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Global warming and avifauna from the Argeş River dam basins (Southern Romania) – long term study case

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Abstract. An attempt to find a link between the global warming, manifested on local scale, and the dynamics of the winter avifauna recorded on the Vâlcele, Budeasa, Bascov, Piteşti and Goleşti Dam Basins from ROSPA0062 Lacurile de acumulare de pe Argeş was achieved in the paper. Based on the data collected between 1999 and 2020 during the MidWinter (the Winter Census of the Wetland Birds), some major conclusions were drawn: the climate change resulted from the analyse of the air temperature registered in the area and it was noticeable in some measure on the phenology of the birds; it influenced the dynamics of the avifauna, as total number of species and individuals, as well as the strength of every species; also, other local and extern elements, like the process of silting of the dam basins, the direct anthropogenic pressure, were involved here.

Keywords: global warming, dynamics of birds, human pressure.

Introduction

The global warming is a delicate topical issue, because not the whole scientific world agrees that it is caused by the human activities (Niederer, 2013). It menaces both the human health and the wildlife. Many species will have to adapt but other won't be able to do this and some predictions show that an increase in temperature of ca. 2°C would induce an extinction of 20-30% of species (Tekalign and Balakrishinan, 2016). Regarding the birds, the climatic change is causing advanced spring migration, changes of habitat, higher possibility of disease transmission, earlier egg-laying time, less food availability and a decline in the population (Li *et al.*, 2022). Also, the warming influences the time of the autumn migration that are starting earlier (Cotton, 2003) and the choice of the wintering sites (Li *et al.*, 2022). These places can be used as an indicator, since the bird wintering centre of abundance continuously are moving to the North (https://www.epa.gov/). Particularly, the waterbirds show a high degree of adaptability to these challenges, because they establish new quarters of wintering (Fox *et al.*, 2019). Also, the displacement of the breeding range for some wetland species was documented as a consequence of the changes of the latitudinal temperature and of the corresponding changed pattern of precipitations (Soultan *et al.*, 2022), though the wintering bird communities are tracking the climate change faster than the breeding communities (Lehikoinen *et al.*, 2021). A recent study on the European birds revealed that the rising temperatures are affecting even the morphology of the birds, while some species reduced their body size and other increased it (McLean *et al.*, 2022). The changes of the body length affected mainly the migratory birds and the changes in body mass affected mainly the non-migratory birds (Dubiner and Meiri, 2022).

The study of the avifauna of the artificial reservoirs begun from the premise that it helps to see how the human pressure exercises on the natural environment, because it is known that the construction of the dam basins destroys the old habitats and creates new ones. They can become good places to live for the birds, mainly outside of the breeding season, the more so as the adequate management plans are implemented (Munteanu and Mătieş, 1983).

In this context, the ornithofauna of the Argeş River dam basins was the subject of many papers still 1960s-1970s, when the reservoirs started to be built. Mătieş (1969) published the first paper on the theme, in which he talked about the birds from the Vidraru dam basin. Only a few works have longer issued until 1990 (Munteanu and Mătieş, 1983, Munteanu *et al.*, 1989), though the avifauna of the dam basins was in the core of the researches of Mircea Mătieş until 1982, when he prematurely died. Activated by the founding of the local branch of the Romanian Ornithological Society in 1990, the researches have focused on the dam basins between Vâlcele and Goleşti and a series of papers, mainly about the winter avifauna, appeared (Gava, 1997, Mestecăneanu *et al.*, 2003, Gava *et al.*, 2004a, 2004b, Gava *et al.*, 2007, Conete, 2011, Conete *et al.*, 2012, Mestecăneanu *et al.*, 2013, Mestecăneanu & Gava, 2015, 2016a, 2018, 2019a, etc.). Meanwhile, the ornithofauna of the other dam basins from the Argeş River was occasionally approached (Petrescu, 2005, Mestecăneanu and Mestecăneanu, 2018-2019, Mestecăneanu, 2019).

Our goal is to find in what extent the phenomenon of the global warming, reflected on local scale, affected the birds from the dam basins of the Argeş River. Specifically, we aimed to answer following questions: did the global warming manifest in the researched area during the period of study? did the global warming reflect in the birds' phenology? was there a trend over years of the number of species and of the number of individuals? was there a good correlation between the variation of the average temperature of the air and the dynamics of the avifauna?

Materials and methods

1. The natural setting of the study area

The dam basins where the research-study was performed belong to ROSPA0062 Lacurile de acumulare de pe Argeş (in English, The dam basins from the Argeş River). They are characterized by a large variation in size, from 122 ha (Piteşti) to 649 ha (Goleşti), while Vâlcele has 408 ha, Budeasa, 412 ha, and Bascov, 162 ha. The Argeş River springs from the Făgăraş Mountains and flows to Danube, gathering the waters from the Transilvanian Alps, Sub-Carpathians, Gethic Piedmont, and the Romanian Plain. The uppstream reservoirs (Vâlcele, Budeasa and Bascov) are situated between the Cotmeana Piedmont, Argeş Hills and the Cândeşti Piedmont, while the downstream ones (Piteşti and Goleşti) are located in the Piteşti High Plain, a subunit of the Romanian Plain (Fig. 1).

The climate is temperate continental with hilly features in the North and plain traits in the South. As a result, the yearly average temperature is 9 ^{0}C, at Piteşti (Barco and Nedelcu, 1974).

The vegetation of the area depends on the relief. The broadleaf forests with *Fagus sylvatica*, in the colder valleys, and with *Quercus* sp., in the warmer plateaux, predominate and interfere with meadows, orchards and settlements. Some buildings are situated next to the water bodies, mostly the case of Piteşti Town, Budeasa and Vâlcele Villages. Mainly toward the ends of the basins and on the islands formed by the silting process, the vegetation gets aspect of wetlands, with coppices of *Alnus glutinosa*, *Salix* sp., *Populus* sp. and reed beds of *Typha* sp. and *Phragmites australis*.

Regarding the human pressure, the settlements are interconnected through a dense web of roads. A highway passes by the Bascov, Piteşti and Goleşti Dam Basins and belt roads border the reservoirs. Some supermarkets were also built in the vicinity of Piteşti and Goleşti. The fishing, poaching, clearing of trees, and the nautical sports, particularly on Bascov, more rarely on Piteşti, are practiced in the area. While the basins are provided with concrete slopes on large areas, some birds use them for resting, like some herons, ducks and cormorants, or for feeding, like some Passeriformes or waders (Mestecăneanu and Gava, 2018).

2. The data collection on birds

Systematically observations performed during 1999-2020 lay to the basis of this study. Generally, they were gathered in the second weekend of January, during the Winter Census of the Wetland Birds, known better as the MidWinter. This is coordinated in Romania by the Romanian Ornithological Society and by the Milvus Group and, on the European level, by Wetlands International. It is a synchronous event whose main purpose is to estimate the birds' populations of the continent to take adequate measures to protect them (https://milvus.ro/). The dam basins were visited once every month, during a day, between 9:00 and 16:00. The dependent of wetlands birds were counted and, additionally, the other individuals from the basins' perimeter. The itinerary method and the method of observations from the fixed points, where the first was unapplied, were used and, as tools, binoculars, a spotting scope and a photo device. The data were worked in Excel to compute some ecological indicators (the constancy, the dominancy, the Dzuba index of ecological significance), respectively correlations and regressions, by the conventional methods (Gomoiu and Skolka, 2001, Zamfirescu and Zamfirescu, 2008). Species denominations and their main phenologic belonging correspond to the Hamlin Guide (Bruun *et al.*, 1999).

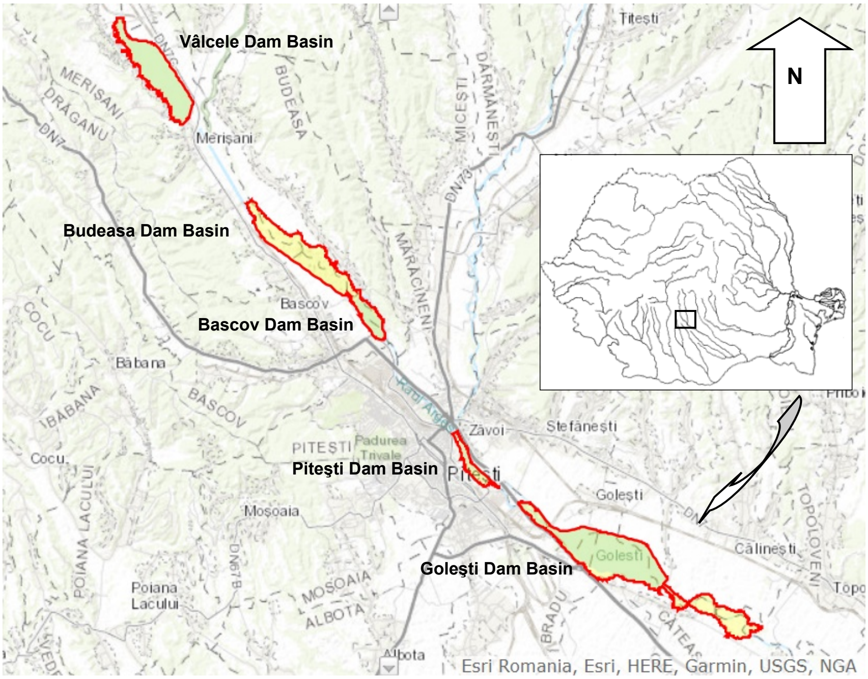

Figure 1. The map of the researched area
(by https://natura2000.eea.europa.eu/, modified).

3. The data collection on clime

The temperature of the air was measured at the Piteşti Weather Station. The values were collected by standard method generally utilised in meteorology. To respond to the questions that underlie this approach, the average temperature of the day was used to calculate the average temperature of January, December, December-January interval, respectively diverse periods of time before the day of observation (3 days, 7 days, 10 days, 14 days, 20 days, 30 days, 45 days, the first 7 days from January, the last 15 days from December, the first 16 days from December), starting from the idea that the temperature of the air is a key factor that influences the dynamics of birds. The trend and the correlation were used to verify this assumption. The data were worked in Excel, too.

Results and discussions

Before discussing the issue of the global warming influence on the dam basins avifauna, we have to establish the context. Thus, during the census, between 1999 and 2020, 88 species of birds were observed in the area and 275,530 individuals. Among them, 38 species (43.8%) represented by 267,759 individuals (97.17%) were dependent on wetlands (Tab. 1). 8 species belong to the Annex I of the Birds Directive 2009/147/CE: most of them (7 species, *Gavia arctica*, *Pelecanus crispus*, *Phalacrocorax pygmeus*, *Cygnus cygnus*, *Egretta alba*, *Haliaeetus albicilla* and *Alcedo atthis*) are dependent on wetlands and 1 species (*Circus cyaneus*) is a terrestrial species.

Table 1. The species of birds observed in the area, the constancy, dominance, Dzuba index of ecological significance, the main phenology in Romania and the percentage increase of strengths from 1999-2009 to 2010-2020.

No.	Species	Constancy	Category of constancy	Dominance	Category of dominance	Dzuba index of ecological significance	Category of Dzuba index of ecological significance	Main phenology in Romania	Percentage increase (1999-2009 – 2010-2020)
1	*Gavia arctica**	9.09	C1	0.00	D1	0.00	W1	W	0
2	*Podiceps cristatus**	72.73	C3	0.10	D1	0.07	W1	S	73.20
3	*Podiceps grisegena**	4.55	C1	0.00	D1	0.00	W1	S	-100
4	*Podiceps nigricollis**	22.73	C1	0.01	D1	0.00	W1	PM	325.00
5	*Tachybaptus ruficollis**	100	C4	0.52	D1	0.52	W2	S	-30.33
6	*Pelecanus crispus**	4.55	C1	0.00	D1	0.00	W1	S	x

7	*Phalacrocorax carbo**	77.27	C4	0.84	D1	0.65	W2	S	523.44
8	*Phalacrocorax pygmeus**	86.36	C4	0.28	D1	0.24	W2	S	73.59
9	*Egretta alba**	77.27	C4	0.08	D1	0.06	W1	S	76.62
10	*Ardea cinerea**	90.91	C4	0.05	D1	0.04	W1	S	-17.65
11	*Cygnus olor**	100	C4	2.18	D3	2.18	W3	PM	-5.91
12	*Cygnus cygnus**	63.64	C3	0.14	D1	0.09	W1	W	498.21
13	*Anser albifrons**	40.91	C2	0.73	D1	0.30	W2	W	151.39
14	*Anas platyrhynchos**	100	C4	41.89	D5	41.89	W5	PM	10.60
15	*Anas strepera**	13.64	C1	0.00	D1	0.00	W1	S	x
16	*Anas acuta**	18.18	C1	0.00	D1	0.00	W1	P	-25.00
17	*Anas penelope**	77.27	C4	0.39	D1	0.30	W2	P	851.46
18	*Anas crecca**	100	C4	5.46	D4	5.46	W4	P	107.13
19	*Anas clypeata**	13.64	C1	0.01	D1	0.00	W1	P	x
20	*Tadorna tadorna**	54.55	C3	0.05	D1	0.02	W1	S	6,050
21	*Netta rufina**	4.55	C1	0.01	D1	0.00	W1	S	x
22	*Aythya marila**	4.55	C1	0.00	D1	0.00	W1	W	-100
23	*Aythya fuligula**	90.91	C4	2.37	D3	2.15	W3	W	110.71
24	*Aythya ferina**	86.36	C4	9.36	D4	8.08	W4	PM	280.72
25	*Aythya nyroca*	27.27	C2	0.00	D1	0.00	W1	S	75.00
26	*Bucephala clangula**	86.36	C4	0.64	D1	0.55	W2	W	572.49
27	*Mergus albellus**	72.73	C3	0.05	D1	0.04	W1	W	-25.93
28	*Haliaeetus albicilla**	4.55	C1	0.00	D1	0.00	W1	PM	-100
29	*Buteo lagopus*	4.55	C1	0.00	D1	0.00	W1	W	-100
30	*Buteo buteo*	90.91	C4	0.03	D1	0.03	W1	PM	50
31	*Accipiter gentilis*	9.09	C1	0.00	D1	0.00	W1	R	-100
32	*Accipiter nisus*	31.82	C2	0.00	D1	0.00	W1	R	-42.86
33	*Circus cyaneus*	27.27	C2	0.00	D1	0.00	W1	W	-25.00
34	*Falco tinnunculus*	59.09	C3	0.01	D1	0.00	W1	PM	33.33
35	*Perdix perdix*	22.73	C1	0.02	D1	0.00	W1	R	-86.96
36	*Phasianus colchicus*	18.18	C1	0.00	D1	0.00	W1	R	700
37	*Gallinula chloropus**	54.55	C3	0.02	D1	0.01	W1	S	-14.71
38	*Fulica atra**	100	C4	10.31	D5	10.31	W5	PM	-1.13
39	*Gallinago gallinago**	18.18	C1	0.00	D1	0.00	W1	P	-83.33
40	*Tringa ochropus**	45.45	C2	0.01	D1	0.00	W1	P	-57.14
41	*Larus argentatus**	100	C4	4.35	D3	4.35	W3	R	110.31
42	*Larus canus**	86.36	C4	5.18	D4	4.48	W3	W	521.84
43	*Larus ridibundus**	100	C4	12.13	D5	12.13	W5	PM	150.32
44	*Columba palumbus*	9.09	C1	0.10	D1	0.01	W1	S	x
45	*Streptopelia decaocto*	63.64	C3	0.02	D1	0.01	W1	R	557.14
46	*Alcedo atthis**	18.18	C1	0.00	D1	0.00	W1	PM	300
47	*Picus viridis*	18.18	C1	0.00	D1	0.00	W1	R	x
48	*Picus canus*	9.09	C1	0.00	D1	0.00	W1	R	0
49	*Dedrocopos major*	27.27	C2	0.00	D1	0.00	W1	R	500
50	*Dendrocopos syriacus*	4.55	C1	0.00	D1	0.00	W1	R	x
51	*Galerida cristata*	31.82	C2	0.01	D1	0.00	W1	R	-81.25
52	*Anthus spinoletta*	68.18	C3	0.05	D1	0.03	W1	S	-65.96
53	*Motacilla cinerea**	9.09	C1	0.00	D1	0.00	W1	S	x
54	*Motacilla alba*	9.09	C1	0.00	D1	0.00	W1	S	-75.00
55	*Lanius excubitor*	36.36	C2	0.00	D1	0.00	W1	PM	-33.33

56	*Sturnus vulgaris*	9.09	C1	0.00	D1	0.00	W1	PM	-100
57	*Garrulus glandarius*	22.73	C1	0.00	D1	0.00	W1	R	600
58	*Pica pica*	95.45	C4	0.27	D1	0.26	W2	R	-13.75
59	*Corvus monedula*	72.73	C3	0.40	D1	0.29	W2	R	12.65
60	*Corvus frugilegus*	90.91	C4	0.66	D1	0.60	W2	R	-24.07
61	*Corvus corone cornix*	90.91	C4	0.06	D1	0.06	W1	R	-38.89
62	*Corvus corax*	81.82	C4	0.07	D1	0.06	W1	R	-40.50
63	*Troglodytes troglodytes*	22.73	C1	0.00	D1	0.00	W1	S	300
64	*Prunella modularis*	9.09	C1	0.00	D1	0.00	W1	S	-100
65	*Regulus regulus*	13.64	C1	0.00	D1	0.00	W1	PM	x
66	*Phoenicurus ochruros*	9.09	C1	0.00	D1	0.00	W1	S	x
67	*Turdus merula*	45.45	C2	0.01	D1	0.00	W1	PM	42.86
68	*Turdus viscivorus*	4.55	C1	0.00	D1	0.00	W1	PM	-100
69	*Turdus pilaris*	31.82	C2	0.07	D1	0.02	W1	PM	92.42
70	*Parus palustris*	4.55	C1	0.00	D1	0.00	W1	R	x
71	*Parus caeruleus*	72.73	C3	0.04	D1	0.03	W1	R	102.78
72	*Parus major*	81.82	C4	0.04	D1	0.03	W1	R	230.43
73	*Aegithalos caudatus*	9.09	C1	0.00	D1	0.00	W1	R	x
74	*Sitta europaea*	9.09	C1	0.00	D1	0.00	W1	R	x
75	*Passer domesticus*	59.09	C3	0.07	D1	0.04	W1	R	548.00
76	*Passer montanus*	68.18	C3	0.12	D1	0.08	W1	R	42.42
77	*Fringilla coelebs*	68.18	C3	0.13	D1	0.09	W1	PM	48.99
78	*Fringilla montifringilla*	9.09	C1	0.01	D1	0.00	W1	W	100
79	*Pyrrhula pyrrhula*	9.09	C1	0.00	D1	0.00	W1	R	x
80	*Coccothraustes coccothraustes*	9.09	C1	0.00	D1	0.00	W1	R	-100
81	*Carduelis chloris*	50.00	C2	0.02	D1	0.01	W1	R	310
82	*Carduelis spinus*	22.73	C1	0.03	D1	0.01	W1	PM	1,660
83	*Carduelis carduelis*	81.82	C4	0.38	D1	0.31	W2	R	-52.99
84	*Carduelis cannabina*	27.27	C2	0.04	D1	0.01	W1	PM	736.36
85	*Emberiza schoeniclus**	59.09	C3	0.02	D1	0.01	W1	PM	-33.33
86	*Emberiza citrinella*	77.27	C4	0.14	D1	0.11	W2	R	383.33
87	*Plectrophenax nivalis*	4.55	C1	0.00	D1	0.00	W1	W	x
88	*Miliaria calandra*	4.55	C1	0.00	D1	0.00	W1	PM	x

Legend: * – species dependent on wetlands; C1 – occasional species, C2 – accessory species, C3 – constant species, C4 – euconstant species; D1, W1 – subrecedent species, D2, W2 – recedent species, D3, W3 – subdominant species, D4, W4 – dominant species, D5, W5 – eudominant species; PM – partial migratory species, W – winter visitor, S – summer visitor, R – resident species; P – species of passage; x – no meaning operation.

The species and the individuals were not equally distributed on the dam basins and the situation do not differ much if we consider the species dependent on wetlands (Tab. 2). In terms of percentual weight, that expresses the percent of species, respectively individuals registered on each dam basin of all species, respectively individuals registered on whole studied area, it is obvious that the trend of the total number of individuals was strongly increasing from upstream to downstream. As a result, the size of the dam basins and the type of the habitats had a secondary role in the birds' distribution. Instead, the influence of the nautical base from the Bascov Dam Basin was clear and it becomes more obvious if we compare Bascov to Pitești, the later with even a lower area than the first. While the two are the smallest of all dam basins and have relatively similar habitats, Pitești is the second as number of individuals, after Golești, the largest one, while Bascov is the latest. The position on the river course is less important regarding the number of species, which remained stable around value of 60 and that, however, tended to increase from upstream to downstream in the case of the species dependent on wetlands. The smallest reservoirs remarked through the maximum (the Pitești Dam Basin), respectively the minimum (the Bascov Dam Basin) number of species, which highlights, again, the importance of the anthropological pressure for the avifauna (Fig. 2). It is worth to mention, too, that Pitești Dam Basin follows by Bascov Dam Basin on the river course.

Table 2. The weight of species and individuals (%) on each dam basin of all registered species, respectively individuals.

Dam basin	Golești	Pitești	Bascov	Budeasa	Vâlcele
Species weight	69.32	77.27	54.55	64.77	76.14
Individuals weight	54.09	20.62	2.48	14.96	7.86
Species weight*	81.58	81.58	57.89	73.68	78.95
Individuals weight*	54.80	20.12	2.38	15.07	7.63

Legend: * - for the species dependent on wetlands.

The occasional species and the subrecedent species prevailed, both by the dominance index and by the Dzuba index of ecological significance (Tab. 1, 3). It is noticeable that no species was recedent by the dominance index, and all subdominant, dominant and eudominant species, the two considered indices, are also euconstant species. The eudominant species totalised 64.32% of all strengths and the dominant species, 19.99%.

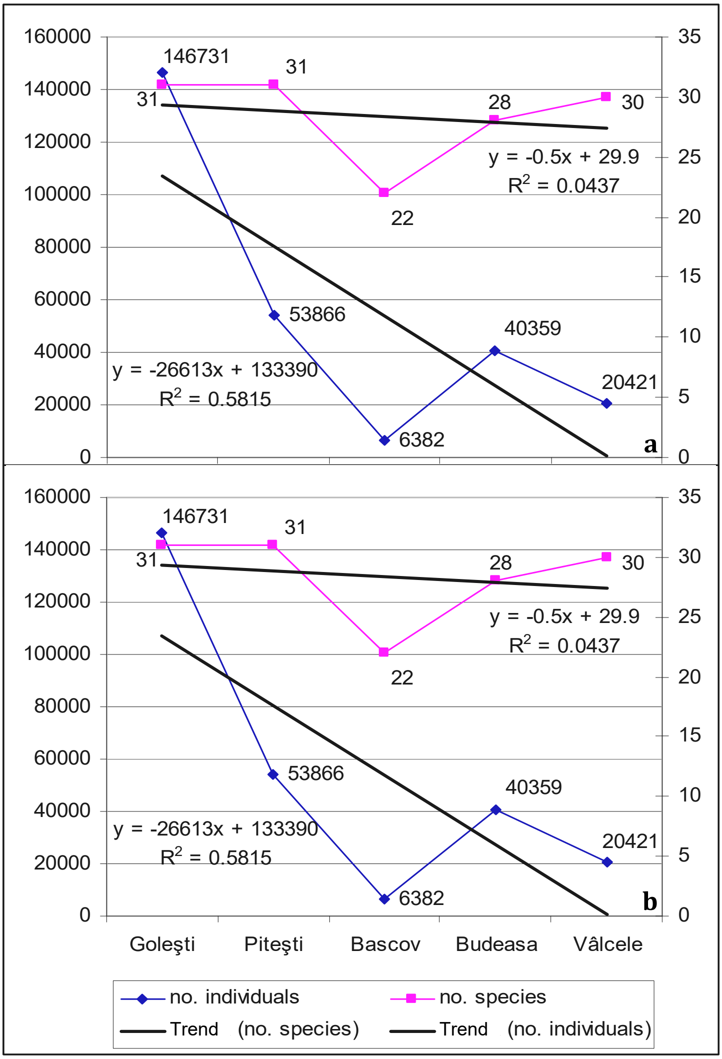

Figure 2. The distribution of species and individuals (a), respectively of species and individuals dependent on wetlands (b) on each dam basin.

Table 3. The distribution of species and their percent of all, by the categories of constancy, dominance and Dzuba index of ecological significance.

Class		1	2	3	4	5
C	**No. species**	38	12	14	24	-
	Weight (%)	43.18	13.64	15.91	27.27	-
D	**No. species**	79	0	3	3	3
	Weight (%)	89.77	0.00	3.41	3.41	3.41
W	**No. species**	68	11	4	2	3
	Weight (%)	77.27	12.50	4.55	2.27	3.41

Legend: constancy (C), 1 – occasional species, 2 – accessory species, 3 – constant species, 4 – euconstant species; dominance (D) and Dzuba index of ecological significance (W), 1 – subrecedent species, 2 – recedent species, 3 – subdominant species, 4 – dominant species, 5 – eudominant species.

Related on the subject of the influence of the global warming on the avifauna of the dam basins, there are some questions we have to respond, as follows.

1. Did the global warming manifest in the researched area?

A strong trend of increase of the average air temperature there was both in January and December, and well as in the period December-January when the observations were performed, but the spreading of the points on the graph around the regression lines is very height, which means a low correlation between the variables. The average temperatures varied very much, even between consecutive years, e.g., the minimum of January (-3.72°C) was recorded in 2006, while the maximum (4.84°C) was recorded in 2007 (Fig. 3). We considered that, for an increase/decrease of more 5% a period, there was a strong increase/decrease, for an increase/decrease of less 5% a period, there was a moderate increase/decrease, and for an increase/decrease of less 1% a period, there was a stable situation.

However, if we compare the period 1998-2008 to the period 2009-2020 (both of 11 years), we see that the average air temperature for December, preceding the time of observations, increased with 1.21°C, from 0,49°C to 1.70°C. For January, when the observations were performed, it decreased with 0.17°C, from -0.20°C to -0.37°C, and for December-January, it increased with 0.52°C, from 0.14°C to 0.66°C. So, the winters seem to arrive later and to become warmer, though January seems to get a little colder, in spite of the increasing trend for the whole interval 1999-2020.

Considering the whole period, the average for December-January was 0.40°C, while for December it was 1.10°C and for January, -0.29°C. By comparison with the average of the air temperature recorded during 1900-1970 (Gava, 2009), the changing is more obvious, the temperature increasing with 0.90°C in December and with 2.30°C in January. Although the Pitesti Weather Station, where the measurements were made, is located on the outskirts of the city, the increase in average air temperature is probably correlated to some extent with the urban development, too.

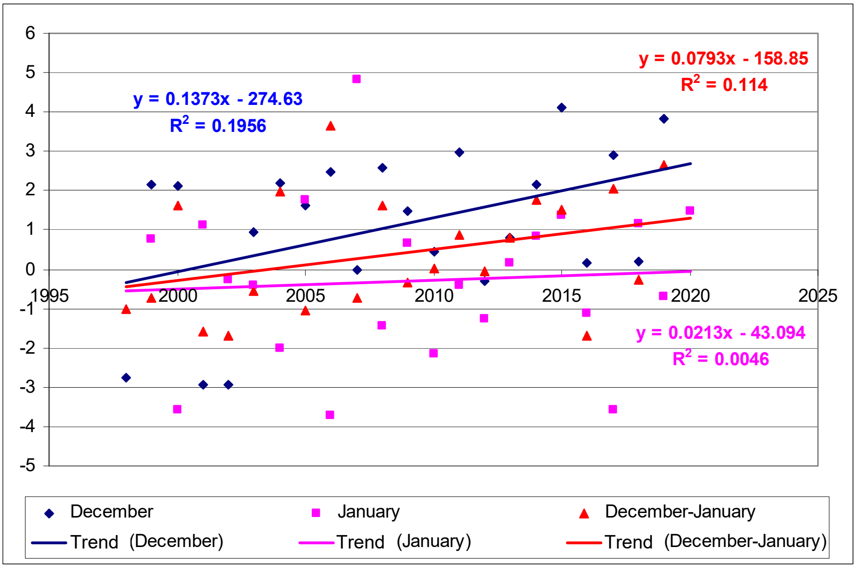

Figure 3. The distribution of the average values of temperature in December, January and in December- January for 1999-2020, at Piteşti.

2. Did the global warming reflect in the birds' phenology?

The weight of the partial migratory species and the weight of the winter visitors decreased from 1999-2009 to 2010-2020, and, instead, the weights of the summer visitors, resident species and species of passage increased. Regarding the species dependent on water, the situation is relatively similar, except for the resident species, for which the weight decreased and not increased. Additionally, we see that the later species had a much smaller importance than in the case of all species and that the resident species, followed by the partial migratory species, had the highest weights among all species, while the summer visitors had the highest weight among the species dependent on wetlands.

By Bruun *et al.* (2009), all eudominant species (*Anas platyrhynchos*, *Fulica atra* and *Larus ridibundus*) are considered migratory species, while, among the dominant species, *Anas crecca* is considered species of passage, *Aythya ferina*, migratory species and *Larus canus*, winter species.

As number of individuals, the partial migratory species decreased as weight, from 1999-2009 to 2010-2020, while the other phenological categories considered to the national level increased, and, here, the winter visitors catch the eye, because their share of the total increased from 4.74 to 11.91 (Tab. 4). Practically, they increased with 299.52% from 1999-2009 to 2010-2020, while the partial migratory species increased with only 40.24%, the summer visitors increased with 114.57%, the passage species increased with 122.02% and the resident species increased with 58.15%, where the total number of individuals increased with 58.86%. The increase of the winter visitors is mainly owned to *Larus canus*, dominant species, because its strength increased with 521.84%, while *Aythya fuligula*, subdominant species, increased with 110.71%. The other winter visitors are subrecedent species (their importance in the ecosystem is low as number of individuals), and, here, it is worth to mention the species dependent on wetlands: *Cygnus cygnus*, *Anser albifrons*, *Bucephala clangula*, whose strengths increased with 498.21%, 151.39%, respectively 572.49%, and *Aythya marila* and *Mergus albellus*, whose strengths decreased with 100%, respectively 25.93%. The two species of gulls, with relatively similar predilection of habitats, also showed increasing strengths with 110.31%, for *Larus argentatus* (resident species, today divided into several taxa), and with 150.32%, for *Larus ridibundus* (partial migratory species). Huge increasing strengths had *Tadorna tadorna* (6,050%), summer visitor, *Carduelis spinus* (1,660%), partial migratory species, *Anas penelope* (851.46%), passage species, *Carduelis cannabina* (736.36%), partial migratory species, *Phasianus colchicus* (700.00%), resident species, *Garrulus glandarius* (600.00%), resident species etc. (Tab. 1). As a result, it means that the phenology of the species was influenced not only by the global warming, but also by other factors such as the development of the habitats (the apparition of new bare shores, shallow waters, coppices, reed beds etc.).

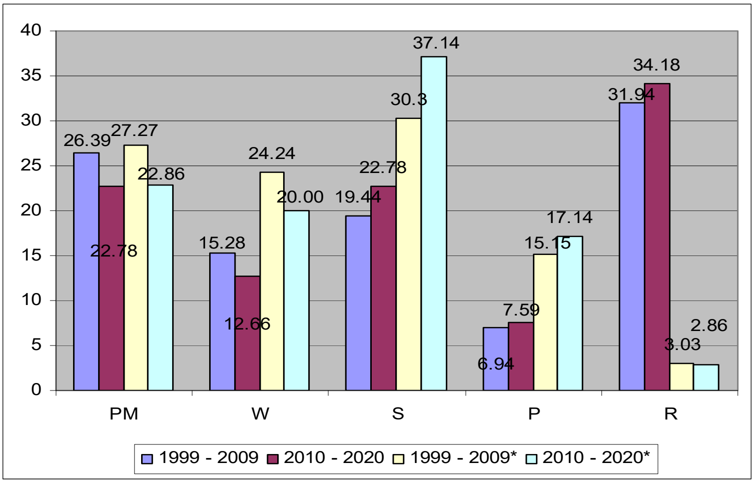

Figure 4. The percent distribution of species and of species dependent on water (*) by the main phenologic categories they belong (PM – partial migratory species, W – winter visitors, S – summer visitors, P – species of passage, R – resident species).

Table 4. The percentage distribution as number of individuals by the main phenological categories.

Main phenology	**PM**	**W**	**S**	**P**	**R**
1999-2009	82.13	4.74	1.72	4.72	6.69
2010-2020	72.51	11.91	2.33	6.60	6.67

Legend: PM – partial migratory species, W – winter visitors, S – summer visitors, P – species of passage, R – resident species.

3. Was there a trend over years of the number of species and of the number of individuals?

Not all species from a certain area have the same ecological demands, and while the global warming up to a particular limit is useful for some, it is unfavourable for others and has less relevance for the rest. As a result, the strength of any species will increase for a well delimited interval of temperature, will remain relatively stable for other interval of temperature, and will decrease for another interval of temperature, by a distribution of Gauss type. As a result, the variation of the avicoenose strength depends on variation of the strengths of all component species, which, over time, can have different importance in the ecosystem. So, general trends caused by the temperature change can be distinguishable, although they can have ups and downs.

In our case, a strong increasing trend was noticeable for the number of species, 56.73% of the variables being really correlated, and also for the number of individuals, where only 18.40% of the variables were really correlated (Figs. 4, 5). For the species dependent on wetlands, the graphs are quite similar (Figs. 6, 7). The coefficient of determination, $R^2 = 0.6421$, respectively $R^2 = 0.1804$, shows an increase with ca. 8% of the real correlation between the variable, in the case of the number of species, and, practically, no change, in the case of the number of individuals, because it was only slightly influenced by the contribution of the species that not depend on the wetlands.

It is interesting that, if we split the period 1999-2020 in two intervals, we find out that the trend of the individuals of species dependent on wetlands strongly increasing between 1999 and 2012, 74.72% of the variables being really correlated, although an obvious decrease was noticed between 2006 and 2008 (Fig. 8). Eliminating the values from these years, R^2 gets 0.86 and, consequently, the decline can be linked both to the construction of the road of belt of Piteşti town, that extended the highway Bucureşti-Piteşti and that passes in the proximity of the Goleşti, Piteşti and Bascov dam basins, inaugurated in November 2007 and to the building of two commercial sites, placed, effectively, on the banks of the Piteşti, respectively Goleşti dam basins, finalised in May 2007 and June 2008. For 2012-2020, the trend strongly decreased, although only 26.78% of the variables were really correlated (Fig. 9). It was caused by the decline of the majority of the eudominant and dominant species, as we will see below.

In Europe, the trend of the common species decreased, mainly in the case of the species from the farmlands, although it increasing after 2007 in the case of forest species (https://www.eea.europa.eu/...chart_1). Most of the species dependent on wetlands that winter in Europe had a favourable trend, too (https://www.eea.europa.eu/...dashboard-01) and, here, the species from the Appendix 1 of the Birds Directive manifested a strong increase, except *Mergus albellus* and *Cygnus columbianus*. The species from the Appendix 2 had different trends, for some, like *Anas strepera*, they increasing, and for others, like *Gallinula chloropus*, *Aythya ferina*, *Aythya fuligula*, *Fulica atra*, *Anas platyrhynchos*, they decreasing (https://europe.wetlands.org/).

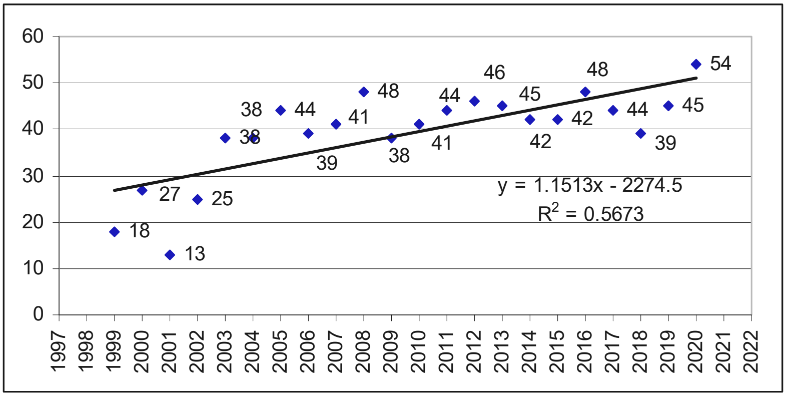

Figure 4. The variation of the number of species during 1999-2020.

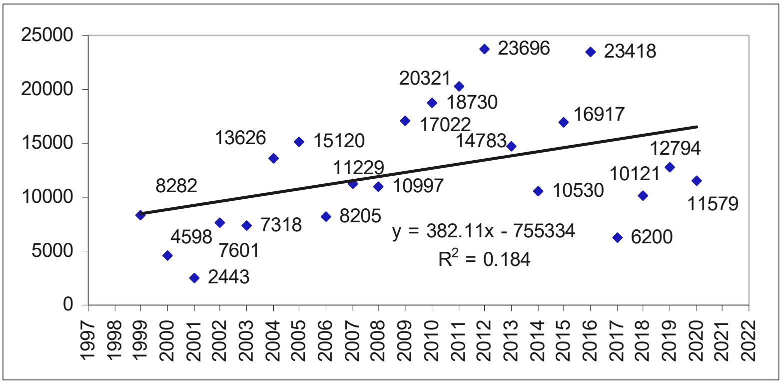

Figure 5. The variation of the number of individuals during 1999-2020.

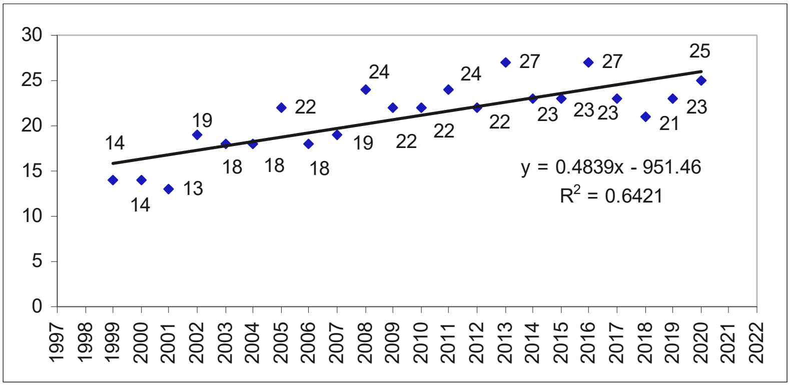

Figure 6. The variation of the number of species dependent on wetland during 1999-2020.

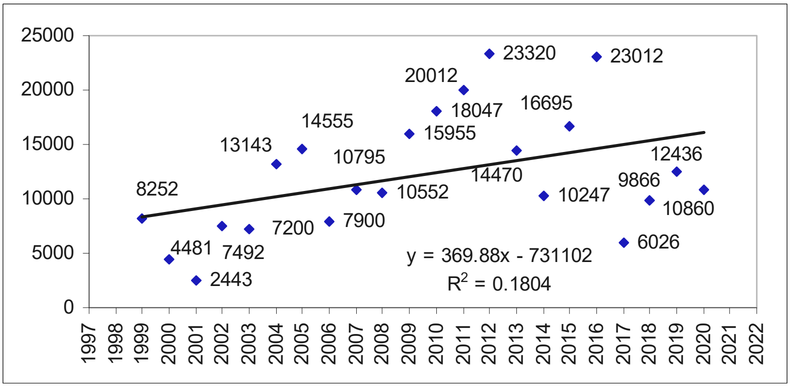

Figure 7. The variation of the number of individuals of species dependent on wetland during 1999-2020.

In our situation, during 1999-2020, *Mergus albellus* and *Gallinula chloropus* showed a stable trend, and *Aythya fuligula*, an increasing trend. For, *Anas platyrhynchos*, eudominant species, the trend was decreasing, while for the other dominant and eudominant species, the trend was increasing, except *Larus ridibundus*, for which it decreased in the last years. The variables are low correlated in the case of *Anas platyrhynchos*, *Fulica atra* and *Anas crecca*, while 30.48% of the variables are really correlated for *Aythya ferina*, 46.63% for *Larus canus*, and 51.23% for *Larus ridibundus*. The regressions lines are: y=-21.814x+49,082 for *Anas platyrhynchos* (R^2=0.0027), y=8.3252x-15,438 for *Fulica atra* (R^2=0.0059), y=117.6x-234,806 for *Larus ridibundus* (R^2=0.5123), y=25.382x-50,321 for *Anas crecca* (R^2=0.0817), y=93.257x-186,228 for *Aythya* *ferina* (R^2=0.3048), and y=74.226x-148,508 for *Larus canus* (R^2=0.4663). If we compare the period 1999-2009 to 2010-2020, we see only two species (2.27% of all, *Gavia arctica* and *Picus canus*) with a stable trend, while 55 species (62.5% of all), respectively 24 species dependent on wetlands (27.27% of all, *Podiceps cristatus*, *Podiceps nigricollis*, *Pelecanus crispus*, *Phalacrocorax carbo*, *Phalacrocorax pygmeus*, *Egretta alba*, *Cygnus cygnus*, *Anser albifrons*, *Anas platyrhynchos*, *Anas strepera*, *Anas penelope*, *Anas crecca*, *Anas clypeata*, *Tadorna tadorna*, *Netta rufina*, *Aythya fuligula*, *Aythya ferina*, *Aythya nyroca*, *Bucephala clangula*, *Larus argentatus*, *Larus canus*, *Larus ridibundus*, *Alcedo atthis*, *Motacilla cinerea*) had increasing trends and 31 species (35.22% of all), respectively 13 species dependent on wetlands (14.77% of all, *Podiceps grisegena*, *Tachybaptus ruficollis*, *Ardea cinerea*, *Cygnus olor*, *Anas acuta*, *Aythya marila*, *Mergus albellus*, *Haliaeetus albicilla*, *Gallinula chloropus*, *Fulica atra*, *Gallinago gallinago*, *Tringa ochropus*, *Emberiza schoeniclus*) had decreasing trends. Consequently, 31 non-dependent on wetlands species (35.22% of all) had increasing trends and 18 non-dependent on wetlands species (20.45% of all) had decreasing trends (Tab. 1).

4. Was there a good correlation between the variation of the average temperature of the air and the dynamics of the avifauna?

Generally, the number of species varied inversely proportional with the average air temperature registered in the period of 20 days before the day of observations and directly proportional with the average air temperature registered in the periods that extend 30 days before the day of observations (Tab. 5). Broadly, that means that the lower the average temperature of the air in January before the day of observations, respectively the higher the average temperature of the air in December, the higher the number of species and inversely. Generally, the highest negative correlations were achieved for the first 7 days of January but they were very weak and weak (-0.11 for the species that not depend on wetlands, -0.26 for the dependent on wetlands species and -0.18 for all species). Very weak correlations, which are worth to be mentioned, were also found for the period of 3 days before the observations. The highest positive correlations were got for entire month of December before the observations (0.38 – weak correlation with the total number of species, 0.28 – weak correlation with the number of species dependent on wetlands, 0.40 – moderate correlation with the number of species that not depend on the wetlands). For the period of the first 16 days of December (30-45 days before the observations), the correlation between the average temperature of the air and the number of species was even better, but still moderate, 0.43.

Concerning the number of individuals (Tab. 5), normally, the correlations were positive, regardless the considered period. However, there were exceptions: the correlation for the first 7 days of January was always negative (-0.19 – very weak correlation both in the case of all number of individuals and of the individuals of species dependent on wetlands, -0.22 – weak correlation in the case of the individuals of species that not depend on wetlands). Also, the individuals of the species that not depend on wetlands were very weakly and negatively correlated with the average temperature of the air from other periods up to 20 days before the observations. Weak positive correlations, between 0.26 and 0.31, were obtained in the case of the census day, while, on long term, that exceeded 30 days, the correlations were always positive. The highest correlations were for December (0.40 – moderate correlation) in the case of the total number of individuals, for the last 15 days from December (0.39 – weak correlation) in the case of the individuals of species dependent on wetlands, and for the first 16 days from December (0.55 – moderate correlation) in the case of the individuals of species that not depend on wetlands. These mean that the strengths of the birds were significantly influenced by the average temperature of the days of observations and by the average temperature of the month of December before the time of observations (the higher the temperature, the higher the number of individuals) and by the average temperature of the air recorded in the first 7 days of January (the higher the temperature, the lower the number of individuals), and reversely. Noticeable also is that the individuals of species that not depend on wetlands, generally responded inversely proportionally to the average temperature of the air on short term, except the days of observations.

Table 5. The correlations (C) between the average air temperature (T) and the number of species (S), respectively individuals (I).

Period	Day of observations	1 day before the observations	3 days before the observations	7 days before the observations	First 7 days from January	10 days before the observations	14 days before the observations	20 days before the observations	30 days before the observations	45 days before the observations	Last 15 days from December	First 16 days from December	December before the observations
C. T. – S.	-0.04	-0.11	-0.19	-0.06	-0.18	-0.06	-0.12	-0.07	0.07	0.22	0.32	0.34	0.38
C. T. – I.	0.31	0.24	0.17	0.25	-0.19	0.25	0.07	0.07	0.23	0.30	0.39	0.19	0.40
C. T. – S.*	0.03	-0.04	-0.19	-0.06	-0.26	-0.07	-0.16	-0.12	0.01	0.08	0.26	0.13	0.28
C. T. – I.*	0.31	0.25	0.18	0.25	-0.19	0.25	0.08	0.08	0.23	0.29	0.39	0.18	0.38
C. T. – S.**	-0.08	-0.13	-0.17	-0.05	-0.11	-0.05	-0.09	-0.03	0.09	0.27	0.31	0.43	0.40
C. T. – I.**	0.26	-0.07	-0.12	0.05	-0.22	0.00	-0.07	-0.05	0.14	0.34	0.33	0.55	0.48

Legend: * - for the species dependent on wetlands; ** - for the species that not depend on wetlands.

It is interesting the way in which the eudominant species (*Anas platyrhynchos*, *Fulica atra* and *Larus ridibundus*) and the dominant species (*Anas crecca*, *Aythya ferina* and *Larus canus*) responded to the variation of the average air temperature (Tab. 6). For *Anas platyrhynchos*, usually, the correlations were positive, although the best were weak (maximum 0.28, for the period of 7 days before the observations). For *Fulica atra*, the correlations were sometimes positive, sometimes negative, the best of them being positive, but weak (0.29) and that in the case of the first 16 days of December. For *Larus ridibundus*, in majority, the correlations were positive, the best of them being moderate (0.42 for December, respectively 0.52 for the last 15 days of December). Also, for *Aythya ferina*, the correlations were positive, except for the first 7 days of January (-0.20, weak correlation), the highest of them being moderate (0.43), in the case of December. For *Anas crecca* and *Larus canus*, the correlations were always positive, the highest of them being moderate: 0.47, for the days of observations, respectively 0.46, for the last 15 days from December, and 0.47, for the entire month of December. Regarding the other constant or euconstant species, *Podiceps cristatus*, *Phalacrocorax carbo*, *Ardea cinerea*, *Anas penelope*, *Emberiza schoeniclus* (species dependent on wetlands) and *Parus caeruleus*, *Parus major*, *Passer montanus* (species independent on wetlands) responded in the same rhythm with the temperature variation. It seems they were advantaged by the mild winters, while *Cygnus olor* and *Cygnus cygnus* (species dependent on wetlands) and *Corvus corone cornix* (species independent on wetlands) inversely responded to the temperature variation and as the temperature decreased, the number of individuals increased and vice versa. *Cygnus olor* and *Cygnus cygnus* were constrained to gather here from the surroundings, where the waters were more inclined to freeze, and *Corvus corone cornix* was attracted on the dam basins by the dead birds. It is noticeable that, generally, the correlations were moderate for *Cygnus olor*, except the day of observations and the day before the observations, when they were very week, and the period of 45 days before the observations, when the correlation was strong (-0.71), that means the lower the local average air temperature of the last 45 days before the observations, the higher the number of individuals and inversely. Normally, the strengths of *Egretta alba*, *Bucephala clangula*, *Passer domesticus*, *Carduelis carduelis* and less of *Aythya fuligula*, *Streptopelia decaocto*, *Pica pica*, *Corvus frugilegus*, *Emberiza citrinella* positively correlated with the temperature, while the strengths of *Mergus albellus*, *Buteo buteo*, *Gallinula chloropus*, *Anthus spinoletta* negatively correlated. It should also be noted that, in general, the strengths of *Phalacrocorax pygmeus*, *Tadorna tadorna*, *Falco tinnunculus*, *Corvus monedula* and *Fringilla coelebs* negatively correlated with the temperature on short term and positively, on long term. Finally, about *Tachybaptus ruficollis*, because its secretive life, a conclusion cannot be formulated (Tab. 6). As a result, we see that some species responded faster than others to the variation of temperature of the air, either positively or negatively, but their dynamics can be determined by both large and local movements.

Table 6. Correlations between the strengths of the constant and euconstant species and the average temperature of the air calculated for different periods from December and January before the time of observations.

Period	Day of observations	1 day before the observations	3 days before the observations	7 days before the observations	First 7 days from January	10 days before the observations	14 days before the observations	20 days before the observations	30 days before the observations	45 days before the observations	Last 15 days from December	First 16 days from December	December before the observations
Podiceps cristatus	0.32	0.20	0.20	0.25	0.25	0.27	0.28	0.24	0.27	0.33	0.16	0.27	0.23
Tachybaptus ruficollis	-0.03	-0.18	-0.16	-0.12	0.24	-0.04	0.03	0.03	-0.08	0.05	-0.18	0.28	0.01
Phalacrocorax carbo	0.18	0.20	0.08	0.20	0.15	0.27	0.20	0.22	0.35	0.34	0.41	0.12	0.42
Phalacrocorax pygmeus	0.00	-0.04	-0.27	-0.26	-0.43	-0.27	-0.37	-0.41	-0.20	-0.16	0.05	0.04	0.16
Egretta alba	0.44	0.32	0.24	0.34	-0.19	0.27	0.13	0.00	0.26	0.38	0.32	0.41	0.48
Ardea cinerea	0.45	0.26	0.28	0.32	0.33	0.35	0.37	0.29	0.35	0.34	0.21	0.11	0.21
Cygnus olor	-0.12	-0.14	-0.42	-0.47	-0.38	-0.47	-0.48	-0.56	-0.64	-0.71	-0.59	-0.44	-0.57
Cygnus cygnus	-0.20	-0.24	-0.36	-0.43	-0.26	-0.41	-0.40	-0.37	-0.33	-0.36	-0.10	-0.23	-0.13
Anas platyrhynchos	0.25	0.22	0.22	0.28	-0.18	0.27	0.10	0.11	0.14	0.15	0.23	-0.02	0.17
Anas penelope	0.22	0.16	0.12	0.31	0.22	0.34	0.30	0.34	0.24	0.29	0.14	0.16	0.20
Anas crecca	0.47	0.23	0.15	0.29	0.12	0.31	0.25	0.25	0.25	0.35	0.25	0.27	0.33
Tadorna tadorna	-0.13	-0.15	-0.08	-0.02	-0.06	0.02	-0.04	0.07	0.11	0.05	0.28	-0.14	0.16
Aythya fuligula	0.42	0.17	0.03	0.14	-0.26	0.11	-0.03	-0.06	0.05	0.15	0.19	0.21	0.28
Aythya ferina	0.29	0.24	0.17	0.21	-0.20	0.21	0.05	0.04	0.22	0.30	0.38	0.25	0.43
Bucephala clangula	0.19	0.24	0.19	0.26	-0.07	0.25	0.13	0.18	0.12	0.15	0.14	0.04	0.11
Mergus albellus	-0.22	-0.43	-0.47	-0.28	-0.38	-0.32	-0.36	-0.35	-0.37	-0.25	-0.28	0.16	-0.13
Buteo buteo	0.02	-0.18	-0.37	-0.20	-0.24	-0.26	-0.24	-0.32	-0.36	-0.40	-0.34	-0.28	-0.35
Falco tinnunculus	0.01	-0.32	-0.41	-0.33	-0.15	-0.29	-0.29	-0.24	-0.05	0.06	0.20	0.30	0.33
Gallinula chloropus	-0.50	-0.56	-0.40	-0.37	-0.02	-0.33	-0.25	-0.19	-0.34	-0.28	-0.31	0.01	-0.22
Fulica atra	0.07	-0.11	-0.18	0.01	-0.17	0.00	-0.07	-0.10	-0.06	0.09	0.03	0.29	0.17
Larus argentatus	-0.17	0.14	0.04	-0.06	-0.13	-0.01	-0.10	-0.09	0.04	0.06	0.21	0.04	0.19
Larus canus	0.15	0.32	0.22	0.22	0.02	0.24	0.15	0.16	0.36	0.38	0.46	0.23	0.47
Larus ridibundus	0.17	0.16	0.20	0.17	-0.11	0.15	0.06	0.06	0.33	0.34	0.52	0.18	0.42
Streptopelia decaocto	0.10	0.05	-0.18	0.01	0.06	0.09	0.03	0.03	0.01	-0.01	0.01	-0.10	0.09
Anthus spinoletta	-0.17	-0.45	-0.49	-0.32	-0.32	-0.36	-0.36	-0.37	-0.33	-0.17	-0.22	0.30	-0.02

Pica pica	0.02	-0.12	-0.06	0.10	-0.01	0.11	0.06	0.13	0.09	0.23	0.17	0.29	0.23
Corvus monedula	0.24	-0.06	-0.15	-0.07	-0.34	-0.10	-0.20	-0.23	-0.09	0.07	0.08	0.36	0.24
Corvus frugilegus	0.34	0.07	-0.02	0.03	-0.28	0.00	-0.11	-0.15	0.01	0.19	0.16	0.43	0.34
Corvus corone cornix	-0.07	-0.08	-0.19	-0.11	-0.13	-0.12	-0.13	-0.18	-0.20	-0.20	-0.23	-0.06	-0.18
Corvus corax	0.05	-0.01	0.02	0.21	0.31	0.27	0.28	0.36	0.20	0.18	0.12	-0.06	0.06
Parus caeruleus	0.51	0.27	0.23	0.20	0.05	0.14	0.15	0.13	0.33	0.38	0.41	0.28	0.39
Parus major	0.04	0.00	0.06	0.15	0.05	0.13	0.12	0.15	0.32	0.39	0.42	0.33	0.42
Passer domesticus	0.35	0.31	0.30	0.22	-0.25	0.15	0.03	0.00	0.05	0.09	0.15	0.04	0.13
Passer montanus	0.10	0.12	0.18	0.34	0.10	0.29	0.27	0.28	0.28	0.33	0.20	0.22	0.20
Fringilla coelebs	-0.16	-0.24	-0.21	-0.09	0.06	-0.08	-0.03	0.00	0.14	0.23	0.25	0.32	0.31
Carduelis carduelis	0.39	0.16	0.16	0.16	-0.17	0.06	0.03	0.03	0.19	0.34	0.30	0.45	0.39
Emberiza schoeniclus	0.24	0.05	0.03	0.29	0.25	0.27	0.30	0.23	0.20	0.29	0.06	0.23	0.15
Emberiza citrinella	-0.07	0.13	0.07	0.21	0.35	0.26	0.30	0.40	0.33	0.26	0.22	-0.01	0.18

The correlations between the temperature and the strengths explain only in small extent the dynamics of the birds and to accurately describe in what extent it influenced their presence, the other environmental conditions should remain constant. In reality, the things differ much and while the area of the basins virtually maintained the same over the years, the scale of silting, for example, strongly developed (Rădoane and Rădoane, 2005). Of course, the process was not linear, depending on the yearly precipitation amount and, primarily, on the human activities in the hydrographical basins of the rivers (and here we refer to the gravel exploitations and the cutting of trees, with results in the water turbidity). Consequently, the land area inside the reservoirs increased to the detriment of the water covered area, that unequally diminished on every dam basin depending on the source of silting, and the Pitești and Golești dam basins seem to be the most affected in the last time. The water deep and the speed of flow changed on some portions and they influenced the time when the ice shell appeared and its size. The habitats evolved in their turn (the coppice vegetation appeared on the new created islets and mainly towards the mouths of the rivers) and the birds feeding or resting areas transformed, which was favourable for some species, whereas for others it was not. Also, the partial eutrophication led to an increase of biodiversity and food resources, beneficial or not to different species of birds. The penetration of some aquatic invasive species or some actions of populating with fish must be taken into consideration, too. Also, other forms of anthropogenic stress permanently manifested, especially through intrusive fishing, illegal hunting and sport competing, as we saw with other occasions (Mestecăneanu and Gava, 2014, 2016b, 2018, 2019b etc.). Although the dam basins constitute a protected area, the human pressure seems to grow with the development of some roads and commercial objectives in the immediate surroundings. All these are factors more or less measurable, but other more or less known influences come from the northern breeding grounds or from the migratory ways where the status of the habitats of breeding, feeding or resting, the rate of breeding success, the mortality, etc., indirectly or directly caused by human or by the natural processes, also contribute to the yearly dynamics of the birds from the wintering or from the passage quarters. The non-climatic factors, like the urbanization, habitat loss, pollution, invasive species, diseases, loss of keystone species, overexploitations, were found as responsible in other studies on the avicoenoses changes, though the rising temperatures seem to have the major role (McLean *et al.*, 2022).

Conclusions

As a result of the data working collected during 1999-2020 about the species of birds that winter on a series of dam basins from the Argeş River situated between Vâlcele and Goleşti, when 88 species and 275,530 individuals were observed (43.18% of the species, respectively 97.17% of the individuals being dependent on wetlands) some conclusions can be draw:

1. A strong increasing trend of the average air temperature was observed in December-January.

2. Over time, the summer visitors, the resident species and the species of passage increased as number, in the detriment of the partially migratory species and of the winter visitors.

3. Except the partial migratory species, the other species increased as weight of individuals from 1999-2009 to 2010-2020 and, here, the weight of the winter visitors increased with not less than 299.52%, mainly due to *Larus canus*, this being the highest increase of all phenological categories.

3. A strong increasing trend of the number of species and of the number of individuals, quite similar to the trend of the average air temperature, both on the whole and regarding the species dependent on wetlands, was remarked, though decreasing tendences were observed in the last years.

4. Except *Anas platyrhynchos*, an eudominant species, *Fulica atra* and *Larus ridibundus* (eudominant species), respectively *Anas crecca*, *Aythya ferina* and *Larus canus* (dominant species) showed general increased trends that, apart from *Larus ridibundus*, suffered a decreasing in the last years. However, comparing 1999-2009 to 2010-2020, the trends are increasing for *Anas platyrhynchos*, *Anas crecca*, *Aythya ferina*, *Larus canus* and *Larus ridibundus* and decreasing for *Fulica atra*.

5. Generally, the lower was the temperature of the air in the first 7 days of January, the higher was the number of species and their strengths registered at the end of the second week of January and, more obviously, the warmer was

December, the higher was the recorded number of species and the number of the individuals.

6. In general, the correlations between the average temperature of the air from different periods of December and January and the strengths of the dominant or eudominant species, except *Fulica atra*, were positive, that means that the higher the average temperature of the air, the higher their strengths.

7. The absence of the strong or very strong correlations between the average temperature of the air and the number of species, respectively the number of individuals, as well as between the average temperature of the air and the strengths of the eudominant and dominant species, corroborated with the phenology of the species, show that **the winter dynamics of the avifauna from the considered dam basins from the Argeş River is a complex event that was partially influenced by the global warming**. The dynamics can indicate both long and short movements of the birds.

8. Other local and general elements, like the development of the habitats, the anthropogenic impact, as well as the breeding success, the mortality in migration, etc., more or less linked in their turn to the global warming, were implied in the dynamics of the avifauna, too. Among them, the silting process of the reservoirs, which led to the increase of the strengths of all species of gulls, for example, and the negative human pressure, mainly observable on the Bascov Dam Basin, arranged for nautical sports, and during the construction of the highroad and of the commercial complexes from the neighbourhood, when the number of birds diminished, were identified in the period of study.

Finally, we must admit that the global warming is a fact visible even without scientific methods and we don't have to be specialists to see some of its effects on the nature and people. Even if it is totally or partially caused by human, according to different opinions, it should be seriously combated since a few decades ago through gradual measures to avoid an inutile stress upon the life of Earth. It is important that the present transition toward a nature-friendly human society to be completed as soon possible, with minimum shocks on the people and without obscure interests.

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