0.0000	62	0.0000	73
Osiek Jasielski (2)	0.1315	104	0.1572	108	0.0014	111	0.2242	69	0.5168	13	0.5643	15
Piechowice (1)	0.3963	30	0.3632	76	0.1769	28	0.2293	67	0.4945	15	0.4747	25
Podgórzyn (2)	0.3589	46	0.4253	52	0.1033	58	0.4627	10	0.2563	32	0.2969	36
Poronin (2)	0.2425	80	0.2679	91	0.2443	14	0.2848	45	0.0142	50	0.0142	60
Puszczykowo (1)	0.4567	18	0.5361	18	0.1234	50	0.5900	2	0.6116	5	0.7240	7
Radków (3)	0.3308	60	0.3699	73	0.0852	66	0.2804	50	0.1281	38	0.1218	46
Radziłów (2)	0.3948	31	0.4922	29	0.0726	77	0.1553	89	0.0000	62	0.0000	73
Rajgród (3)	0.1281	106	0.4939	28	0.0734	75	0.1090	105	0.0000	62	0.0000	73
Sękowa (2)	0.1416	103	0.2316	102	0.1672	33	0.2815	49	0.2950	28	0.3694	32
Skała (3)	0.4269	24	0.4599	38	0.1271	48	0.3614	26	0.3098	27	0.4947	22
Słońsk (2)	0.4048	28	0.4489	40	0.2321	16	0.2494	60	0.0086	52	0.0532	54
Smołdzino (2)	0.3650	43	0.4681	37	0.0462	93	0.1579	87	0.0000	62	0.0000	73
Sokoły (2)	0.4704	14	0.5220	23	0.1048	56	0.1560	88	0.0027	56	0.0029	67
Sosnowica (2)	0.3296	61	0.4485	41	0.1479	42	0.1587	86	0.0000	62	0.0000	73
Stare Babice (2)	0.3901	33	0.5397	17	0.1604	39	0.4865	8	0.9378	1	0.9033	3
Stary Brus (2)	0.5380	4	0.6060	11	0.0783	74	0.0823	107	0.0000	62	0.0000	73
Stęszew (3)	0.3749	40	0.4130	57	0.1034	57	0.3396	28	0.3719	22	0.5795	13
Suchowola (3)	0.5263	6	0.6893	4	0.0920	61	0.1437	94	0.0000	62	0.0000	73
Sułoszowa (2)	0.5002	9	0.5284	22	0.0000	112	0.4681	9	0.1622	37	0.2711	37
Suraż (3)	0.4802	13	0.5090	25	0.1710	32	0.2221	71	0.0000	62	0.0000	73
Suwałki (2)	0.4384	21	0.6501	7	0.0378	97	0.2772	53	0.0000	62	0.0000	73
Szczawnica (3)	0.1929	90	0.2607	93	0.1539	40	0.3216	34	0.0000	62	0.0000	73
Szczytna (3)	0.3329	59	0.3192	85	0.1336	44	0.1220	102	0.2062	34	0.2085	39
Szklarska Poręba (1)	0.3806	36	0.4121	58	0.1895	24	0.3672	21	0.5036	14	0.5105	19
Sztabin (2)	0.4809	12	0.6429	8	0.0555	88	0.0763	110	0.0000	62	0.0000	73
Świnoujście (1)	0.2911	72	0.3162	86	0.2730	9	0.3078	41	0.5811	8	0.4867	23
Trzcianne (2)	0.3109	66	0.4315	49	0.0596	85	0.1547	90	0.0000	62	0.0000	73
Tuczno (3)	0.3543	48	0.3851	66	0.2111	20	0.2749	54	0.0000	62	0.0000	73
Turośń Kościelna (2)	0.5130	8	0.5119	24	0.1114	54	0.2304	66	0.1153	39	0.2604	38
Tykocin (3)	0.3643	44	0.4365	48	0.0682	80	0.0828	106	0.0000	62	0.0000	73
Urszulin (2)	0.4039	29	0.6118	9	0.0442	95	0.2824	48	0.0000	62	0.0000	73
Ustka (2)	0.4648	15	0.5361	19	0.4554	1	0.5753	4	0.0000	62	0.0682	51
Ustrzyki Dolne (3)	0.2171	85	0.2399	99	0.1357	43	0.1492	91	0.0030	55	0.0039	66
Wicko (2)	0.2752	73	0.3979	62	0.1020	59	0.1346	96	0.0000	62	0.0050	65
Wielka Wieś (2)	0.4222	27	0.4711	36	0.0652	81	0.5776	3	0.7242	4	0.8895	4
Wierzbica (2)	0.1850	92	0.5700	14	0.0822	70	0.1673	84	0.0000	62	0.0000	73
Witnica (3)	0.2537	77	0.3339	82	0.0816	72	0.2320	64	0.2735	31	0.3872	30
Wizna (2)	0.2462	78	0.4164	55	0.0734	76	0.1229	100	0.0000	62	0.0000	73
Wolin (3)	0.2963	69	0.4079	60	0.1625	38	0.1844	80	0.1123	40	0.1831	40
Zakopane (1)	0.3233	63	0.3508	79	0.2885	6	0.4023	15	0.0622	43	0.1347	44
Zamość (2)	0.1088	110	0.1902	107	0.0336	98	0.1150	104	0.1873	35	0.3877	29
Zawoja (2)	0.0751	114	0.1021	112	0.0309	99	0.0496	112	0.0000	62	0.0000	73
Zwierzyniec (3)	0.4252	26	0.4567	39	0.0605	84	0.2598	59	0.0898	41	0.3074	35

Notes: (1) urban municipality, (2) rural municipality, and (3) urban-rural municipality; SDM—synthetic development measure value; L—position based on SDM positions from 1 to 10 are marked in gray, indicating the highest level of development regarding the studied phenomenon among the analyzed municipalities.

The municipalities ranked among the top 10 in the analyzed period, based on the rankings taking into account the values of three SDMs, are presented in the table below (Table 3).

Table 3. Ranking leaders SDMwater SDMsewage and SDMgas in the years 2003–2018.

SDM_{water}	SDM_{sewage}	SDM_{gas}
Bargłów Kościelny (**entire period**)	Białowieża (2003; 2011–2014)	Czosnów (2014–2017)
Chojnice (2003–2004)	Czorsztyn (2003–2012)	Dębowiec (2003–2006)
Grajewo (2004; 2014–2018)	Dobiegniew (2006–2008)	Dopiewo (2007–2018)
Jaświły (2005–2010)	Jabłonka (2010–2018)	Izabelin (**entire period**)
Kampinos (2003–2012; 2018)	**Jelenia Góra (2003–2010; 2013)**	**Jelenia Góra (2003–2006; 2008; 2012–2013)**
Kobylin-Borzymy (2003–2010)	**Karpacz (2014–2018)**	**Karpacz (2003–2013; 2016; 2018)**
Ludwin (2003–2013)	**Kostrzyn nad Odrą (2003–2006)**	Komorniki (2007–2018)
Narewka (2013–2018)	**Kowary (2009–2011)**	**Kostrzyn nad Odrą (2003–2013; 2017–2018)**
Nowinka (2011–2018)	Kudowa Zdrój (2003–2004)	**Kowary (2012–2013)**
Nowy Dwór (**entire period**)	**Lipinki (2015)**	**Lipinki (2014–2015)**
Stary Brus (2003–2017)	Lipnica Wielka (2013–2018)	Łomianki (**entire period**)
Suchowola (**entire period**)	Łapsze Niżne (2003–2005)	**Międzyzdroje (2015–2018)**
Sułoszowa 2003	Łapy (2005–2008)	Osiek Jasielski (2014)
Suwałki (2005–2018)	Łeba 2003–2013)	**Puszczykowo (2003-2007, 2009–2011; 2014–2018)**
Sztabin 2005–2018)	**Międzyzdroje (2004–2009)**	Stare Babice (**entire period**)
Turośń Kościelna (2003–2004)	**Narewka (2009)**	**Świnoujście (2003–2011)**
Urszulin (2011–2018)	**Nowinka (2014–2018)**	**Wielka Wieś (entire period)**
	Ochotnica Dolna (2013–2014)	
	Podgórzyn (2009–2012; 2014–2018)	
	Puszczykowo (2004–2018)	
	Skała (2012)	
	Stare Babice (2015–2018)	
	Sułoszowa (2016–2018)	
	Świnoujście (2003; 2007–2008)	
	Ustka (**entire period**)	
	Wielka Wieś (2010–2018)	
	Zakopane (2003–2013)	

Legend: the years in brackets show periods in which municipalities were ranked among the top ten. Municipalities in bold are listed in at least two columns.

It is characteristic that some of the municipalities are listed among the leaders of the rankings developed based on various SDMs. This suggests that infrastructural investments are implemented comprehensively. If a municipality has the respective financial resources, it invests simultaneously in the construction of the three analyzed networks. No regularity can be identified regarding the location of the municipalities-leaders. These municipalities are characterized by a different status (urban, rural, and urban-rural) and are connected with different national parks.

The analysis indicates a relative stability of SDMwater leaders. In the entire research period, this group included 17 municipalities. The municipalities connected with Biebrza National Park (NP), i.e., Bargłów Kościelny, and Nowy Dwór, throughout the entire studied period, were ranked as the first and the second, respectively. The comparison of positions at the beginning and at the end of the analyzed period shows that 66 examined municipalities recorded a lower, 46 a higher, and 5 maintained their position. The majority of municipalities showed changes in their ranking position. Only 40% of the municipalities changed their position by a one-digit value. In terms of growth, Leipzig (connected with Biebrza NP) was the dominating one (increased by 80 positions in the ranking), whereas the largest drop (by 58 positions) was recorded by Jabłonka municipality (Babia Góra NP).

The absolute growth in SDMwater value, calculated as the difference in SDMwater value in 2018 (analyzed) and 2003 (baseline), indicates that the measure value dropped only in 12 municipalities: Jabłonka, Nowy Targ, Nowy Żmigród, Piechowice, Lipnica Wielka, Chojnice, Szczytna Lutowiska, Bukowina Tatrzańska, Dopiewo, Mszana Dolna, and Turośń Kościelna. It means that the development of water supply network was recorded in the vast majority (90%) of municipalities, levelling off the increase in the number of users.

Positive changes in the value of SDMwater were primarily the consequence of a longer distribution network; as many as 106 municipalities extended their water supply network. Łomianki municipality was the leader in this respect (the length of the functioning distribution network increased by 144 km). It should be noted, however, that this municipality is territorially connected with Kampinos NP and located near the country capital. Łomianki—in a sense—was affected by the suburbanization phenomenon, resulting from the residential housing pressure of Warsaw community.

The observations during the period 2003–2018 allow stating that the infrastructure that provides access to water is developing in the vast majority of the analyzed municipalities. This phenomenon should definitely be considered a positive one.

This analysis indicates that in the case of SDMsewage the leadership changes were much greater than in relation to SDMwater. In the analyzed period, 27 municipalities were listed among the top ones. In the Ustka municipality, which is connected with Słowiński, NP was the leader and for most part the studied period was ranked first. The second position was undisputedly taken by the Puszczykowo municipality located near Poznań metropolis (Wielkopolska NP).

The comparison of positions occupied at the beginning and at end of the research period shows that 68 analyzed municipalities recorded lower and 48 higher, while one maintained its ranking position. The majority of municipalities were characterized by significant changes in their ranking positions. Only 23% of them changed their position by a one-digit value. In terms of growth, Sułoszowa municipality connected with Ojców NP dominated (increase by 103 places in the ranking) and the largest drop (by 58 places) was noted for Szczytna municipality (Stołowe Mountains National Park).

The absolute growth in SDMsewage value, calculated as the difference in SDMsewage value in 2018 (analyzed) and 2003 (baseline), indicates that the measure value dropped only in three municipalities: Szczytna, Hańsk, and Grajewo. Due to the fact that the sewage network does not exist in all the municipalities of Giby, Krasnopol, and Kobylin-Bokuje, (they occupied ex aequo in the last position in the ranking), it can be stated that in approximately 95% of the analyzed municipalities in the sewage network development leveled off the increase in the number of users.

Positive changes in the value of SDMsewage resulted mostly from the increase in the length of sewage network. As many as 106 municipalities recorded this network extension. The Jabłonka municipality, which is connected with Babia Góra NP, was the leader in this respect (the length of the network increased by 106 km).

The observations made for the period 2003–2018 allow stating that the sewage infrastructure is under development in the vast majority of the analyzed municipalities. This phenomenon should definitely be considered a positive one.

The analysis shows that in the case of SDMgas, the group of leaders included 17 municipalities, which was identical for SDMwater. Keepin in mind that as many as 17 units did not have a gas network during the study period (thus ranked ex aequo at the last position), it can be adopted that the variability in this respect was slightly higher than in the case of SDMwater. The unquestionable ranking leaders were: Łomianki municipality (first or second ranking position throughout the entire analyzed period) and Stare Babice municipality (first or second position, and incidentally, in 2008, fourth in the ranking) connected with Kampinos NP, and located in the vicinity of Warsaw.

The comparison of positions from the beginning and the end of the analyzed period shows that 87 examined municipalities recorded a decrease and 25 an increase, while five maintained their position. In total, 60 municipalities changed their position by two-digit values, which constituted a slight majority. In terms of growth, Dopiewo municipality connected with Wielkopolska NP was the dominating one (increase by 24 ranking positions) and the largest drop (73 places) was recorded by the Krempna municipality (Magura NP).

The absolute growth in SDMgas value, calculated as the difference in SDMgas value in 2018 (analysed) and 2003 (baseline), indicates that the measure value dropped in 15 municipalities: Świnoujście, Lewin Kłodzki, Stare Babice, Kudowa-Zdrój, Jelenia Góra, Kowary, Piechowice, Dębowiec, Radków, Czarna, Dukla, Krempna, Leoncin, and Izabelin oraz Brusy.

Bearing in mind that the gas network is nonexistent in the municipalities of Sosnowica, Stary Brus, Urszulin, Kamienica, Szczawnica, Zawoja, Lutowiska, Bargłów Kościelny, Lipsk, Grajewo, Radziłów, Jedwabne, Wizna, Giby, Krasnopol, Nowy Dwór, and Szczawnica (they occupied ex aequo the last ranking position), it can be stated that the development of a gas network was recorded in almost 73% of the analyzed municipalities, which leveled off the increase in the number of users.

Positive changes in SDMgas value derived mainly from a larger number of populations using gas networks. Due to the absence of data on the length of a functioning network, it can be presumed that not only the number of connections but the length of the network increased. The development of the gas network in the analyzed municipalities should be assessed positively.

5. Discussion

It is difficult to indicate the research comparable to the one presented in the article. The authors are aware of this situation and the reasons for no comparability of the studies on Polish national parks with the national parks in other countries have already been described in detail [3]. Although national parks are known worldwide, this term is associated with different security regimes in various countries, as well as organizational and legal differences resulting from the functioning forms of such parks and also the rights and entitlements of local authorities. These differences often result from just the size of the park. However, the above does not change the fact that Polish national parks represent an important link in the protection of European nature and also an important destination for domestic tourist traffic.

The specificity of protected areas means that from both natural and economic perspectives it is important to properly understand the message presented on the Federation of Nature and National Parks of Europe (EUROPARC Federation) website: "nature knows no boundaries" [33]. Nature protection requirements are not synonymous with the need to eliminate a human being from the protected space. The research results indicate that the function of nature conservation, as well as the economic functions (including tourism), are not mutually exclusive [34]. However, the communities residing in the municipalities territorially connected with national parks, the investors operating within the discussed area and also tourists have to comply with stricter environmental standards.

Users make space evolve, as it changes physically and functionally. This refers to both urban space [35,36], rural areas [37,38], and valuable natural areas the least changed by a man. Therefore, in the context of the presented article, this phenomenon applies to the area of national parks and the areas of municipalities connected with them.

The EUROPARC Federation clearly emphasizes that sustainable tourism is desirable for both parks and people (in the sense of local communities and tourists). At the same time, it should be emphasized that the concept of sustainable tourism is still open and widely discussed. Even though there is a consensus regarding the principle that an ongoing and sustainable development of tourism is such a method for doing business and organizing social life, which ensures both the development and preservation of the environmental values along with improving the quality of people's lives, there are still many detailed interpretations of the discussed concept [39,40].

Balancing the tourist function not only takes time but it remains a complicated process [33,40]. The significance of the aforementioned issue is also strengthened by the fact that 2017 was announced the International Year of Sustainable Tourism for Development.

To sum up, it can be stated that technical infrastructure is indispensable not only for the development of economic initiatives (including the who influences the multifunctional and sustainable development of municipalities. It is natural, then, that technical infrastructure has to be supplemented by social infrastructure (these problems—although very interesting—are not the subject matter of this article).

6. Conclusions

The conducted empirical research allowed us to achieve our defined research goals. We were forced to adjust the adopted indicators to the available statistical data. Despite that, we managed to develop measures that allowed for a comprehensive and measurable approach to the analyzed problems.

The collected results allowed us to conclude that, between 2003–2018, the development of the analyzed technical infrastructure elements were recorded in the vast majority of municipalities. Therefore, the level of anthropopressure declined, which was caused by the local community and tourists in municipalities within the most valuable natural areas.

The largest percentage of municipalities that were characterized by an increase in synthetic development measures were referred to sewerage network research. As many as 95% of the analyzed municipalities recorded an increase in the absolute value of SDMsewage in the period 2003–2018. Slightly lower values were true for the water supply network, in the case of which development was observed in 90% of municipalities. The poorest—although not to be considered bad—refer to the gas network. In total, 73% of the studied municipalities recorded development in this area.

In view of the above, the research hypothesis put forward at the beginning of the article should be adopted and it should be recognized that the development of water supply, sewage, and gas networks is observed in the municipalities territorially connected with national parks.

The interpretation of the collected results (SDMwater, SDMsewage, and SDMgas) highlight an important nuance: in the set of 117 units there are both urban municipalities which, in the past, played the role of voivodship capitals (Jelenia Góra), and also rural municipalities inhabited by less than 2000 people (Lewin Kłodzki, Cisna). Hence, the settlement and population system as well as the wealth of local governments in the analyzed municipalities are very different. It is highly positive that despite the abovementioned differences, the municipalities remain connected not only by their tourist attractiveness and unique nature, but also by striving to protect it. Its measurable expression is the identified development of the analyzed technical infrastructure elements, which is highly important in the context of aiming at sustainable tourism development in the naturally valuable areas.

Summing up the presented discussion it should, yet again, be emphasized that the processes occurring in the environment or the exchange of value streams between specific spaces do not respect the administrative boundaries of the protected area. Therefore, the functioning of the analyzed technical infrastructure is extremely important for the nature protection of national parks.

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