Monitoring of wintering geese in the AES Geo Energy Wind Farm "St. Nikola" territory and the Kaliakra region in winter 2016/2017

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TERMS OF USE

Contents

Introduction

This report presents results of the ornithological survey and monitoring at Saint Nikola Wind Farm (SNWF) in the period 01 December 2016 to 15 March 2017, continuing from similar studies in previous winters before and after construction of SNWF including period of carcass searches and Turbine Shut Down System application in winter 2016-2017. As stated in previous reports the primary objective of wintering bird studies at SNWF is to investigate the possible effects of the wind farm on geese populations, notably the Red-breasted Goose *Branta ruficollis* (RBG) due to its globally threatened conservation status. Previous years' wintering studies at SNWF have been reported and presented for download on the AES SNWF website.

To date, as documented by previous reports, there have been no indications that SNWF has had any adverse impact on wintering geese, including RBG, and the more abundant Greater White-fronted Goose (*Anser albifrons*) (GWFG). This report presents the latest results, from the 2016-17 winter monitoring of SNWF.

Methods

The same methods as in previous winter surveys were applied in order to have best compatibility of the obtained data within all years. These methods were described in detail by a number of previous reports, available at: http://www.aesgeoenergy.com/site/Studies.html

Data was collected within a 'core study area' that encompassed an area centered on the SNWF wind farm, but with additional areas in a buffer that extended at least 2 km from the wind farm (Figure 1)

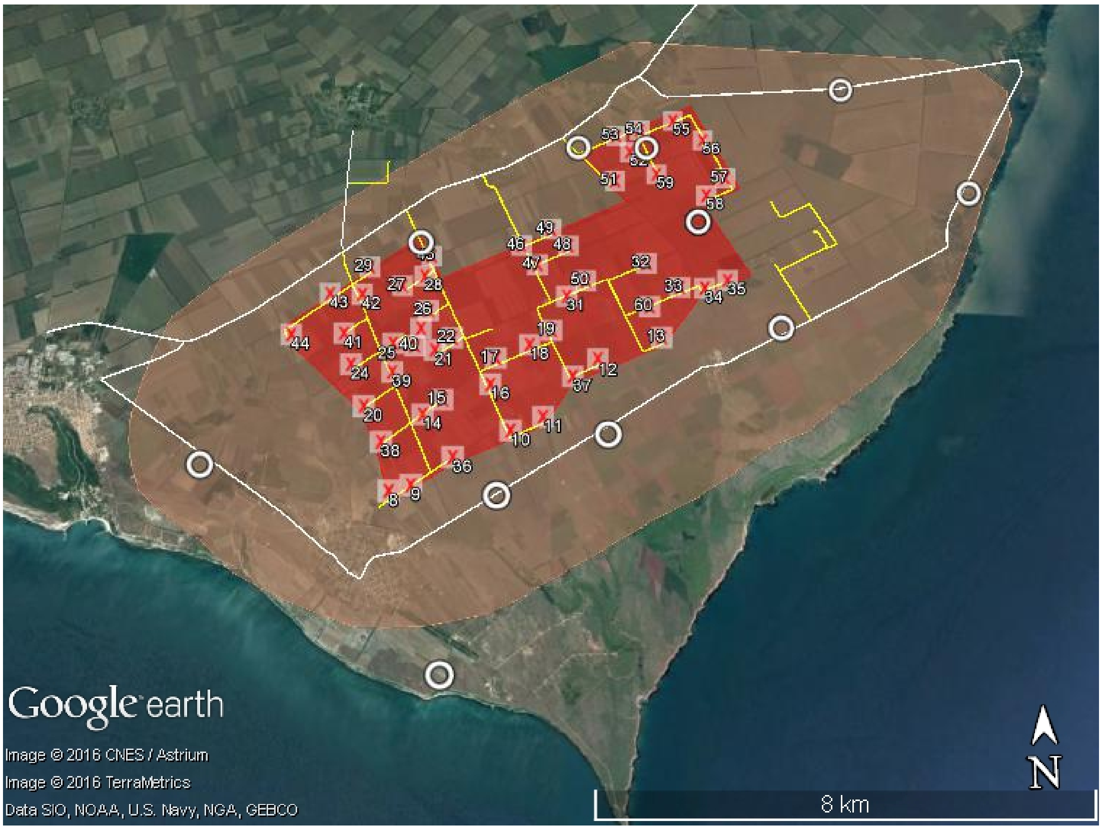

Figure 1. *Map of the "SNWF" study area (red), the "core study area" (brown) and observation points (white circles) covered by the winter monitoring 2016 – 2017.*

Searches under turbines for collision victims were set to be undertaken, as in previous winters, under a protocol for a basic seven day search interval as presented in Table 1. Details of the searching methodology were published in previous reports available at the web site http://www.aesgeoenergy.com/site/Studies.html. For the last two winters we have extended the period of searches to March 30.

Table 1. Number of searches per turbine in the period 01 December 2016 – 30 March 2017.

№ Turbine	December	January	February	March	Total
8	1	3	3	1	8
9	1	3	3	1	8
10	1	2	4	1	8
11	1	2	4	1	8
12	1	2	5	1	9
13	1	2	3	1	7
14	1	3	4	1	9
15	1	2	5	1	9
16	1	2	4	1	8
17	1	2	4	2	9
18	1	2	4	1	8
19	1	2	5	1	9
20	1	3	4	1	9
21	1	3	4	1	9
22	1	3	4	1	9
23	1	2	5	1	9
24	1	4	4	1	10
25	1	4	4	1	10
26	1	3	4	1	9
27	1	3	4	1	9
28	1	3	4	1	9
29	1	4	4	1	10
31		3	4	1	8
32	1	2	4	1	8
33	1	2	4	1	8
34	1	2	4	1	8
35	1	2	4	1	8
36	1	3	3	1	8
37	1	2	4		7
38	1	3	4	1	9
39	1	3	4	1	9
40	1	4	4	1	10
41	1	4	4	1	10
42	1	4	4	1	10
43	1	4	4	1	10
44	1	4	4	1	10
45	1	3	4	1	9
46	1	3	4	1	9
47	1	3	4	1	9

№ Turbine	December	January	February	March	Total
48		3	4	1	8
49	1	3	4	1	9
50	1	2	4	1	8
51	1	2	4	2	9
52	1	2	4	1	8
53	1	2	4	1	8
54	1	2	4	1	8
55	1	2	4	1	8
56	1	2	4	1	8
57	1	2	4	1	8
58	1	2	4	1	8
59	1	2	4	1	8
60	1	2	4	1	8
Grand Total	50	**138**	**208**	**53**	**449**

A detailed information of methods underlying the decisions and procedures for switching off turbines (the Turbine Shutdown System: TSS) under a risk of bird collisions, is described in a number of previous reports and in the Owner Ornithological Monitoring Plan. The feeding grounds and flight activity of geese within the wind farm and surrounding areas identified in the winter surveys were investigated daily and the number of feeding geese at these sites and weather conditions (i.e. heavy mist, fog) were the bases of decisions for the TSS for reduction of the collision risk. As in previous winters, if substantial goose activity at SNWF coincided with weather conditions of adverse visibility then the TSS would be enacted. During this winter monitoring the TSS has been also effectively enacted to avoid any possibility of collision for White-tailed eagles (*Haliaeetus albicilla*) hunting geese in January 2017 (see Table 6).

All observations per day were digitized and mapped for analysis and presentation in this report.

List of participants in the observations

Dr. Victor Metodiev Vasilev – Field ornithologist; Qualified carcass searcher
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Member of BSPB since 1992

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Student in Biology

Results and Discussion

Temporal dynamics and composition of species

Geese were observed within the core study area between 10th December 2016 and 2nd March 2016. The numbers of geese observed in the core study area each day are presented in Table 2.

Table 2. All observed geese numbers by species and day of monitoring in the core study area.

Date	A. albifrons	A. anser	Anser/ Branta	B. ruficollis	Grand Total
10.12.2016	200				200
14.12.2016	150				150
20.12.2016	34				34
23.12.2016	30			2	32
25.12.2016	150				150
26.12.2016	26				26
5.1.2017	45				45
8.1.2017	1593	10	8236	745	10584
9.1.2017	1383	64	7697	1215	10359
10.1.2017	17	1		11	29
11.1.2017	170	73	15		258
12.1.2017	344	69	2291	116	2820
13.1.2017	170	20	2006	133	2329
14.1.2017	167	50	4764	24	5005
15.1.2017	43	13	2077	186	2319
16.1.2017			7007		7007
17.1.2017	40		3340	20	3400
18.1.2017	24		1962	110	2096
19.1.2017	1794		16604	2535	20933
20.1.2017	700		15715	50	16465
21.1.2017			20982		20982
22.1.2017	120		34903		35023
23.1.2017	2563	130	24660	1971	29324
24.1.2017	305		32740	220	33265
25.1.2017		23	20692		20715
26.1.2017	60		24886	130	25076
27.1.2017			31864		31864
28.1.2017	9		22142		22151
29.1.2017		38	31497		31535
30.1.2017	181		26858	180	27219
31.1.2017	84		21347		21431
1.2.2017	45	52	23586		23683
2.2.2017	213	37	39890		40140
3.2.2017	794	18	18215	120	19147
4.2.2017	88	60	21316		21464
5.2.2017			13120		13120
6.2.2017	112		8063		8175

Date	A. albifrons	A. anser	Anser/ Branta	B. ruficollis	Grand Total
7.2.2017	5		1365	92	1462
8.2.2017	1		590	50	641
9.2.2017	26	12	3479	325	3842
10.2.2017			4566		4566
11.2.2017	40	1	1686		1727
12.2.2017	1120	14	1043	48	2225
13.2.2017	8019		1424		9443
14.2.2017	13	9	1493	1	1516
15.2.2017	285		1890		2175
16.2.2017			1420		1420
17.2.2017			195		195
18.2.2017	427				427
19.2.2017			87		87
20.2.2017			17		17
21.2.2017			290		290
22.2.2017			12155		12155
23.2.2017			4820		4820
2.3.2017	45		400		445
Grand Total	**21635**	**694**	**525395**	**8284**	**556008**

All species of geese were present in the core study area between 8th of January and 14th of February 2017, apart from a small number seen in the first days of March (Table 2 and Figure 2).

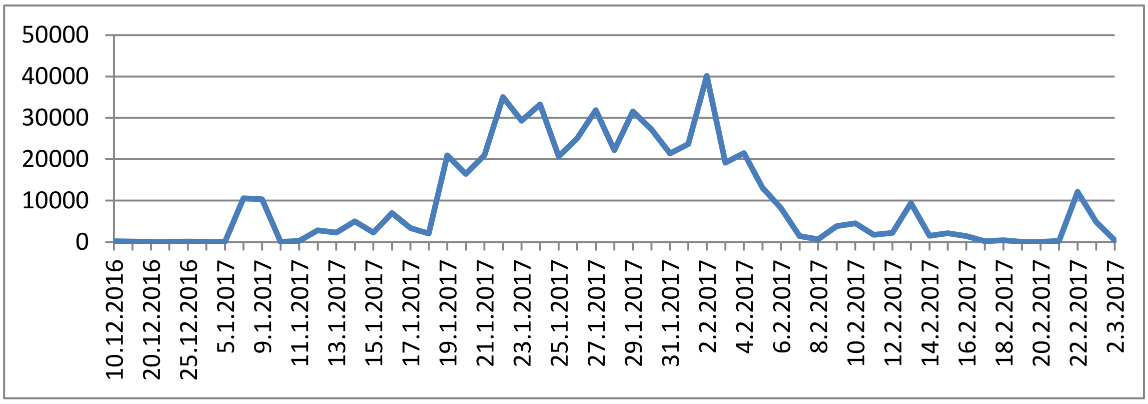


Figure 2. *Temporal distribution of geese (all species) observed in the core study area in winter 2016-2017.*

One Barnacle Goose (*Branta leucopsis*) was observed on 13th January. This is an unusual appearance because of the northern range of Barnacle Geese.

Unusual for the season, but recorded first in the previous two winters (see winter reports 2014-2015 and 2015-2016) several flocks of Dalmatian Pelicans (*Pelecanus crispus*) were observed on 3rd December, 9th and 10th January as well as on 4th February (Table 3).

The number of birds per species, excluding geese species, is presented in Table 3.

Table 3. The total number of observed birds of different species (excluding geese: see Table 2 for geese) in the core study area (Figure 1) recorded in winter season 2016 - 2017.

Species	December	January	February	March	Total
A. cinerea		1		11	12
A. gentilis	1	1	1		3
A. nisus	1	1	1	2	5
A. platyrhynchos		67			67
B. buteo	101	28	8	2	139
B. lagopus	4	8	3		15
B. rufinus	5	3		2	10
C. aeruginosus		1	2	4	7
C. columbianus		3			3
C. corax	1	3	2		6
C. cornix	13	4			17
C. cyaneus	10	89	39	2	140
C. cygnus	68	164	72	14	318
C. olor		610	615		1225
Cygnus sp.		455	187		642
C. monedula	27	145			172
C. oenas		140	75		215
C. palumbus		62			62
E. alba		9			9
E. alpestris		4			4
F. cherrug		4			4
F. columbarius	1	7			8
F. peregrinus/cherrug		1			1
F. subbuteo		1			1
F. tinnunculus	6	3	1	1	11
H. albicilla		3	2		5
L. canus		37			37
L. excubitor		1			1
L. fuscus		2			2
L. michahellis	36	24			60
P. apricaria	78		1		79
P. carbo	404	10	339	415	1168
P. crispus	28	62	3		93
P. onocrotalus	18				18
S. vulgaris	950				950
T. tadorna		80	12		92
T.pilaris		175			175
A. strepera	21				21
Grand Total	1773	2208	1363	453	5797

Total number of observed goose species and their locations

The total numbers of all observed individuals of three species of goose, RBG (*Branta ruficollis*), GWFG (*Anser albifrons*) and Greylag Goose (*Anser anser*) during the whole period of the winter monitoring 2016-2017 in the core study area, are shown in Table 4.

Table 4. The number of geese of different species recorded in the core study area in winter 2016/2017.

Species	December	January	February	March	Total
A. albifrons	590	9812	11188	45	21635
A. anser		491	203		694
Anser/ Branta		364285	160710	400	525395
B. ruficollis	2	7646	636		8284
Grand Total	**592**	**382234**	**172737**	**445**	**556008**

The recorded movements of geese as well as feeding locations were mapped day by day (see Annex 1). Identification of all individuals in the mixed flocks of geese is impossible from a distance in early morning and evening hours. The numbers indicated in the maps, presented in Annex 1 represent total geese numbers observed day by day in the period when RBG were present in the core study area. The blue and red arrows represent morning and evening movements respectively. The green colour indicates fields with wheat potentially suitable for feeding geese. Solid symbols represent records of geese on the ground.

The same colour-coding and symbols are used in summarized presentations of all observed mapped records of geese for January and February, shown in Figure 3 and 4 respectively.

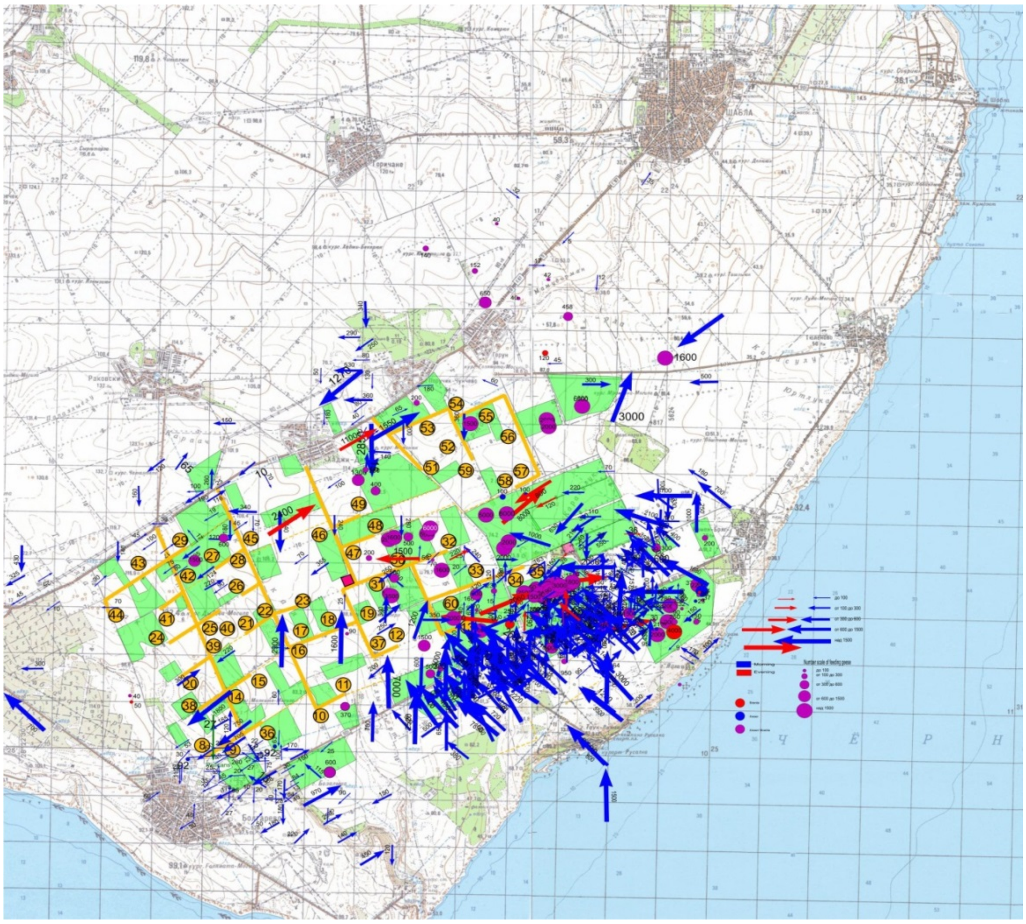


Figure 3. *Spatial summary of geese records in January 2017.*

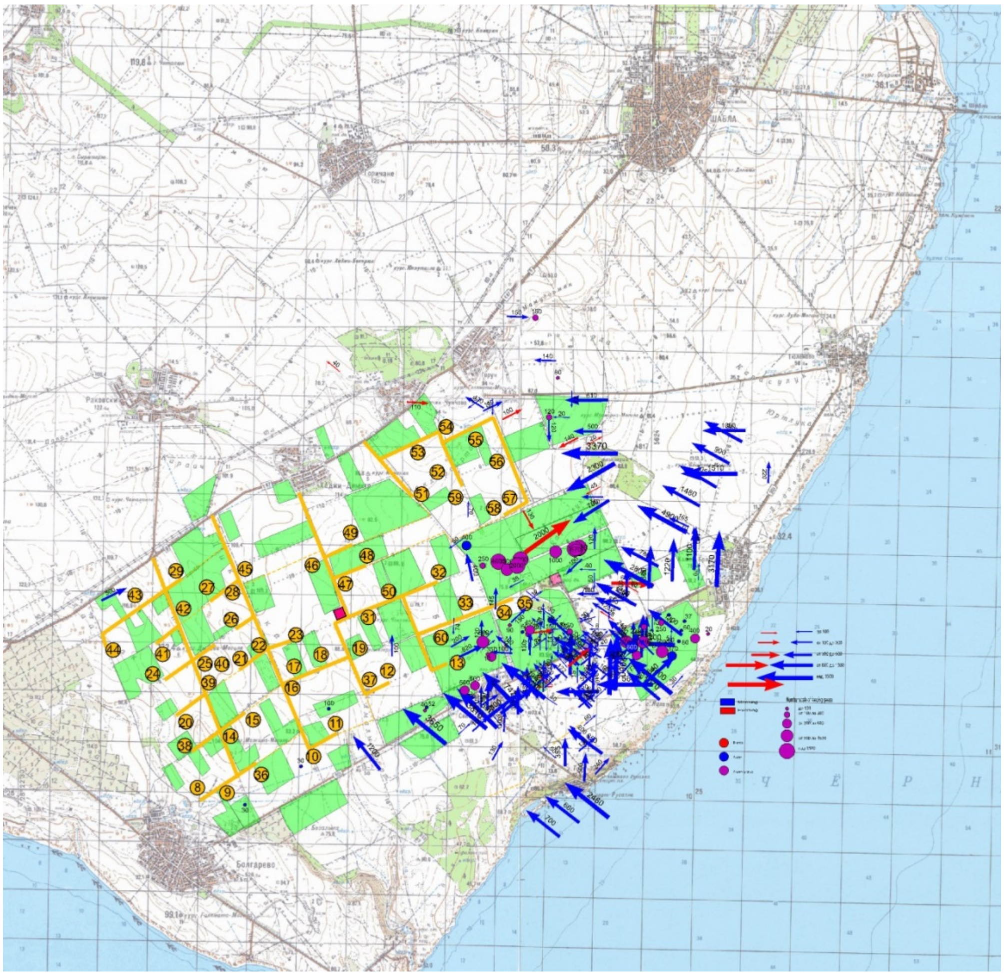


Figure 4. *Spatial summary of geese records in February 2017.*

Table 5. Numbers of observed feeding geese, by species, in the core study area with recorded geographic coordinates of every observed flock.

Date	Time	Species	Number	Coordinates N	Coordinates E
9.1.2017	09:30	Anser/Branta	370	43.421254°	28.451308°
9.1.2017	09:56	Anser/Branta	600	43.411561°	28.451993°
9.1.2017	08:12	Anser/Branta	230	43.445799°	28.488940°
9.1.2017	08:18	Anser/Branta	180	43.432956°	28.505985°
9.1.2017	11:06	A. albifrons	130	43.449032°	28.509113°
9.1.2017	11:06	B. ruficollis	30	43.449032°	28.509113°
11.1.2017	07:40	A. albifrons	42	43.411894°	28.413944°
11.1.2017	08:30	A. albifrons	12	43.415392°	28.423686°
11.1.2017	08:42	Anser/Branta	90	43.418602°	28.433820°
11.1.2017	11:30	A. anser	65	43.463973°	28.411303°
12.1.2017	12:15	Anser/Branta	1000	43.445652°	28.493809°
12.1.2017	13:30	Anser/Branta	4000	43.446370°	28.531780°
12.1.2017	07:45	A. albifrons	165	43.413998°	28.425066°
12.1.2017	07:45	A. anser	62	43.413998°	28.425066°
12.1.2017	07:45	B. ruficollis	30	43.413998°	28.425066°

Date	Time	Species	Number	Coordinates N	Coordinates E
12.1.2017	09:45	Anser/Branta	1000	43.448463°	28.497260°
13.1.2017	10:00	Anser/Branta	1000	43.446159°	28.506192°
13.1.2017	13:27	A. albifrons	170	43.455046°	28.540695°
13.1.2017	13:27	A. anser	20	43.455046°	28.540695°
13.1.2017	13:27	B. ruficollis	10	43.455046°	28.540695°
14.1.2017	07:30	Anser/Branta	110	43.444486°	28.506387°
15.1.2017	08:07	A. anser	13	43.440920°	28.517496°
15.1.2017	09:15	B. ruficollis	150	43.455011°	28.529327°
17.1.2017	07:25	Anser/Branta	600	43.443776°	28.504036°
17.1.2017	07:45	Anser/Branta	250	43.438253°	28.514902°
18.1.2017	11:18	Anser/Branta	325	43.443581°	28.508386°
18.1.2017	11:18	Anser/Branta	50	43.441272°	28.535133°
19.1.2017	12:35	B. ruficollis	500	43.440189°	28.490669°
19.1.2017	12:05	Anser/Branta	500	43.443266°	28.498384°
19.1.2017	12:30	A. albifrons	800	43.433919°	28.503639°
19.1.2017	12:30	B. ruficollis	200	43.433919°	28.503639°
19.1.2017	14:16	Anser/Branta	1500	43.442688°	28.520042°
19.1.2017	14:25	Anser/Branta	2000	43.445470°	28.531493°
19.1.2017	14:37	B. ruficollis	1500	43.448458°	28.538952°
19.1.2017	14:37	Anser sp.	700	43.448458°	28.538952°
19.1.2017	15:50	Anser/Branta	700	43.436528°	28.501266°
20.1.2017	08:40	Anser/Branta	735	43.447022°	28.503350°
20.1.2017	09:45	Anser/Branta	740	43.443897°	28.529260°
20.1.2017	15:30	Anser/Branta	700	43.440319°	28.489339°
20.1.2017	15:30	Anser/Branta	2300	43.438007°	28.481059°
21.1.2017	10:00	Anser/Branta	2500	43.455315°	28.462618°
21.1.2017	10:00	Anser/Branta	250	43.442419°	28.534126°
24.1.2017	10:00	B. ruficollis	100	43.447322°	28.499462°
27.1.2017	09:10	Anser/Branta	4000	43.445794°	28.497184°
27.1.2017	09:30	Anser/Branta	30	43.442165°	28.531518°
28.1.2017	09:42	Anser/Branta	300	43.432531°	28.477446°
28.1.2017	09:42	Anser/Branta	60	43.427019°	28.478448°
29.1.2017	13:00	Anser/Branta	6000	43.483115°	28.510656°
29.1.2017	13:00	Anser/Branta	2000	43.467495°	28.487786°
29.1.2017	08:38	Anser/Branta	30	43.442165°	28.531518°
29.1.2017	12:00	Anser/Branta	2000	43.443450°	28.506148°
30.1.2017	12:03	Anser/Branta	500	43.432221°	28.477192°
30.1.2017	12:03	Anser/Branta	1800	43.448505°	28.508671°
30.1.2017	13:30	Anser/Branta	2000	43.479537°	28.503135°

Date	Time	Species	Number	Coordinates N	Coordinates E
30.1.2017	13:30	Anser/Branta	6000	43.459309°	28.492061°
30.1.2017	14:44	Anser/Branta	90	43.441323°	28.532235°
31.1.2017	15:40	Anser/Branta	93	43.438079°	28.536356°
5.2.2017	10:00	Anser/Branta	3000	43.459146°	28.506541°
8.2.2017	10:20	Anser/Branta	250	43.446401°	28.533017°
10.2.2017	09:35	Anser/Branta	120	43.482420°	28.505876°
10.2.2017	11:30	Anser/Branta	150	43.494996°	28.510251°
11.2.2017	08:45	Anser/Branta	1000	43.442330°	28.524176°
11.2.2017	12:10	Anser/Branta	30	43.418355°	28.441167°
13.2.2017	11:50	Anser/Branta	400	43.461010°	28.483121°

Observations of geese activity in the winter 2016-2017 revealed a prevalence of morning flights when geese usually headed from the sea to the agricultural fields passing through the SNWF territory.

The maximum number of geese including RBG in SNWF was observed in mixed species flocks between 19th January and 04th February.

The proportion of RBG could not always be precisely evaluated but in all the observations available where the proportions of species could be identified it was consistent with previous winters' records, and varied between 10% and 50%. The numbers of geese observed in February and March were much lower than the number of geese in January.

Under good visibility and at close distance when species could be identified and counted, around 8000 RBG and 21000 GWFG flights were observed. Additionally 500000 birds in flights of mixed species flocks were observed under lower visibility conditions. Assuming between 10 and 20 % proportion of RBG in these mixed flocks we can conclude that over 60000 RBG and 470000 GWFG used the airspace above the core study area for the whole winter 2016/2017. Estimated total counts of all geese seen flying and feeding within SNWF across the winter were around 500000.

Analysis of the environmental factors linked to the presence, flock size and numbers of geese in SNWF

In order to examine whether the wintering geese numbers in the study area (SNWF) correlate with the number of geese in wider part of the wintering range under the same ecological regime of Dobrudzha we have analyzed long time data series of wintering geese in SNWF and data available in the published reports of conservation organizations counting birds in whole wintering range of RBG. The main aim of this comparative analysis is to highlight the potential influence of environmental factors such as ambient temperature, water and food availability and seasonal patterns of geese life cycle in the observed variations in geese numbers observed in different winter seasons in SNWF.

Ambient temperature, duration of cold winter period and geese numbers in SNWF

A simple analysis of the observed daily geese counts with respect to ambient temperature revealed a weak, not significant, negative correlation (r = -0.006) between geese numbers and the ambient temperature for the complete period of SNWF operation i.e. for the winters 2010-2011 to 2016-2017 (Figure 5).

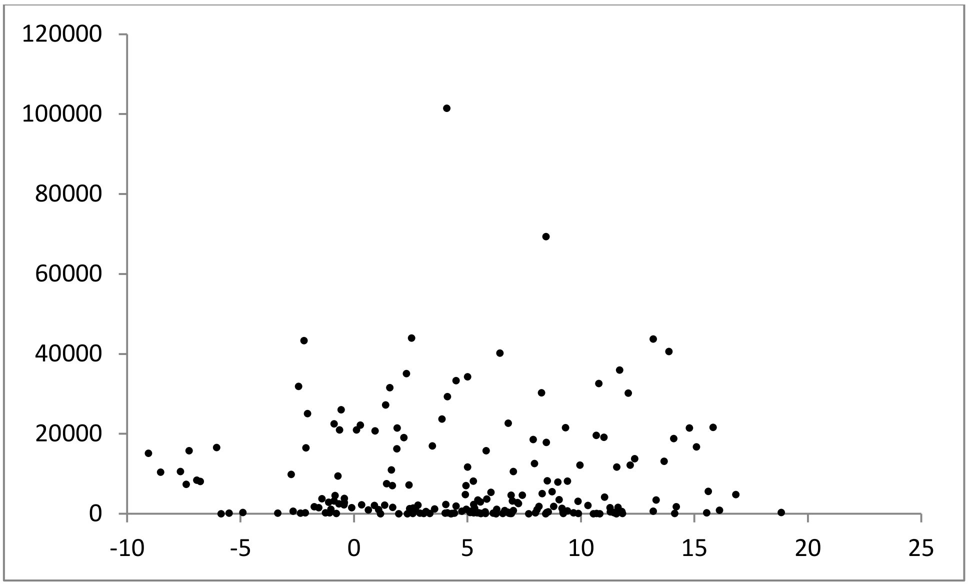


Figure 5. *Daily counts of geese (y axis) with respect to daily ambient temperature (x axis) across the winter seasons 2011 – 2017.*

This result, considering daily records across several winters, showed no statistical support for the significance of the local ambient temperature as an influential environmental factor, despite the observation that geese only appeared in the coldest part of the winter season. Records of geese occurred between -10 and almost + 20 degrees Celsius, with no evidence of any peaks or greater number of birds related to specific temperature(s).

On the other hand, a significant, but weak, negative correlation between daily temperature and geese counts has been observed in some of the winter seasons (two of six winters: Table 6). In one season, however, the correlation between temperature and geese numbers was positive; although this was not statistically significant.

Table 6. Correlation coefficients between daily geese numbers and ambient temperature in different winters of the post-operational SNWF monitoring period.

Correlation coefficient (r)	Winter season
-0.22548*	**2011-12**
-0.09183	2012-13
-0.07749	2014-15
0.085509	2015-16
-0.14176*	**2016-17**

* significant weak negative correlation

Such weak relationships in simple correlative analyses between the abundance of geese and local temperatures at SNWF are not wholly unexpected. Winter temperatures have been cited as influential in the distribution of RBG and their GWFG flock-mates. However, this is only one of several factors which have been suggested or recorded as influential for birds which are highly itinerant during winter (Simeonov & Possardt 2012; Cranswick *et al*. 2012; Harrison *et al*. 2015) and whose distribution across a wide geographic range, between and within winters, is apparently opportunistic and difficult to predict (e.g. Simeonov & Possardt 2012; Harrison *et al*. 2015). Relevant purported influential factors include access to preferred food (wheat), accessibility of food in large open areas, access to open water for roosting, access to freshwater for drinking, and freedom from hunting or other anthropogenic disturbance (Sutherland & Crockford 1993; Hulea 2002; Cranswick *et al*. 2012; Simeonov & Possardt 2012; BirdLife International 2015; Harrison *et al*. 2015). Temperature can affect several of these factors directly or indirectly; but likely, primarily, its influence will play out across a wide potential wintering range.

Despite the relatively low support of the correlation between local temperatures and geese numbers it is seems likely that decreasing temperature can be a trigger for wintering geese appearance in SNWF and the region in general; especially if, as most likely, these temperatures reflect decreasing temperatures in more northerly regions of the geese wintering range. This trigger may be apparent from the daily dynamics of temperature and geese numbers of the 2016-2017 winter, presented in Figure 6.

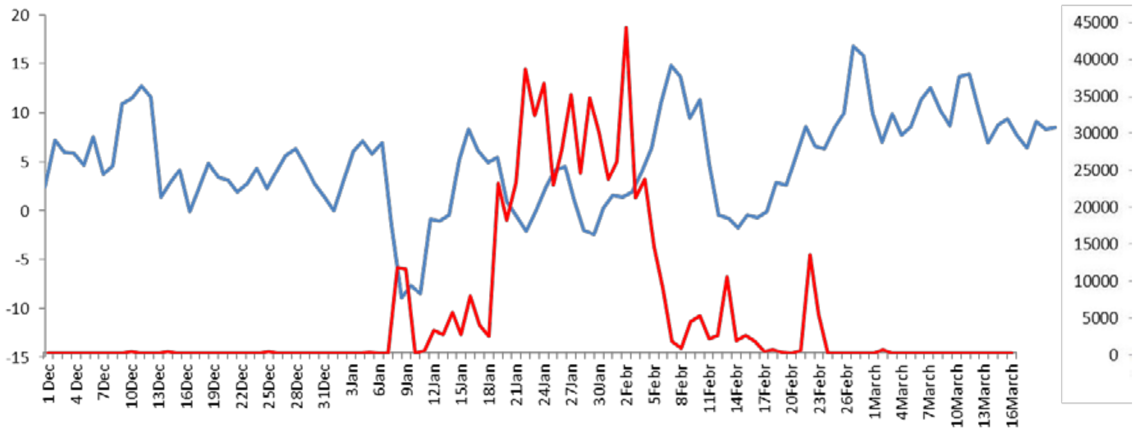


Figure 6. *Changes in ambient temperatures (blue line and left y axis) and total geese count (red line and right y axis) observed per day in SNWF in winter 2016-2017.*

As described in previous studies (*op. cit.*) and AES winter monitoring reports, in general geese are present in Bulgaria between December and early March. The first cold days in SNWF in this period may reflect a triggering drop in temperature further north and/or inland, rendering wintering resources there inaccessible, and so the geese in Ukraine, Russia and/or Romania then move southward and towards the coastal Dobroudzha (including SNWF). In 2016-2017 winter the number of RBG as well as GWFG increased in SNWF territory after a marked drop in local temperature on 6th January (Figure 6). In the days immediately afterwards, when temperatures were well below zero (8th and 9th January see ANNEX 1) there were observations of high numbers of geese moving to the south and crossing SNWF territory; implying that conditions were too cold even for SNWF and the locale. As temperatures rose immediately afterwards, geese returned. Still later in the 2016-2017 season the increased temperature at the beginning of February might have reflected a similar temperature increase to the north, re-opening resource availability there. Hence, this probably prompted the return migration of geese to the north, and so their numbers decreased in SNWF.

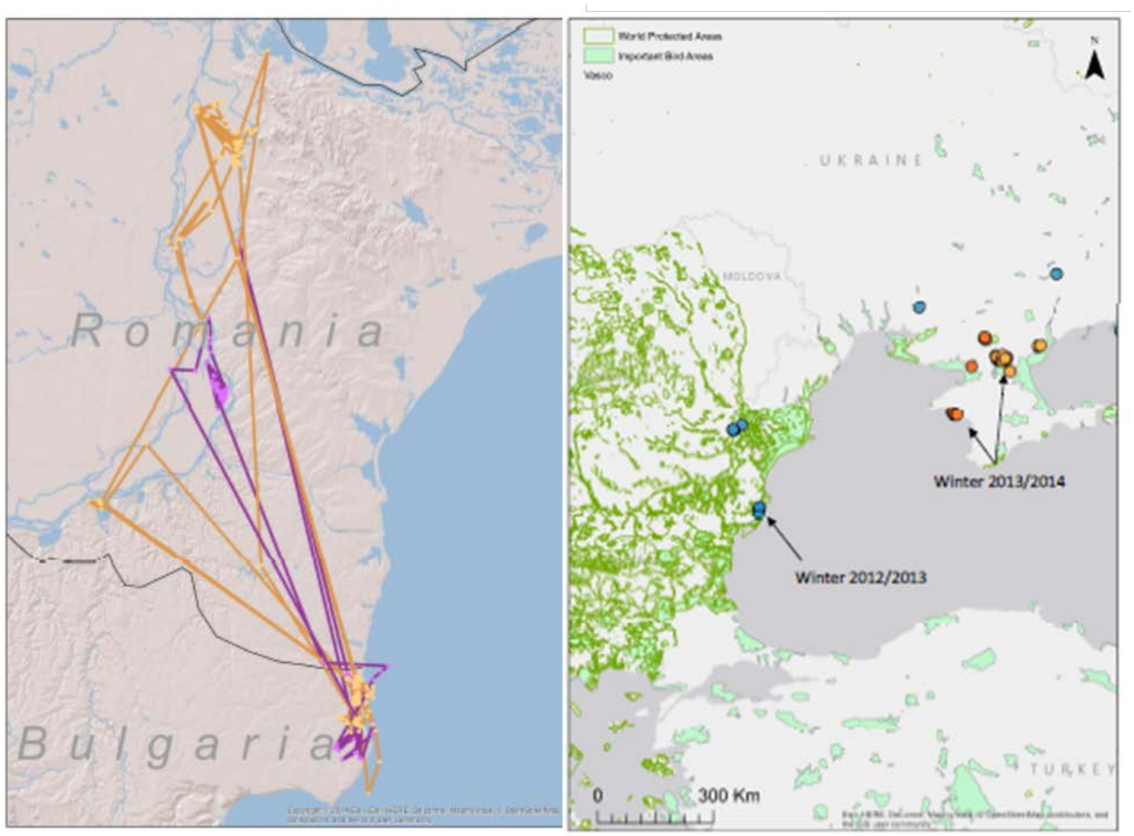
Although not analysed in detail here, a subjective review of previous winters' data collected at SNWF suggests that the relatively longer cold period in winter 2016-2017 could explain the relatively higher numbers of geese of all species including RBG in SNWF compared to some earlier winters.

It is likely that the opportunistic wintering behaviour (and so the itinerant movements) of the three species of geese which are observed in SNWF is the result of complex interactions between temperatures and wintering geese; which cannot be revealed by simple local correlations. While superficially complex, however, the observed movements (and so the presence of geese within SNWF, as only a small part of a much larger wintering range) may be due to a set of more simple hierarchical decisions taken within a broad behavioural strategy of wintering geese, governed by cost-effective use of and access to key resources to survive the winter and subsequently return to the breeding grounds in optimal condition.

A broad behavioural strategy for the geese may be to winter as close to the breeding grounds as possible and, within this strategy, to use a subsidiary set of hierarchical decisions governing movements between wintering sites that provide an abundance of food (primarily wheat fields) in areas with open visibility which also allow large feeding flocks (large fields) and, nearby access to ice-free freshwater; away from human disturbance and sources of actual or perceived mortality (in this regard, hunters will undoubtedly provide a more serious pressure than natural predators, or fishermen or farmers: Rozenfeld 2008; Rusev 2008; Cranswick *et al*. 2012; Petkov & Iliev 2014). Temperature (and other weather conditions) is most likely broadly influential via its effects on the changing availability of some of these key resources at a large scale, thereby governing at least some movements and shifts within the broad potential wintering range, within and between winters (e.g. Sutherland & Crockford 1993; Hulea 2002; Cranswick *et al*. 2012; Simeonov & Possardt 2012; BirdLife International 2015).

A thorough set of analyses incorporating measures of the many factors which may interactively affect the movements of wintering geese is beyond the scope of this report, but here we highlight some recent results which provide further suggestive evidence for the role of several contributory factors which had been previously identified or supposed.

Following from earlier studies and insights (e.g. Simeonov & Possardt 2012; Cranswick *et al*. 2012) further support for the opportunistic wintering behaviour of RBG has been provided recently by a team from Wildfowl & Wetlands Trust, Slimbridge, UK (Figure 7) (Harrison *et al*. 2015: http://bspb-redbreasts.org/files/docs/1477652409_184.pdf). These data clearly demonstrate that the same individuals of RBG can winter in a large region including territories in Romania, Ukraine and NE Bulgaria. Therefore this re-affirms that the appearance of geese in SNWF in a specific winter season, or within a season, is probably a result of larger scale processes rather than the simple effect of ambient temperature in SNWF territory.



GPS and satellite tracking results of Red-breasted geese in Bulgaria according BSPB data:
http://bspb-redbreasts.org/files/docs/1477652409_184.pdf

Figure 7. *Results from GPS tracking of RBG captured and PTT tagged in Dobroudzha, Bulgaria (from Harrison et al. 2015). The left panel shows the movements of two RBG (orange and purple) within a winter. The right panel shows the main wintering locations (labelled by arrows) for one RBG in two different winters. Other circles of the same colour, not labelled by arrows, refer to the same birds' spring migration records.*

The tracking data presented in Figure 7 may point to the importance of open water bodies for wintering geese. The satellite tracking and especially GPS positioned local movements indicate the spatial distribution of geese along the River Danube which is an important wintering area, as are the areas around the freshwater lakes of Shabla and Durankulak in Bulgaria, to the north of SNWF (Harrison *et al*. 2015). Important wintering locations identified by the satellite tracking data presented by Harrison *et al*. (2015) add to previous studies (*op. cit.*) showing a strong affinity with open freshwater coupled with nearby access to agricultural food supplies. The report by Harrison *et al*. (2015) makes no mention of temperature affecting ice-free freshwater bodies and its influence on movements. The periods when we have observed low temperatures (below zero) at SNWF, however, may have reflected a "trigger" for geese appearance in SNWF, through the freeze of the most important freshwater bodies away from NE Bulgaria.

This 'freshwater freezing factor' is unlikely to be a holistic explanation behind the presence of geese in SNWF, and so would further militate against any simple correlations between local presence of geese and temperature. There are no freshwater bodies in the vicinity of SNWF. As has been known for many years (e.g. Dereliev 2000a, b, 2006; Dereliev *et al*. 2000; Cranswick *et al*. 2012; previous AEG winter monitoring reports) the Shabla and Durankulak lakes, further north of SNWF in coastal Dobroudzha, are the focus of wintering geese in NE Bulgaria. This has been further confirmed, if such confirmation was needed, by the EU LIFE Project on RBG conservation in Bulgaria, which reported in 2015: http://bspb-redbreasts.org/en/Technical-reports-and-documents-related-to-the-project.html. While the presence of geese in coastal Dobroudzha, focused on Shabla and Durankulak lakes, may be explained by unsuitable freezing temperatures to the north and inland, the presence of geese in SNWF – which is not close to the freshwater lakes – should require consideration of additional factors.

One such factor will be hunting pressure at the Shabla and Durankulak lakes and the immediate (preferred) hinterland for feeding, forcing geese to use safer (if otherwise less preferred) feeding locales in the wider region which would include SNWF, and also use less preferred roosting locations on the Black Sea. As in previous studies and reviews (including previous AEG monitoring reports for SNWF), Harrison *et al*. (2015) made reference to the likely influence of hunting pressure on RBG movements; including movements between Bulgaria and Romania. Quantifying 'hunting disturbance' is difficult but has been highlighted as a priority for future monitoring by the EU LIFE Project on RBGs (e.g. Harrison *et al*. 2015).

Consequently, formal consideration of this hunting influence, so far as it may disturb birds from the Shabla and Durankulak lakes' hinterland towards SNWF, is beyond the scope of the present report. What is possible, nevertheless, is to examine or to speculate on how the presence of geese in the wider Dobroudzha region (which includes the Shabla and Durankulak lakes) relates to the presence of geese within the SNWF study area.

Dynamics of geese numbers in SNWF with respect to total number of geese in coastal Dobroudhza.

The data for recent goose counts for coastal Dobroudzha has been published in the report of LIFE09 NAT/BG/000230 project "Safe Ground Redbreasts - Conservation of the wintering population of the globally threatened red-breasted goose (*Branta ruficollis*) in Bulgaria" (European Commission 2015) This LIFE Project started 1st September 2010 and ended 31st May 2015.
http://ec.europa.eu/environment/life/project/Projects/index.cfm?fuseaction=search.dspPage&n_proj_id=3819.

In this LIFE Project report led by BSPB (European Commission 2015) the SNWF area is concluded to be low quality habitat for RBG and presumably for all wintering geese species (Figure 8: see also Harrison *et al*. 2015, for additional confirmatory data from GPS records of PTT tagged birds during the LIFE Project). This regional pattern of spatial utilization profiles by RBG is very similar to those observed before SNWF wind farm was operational and prior to the LIFE Project (e.g. Dereliev 2000a, b; 2006; AEG reports on pre-construction records at SNWF and in the wider region).

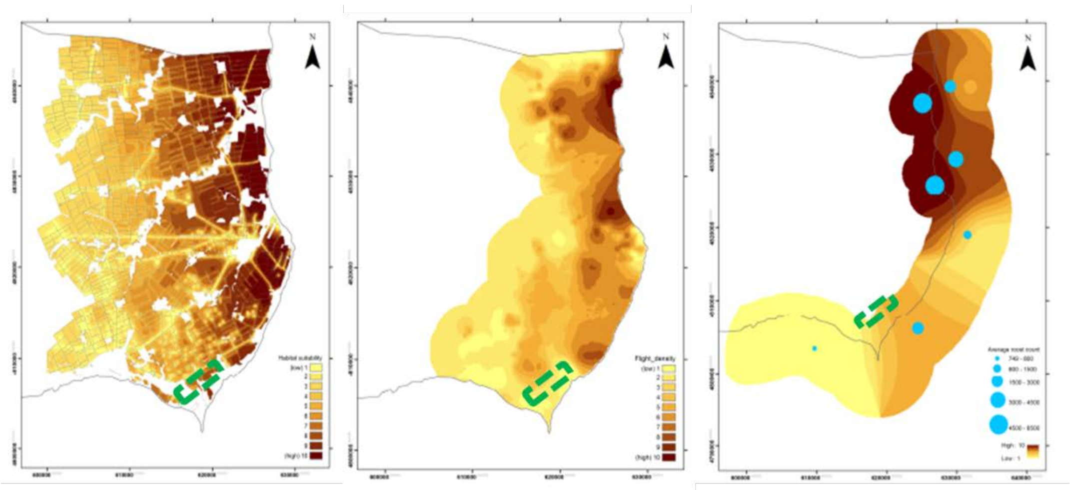


Figure 8. *SNWF territory (green) and composite map of feeding fields (left), interpolated flight density (centre) and interpolated average counts at roosting sites (right) distributions of RBG according to BSPB report* (European Commission 2015) *(http://ec.europa.eu/environment/life/project/Projects/index.cfm?fuseaction=search.dspPage&n_proj_id=3819.)*

Broadly, albeit simplistically, these recent LIFE Project materials and other AEG reports on monitoring at the SNWF wind farm further indicate that: 1) SNWF wind farm was not constructed in an "important" area for wintering RBG and other geese: these important areas in Bulgaria were (e.g. Dereliev 2000a, b), and continue to be, around the freshwater lakes to the north, and 2) there has been, nonetheless, no wholesale abandonment of the wind farm area after the construction and operation of the SNWF turbines, even though its locale was and remains fundamentally a less-preferred feeding resource.

What may shift this feeding preference towards SNWF, in some circumstances, is hunting (and/or fishing) activity at or around the freshwater lakes. Such human disturbance may also force birds to use safer roost sites on the Black Sea (European Commission 2015; this and previous SNWF monitoring reports), and as birds drift on sea currents overnight (Harrison *et al*. 2015), this too may bring subsequent goose activity closer to SNWF. This southward current-driven drift during occasional use of the Sea as a less-preferred roost area likely explains the diurnal pattern observed in the 2016-2017 winter (Figures 3 & 4) and as reported in previous winter reports on the monitoring of geese at SNWF: there were many morning flights from roosting sites on the Black Sea, across the wind farm, but relatively few evening flights in the opposite direction.

Therefore, low winter temperatures to the north of Bulgaria may lead to the presence of geese in NE Bulgaria (and so, primarily, at the preferred wintering areas to the north of SNWF, around Shabla and Durankulak lakes of Doubroudzha). Other factors, independent of ambient temperatures, notably hunting pressure or other human disturbance near these preferred areas of Doubroudzha, may subsequently force birds to exploit opportunistically less-preferred areas to the south, including the SNWF core area. Hence, ambient local temperature and the presence of geese at SNWF core area should not be expected to be strongly linked, but merely hinted only by weak links, because wider and more complex processes are likely at play.

Influence of wind turbines on distribution of feeding geese

It is patently obvious that large-scale displacement of feeding geese (i.e. from the wind farm) has not occurred due to SNWF, both from previous SNWF winter monitoring reports published by AES (including the present report: Figures 3 & 4, and Annex 1) and the recent results of the LIFE Project (European Commission 2015). However, small-scale displacement of feeding geese around individual wind turbines has been described by a recent preliminary report as part of the LIFE Project (Harrison & Hilton 2014). This study used a multi-variate analysis which included several other landscape features as potentially influential variables, and the fine-scale distribution of feeding geese was sampled by recording of goose droppings in fields.

Harrison & Hilton (2014) concluded that the negative influence of wind turbines on feeding goose distribution was substantially less than the presence of powerlines, and also less than tree lines (i.e. shelterbelts). The study equated these three landscape components collectively as "tall landscape features", which is arguably an over-simplification so far as how geese may perceive these three different features as threats to their survival and when also, even simply physically, they are clearly not comparable.

On other factors evaluated by Harrison & Hilton (2014): although considered to be relatively small and with low confidence on influence; roads and human settlements were also negatively associated with the presence of feeding geese, and (more so, on importance) high use by feeding geese was positively associated with a high index of 'openness'. On the other hand, the modelled influence of roads and openness extended to far greater distances than powerlines, shelterbelts (tree lines) or wind turbines.

The modelling of Harrison & Hilton (2014) estimated that the negative influence of wind turbines on preventing geese from feeding in 'otherwise suitable' habitat was restricted to a very small area around turbines, such that any influence by 100 m distance had largely disappeared. (We will revisit this conclusion of a highly limited displacement effect - fine-scale, later.) Their models predicted that the presence of wind turbines in their wide study area of coastal Doubroudzha, at the time of analysis, would reduce habitat availability by - only - 6 % (recall that there are other wind farms to the north of SNWF closer to the intrinsically preferred feeding areas of geese in coastal Doubroudzha).

Moreover, the study broadly tried to account for the changing influence of wheat cultivation, as a preferred feeding crop, but this key factor was not part of their 'landscape factor' analyses. Nor was the extent of a cultivated field under the preferred feeding crop, when both are known, or could be hypothesized to be, important influences (references *op. cit.*). The 'openness' index used by Harrison & Hilton (2014) does not quite encapsulate such likely influences.

In particular, distance to roost site was also conspicuously absent as a modelled factor in the analyses, when it is highly apparent from other materials both as part of the same LIFE Project (European Commission 2015: see Figure 8, above) and previous studies (e.g. Dereliev 2000a, b) that, intrinsically, feeding geese in coastal Doubroudzha strongly prefer fields close to the Shabla and Durankulak lakes. That this critical factor was not included is evident from the description of Methods in Harrison & Hilton (2014), and in the presentation of Results both on the current and predicted loss of habitat due to wind turbines (Figure 7 on page 26, and Figure 6 on page 25, of Harrison & Milton 2014).

It is obvious, therefore, in this baseline prediction of habitat suitability from the models of Harrison & Hilton (2014; their Figure 7) that this study is at odds with the modelled suitability documented elsewhere within the same LIFE Project. In not considering this important factor of 'distance to roost' and, even disregarding other unrelated queries related to this study, Harrison & Hilton (2014) have likely: 1) overestimated the potential adverse impact through displacement of current operational wind farms well to the south of the roost lakes, such as, notably, SNWF (and so for operational wind farms, overestimated the total predicted adverse fine-scale displacement effect, at 6 % habitat loss); 2) overestimated the potential displacement impact of <u>proposed</u> wind farms well to the south of the lakes e.g. those to the west of SNWF; but c) underestimated the potential adverse displacement impact of any <u>proposed</u> wind farms close to the roost lakes.

There are still further issues which should be raised; although likely less influential analytically than the omission of the 'distance-to-roost' factor. One such further issue, given the number of fields sampled for geese droppings, is the analytical (statistical) power to distinguish between the three "tall landscape features" (powerlines, shelterbelts, and wind turbines). Harrison & Hilton (2014) used records of geese droppings collected within SNWF, amongst other sites. The large majority of SNWF turbines (83 %) are close to (within 100 m of) a shelterbelt. With such a strong association between two of the "tall landscape features" there may not have been sufficient samples to separate properly these two variables in the multivariate analyses of Harrison & Hilton (2014).

A further potential (related) issue concerns whether the fine-scale displacement of feeding geese was a reaction to the turbine itself or to the availability of food around a turbine. An area of hard standing surrounding each turbine at SNWF (utterly devoid of cultivation) is typically about 65 x 40 m. When farmers cultivate areas around such ‘hard-engineered’ anthropogenic features associated with a turbine (or a hard-surfaced road, for example), there will be an additional surrounding area of poor or no cultivation, because of poorer soil quality and/or farmers unwilling to risk damage to machinery when preparing the ground, planting or cropping. Also, although perhaps more likely to have been implicitly included by the study’s analytical variable measures, there are uncultivated areas taken up by access tracks to fulfill turbine maintenance requirements; and proximity to shelterbelts (and so also the uncultivated areas this habitat occupies).

In other words, the area around a turbine where there is no or limited food for a goose is at or towards the limit at which the study of Harrison & Milton (2014) placed the fine-scale displacement distance of a turbine. Therefore, arguably at least some, or most, of this displacement in response to a turbine as posited by Harrison & Milton (2014) was actually a reaction to the absence of any food for a goose to feed on around a turbine; rather than a reaction to the turbine *per se*.

One other, more subtle matter, not considered as a positive influence of SNWF by any material in the LIFE Project studies, is how the observers and activities of monitoring associated with SNWF dissuade hunters from shooting and/or disturbing geese within the wind farm area, and so presents SNWF as a ‘safe haven’ for feeding geese away from the intensively hunted areas. The threat of hunting is not only severe by way of direct mortality (as we noted earlier) but also through indirect adverse effects through disturbance displacing birds from preferential feeding areas and more energy-efficient behaviours. The LIFE Project outputs (European Commission 2015) and earlier studies (*op. cit.*) make repeated reference to the adverse disturbance (displacement) effects of hunting on geese, but make no reference to the positive opportunities that the leasing of land by wind farm developers could make by excluding hunting (and/or deploying dedicated monitoring teams employed by wind farm developers as ‘police’).

As regards hunting and displacement; this relationship can create gross disturbance impacts and so, adversely affect birds’ access not only to parts of fields, but many fields, and larger parts of coastal Doubroudzha; as well as critical freshwater roosting and drinking sites. This much is highly apparent from the LIFE Project studies, and many previous works. Hunting pressure is difficult to quantify (as documented by European Commission 2015) but it is extremely obvious in this same set of publications that its influence can be substantial on preventing geese from using sites that they would otherwise have been used.

That recording its influence is more difficult to quantify than, say, the size of a field, or the fixed stationary presence of a shelterbelt or a wind turbine, has probably taken this factor out of analyses that can objectively characterize these other factors (e.g. Harrison & Hilton 2014). Even though, at least subjectively, hunting activity is probably far more influential than any of these other factors that are more easily objectified. What this can create is an undue emphasis on the more readily quantified factors, because hunting lacks the statistical ‘clout’ and analytical comparability through its (understandable) omission as an objectively defined factor. To be fair, Harrison & Hilton (2014) do note, in their Discussion, the likely gross effects of hunting on displacement of feeding (and roosting) geese, but this factor arguably receives the minimal attention that it does in the preliminary report because it was not part of the study’s analytical framework. This is not to say, however, that it was not, probably, a critical influence (according to other studies, but from more ‘subjective’ data) and far more severe than any of the factors included as analytical variables.

Overall, on displacement of feeding geese, the study described by Harrison & Hilton (2014) as the authors rightly claim, is a major step-forward in the study of how feeding geese may be displaced by several landscape features. The study is published as preliminary, only, and it would seem, accordingly, that further work is needed on the study's methods and analyses; we have made some suggestions here in the present report.

Harrison & Hilton (2014) placed most emphasis on the possibility of significant future adverse effects of proposed wind farms rather than current effects of operational wind farms due to, for example, SNWF. We have nevertheless argued above how even the minor adverse effect of current wind turbines described by Harrison & Hilton (2014), such as those at SNWF, will likely have been exaggerated. The concerns expressed by Harrison & Hilton (2014) on wind farms may have greater relevance so far as the effect of any future proposed wind farm developments close to the Shabla and Durankulak lakes, where geese intrinsically prefer to feed. Indeed, as we have noted, this study may have underestimated any adverse impact of proposed wind farms in such locations; although the scale of any intrinsic impact should probably be reconsidered in light of other issues we have raised above.

The conclusions of Harrison & Hilton (2014), and in light of additional considerations noted above, however, do not indicate that SNWF, in itself, is a problem for RBG or other geese so far as displacement from feeding areas. There are many more serious issues which require to be addressed as conservation priorities for RBG, than any fine-scale displacement effects of SNWF – which appear to be at worst, negligible; and more likely have no discernible impact. This much is also apparent from many of the other products of the LIFE Project (European Commission 2015). In this respect there is convergence with the conclusions of the present report and, repeatedly, previous reports published as part of the AES monitoring of the SNWF wind farm area in winter.

Carcass monitoring results

All 52 turbines were scheduled to be searched every seventh day (if the areas under turbines were accessible) for carcasses during the whole winter survey period (1st December 2016 – 15th March 2017) when more birds are at risk of collision. The last wintering geese in SNWF are typically observed at the beginning of March; therefore, for surety of adequate coverage, the searches continued after 1st March, but with lower frequency until the end of the month. The actual frequencies of searches are presented in Table 1. The weather condition (ambient temperature, rain and snow coverage) which may have an impact on the frequency and results of the searches has been previously discussed in several winter monitoring reports available at: http://www.aesgeoenergy.com/site/Studies.html. In the 2016-2017 winter thirteen days in January and four days in February were extremely cold and access to the turbines was impossible. In the remaining period of the winter monitoring 44 searches in 100 % of the plots and 377 searches by binoculars and walking transects in a limited turbine plot area were made.

In February 2010 a trial was conducted to examine the searcher efficiency and carcass persistence rate during winter (see report on 2009-10 winter). The results from such trials are important to calibrate the results of systematic searches for collision victims and to inform the timing and frequency of these searches (see previous monitoring reports at: http://www.aesgeoenergy.com/site/Studies.html).

In the 2015-2016 winter, a re-examination of searcher efficiency and carcass persistence rate was performed in January 2016 as part of the monitoring program, when 14 hen carcasses were placed around six turbines and searched for their persistence at daily intervals. All carcasses had disappeared within a week of placement. These results were similar to the earlier trial in

2010, and broadly confirmed the efficiency of searches under turbines every seven days: the detailed trial results are available in the report for the winter 2015-2016 (http://www.aesgeoenergy.com/site/Studies.html).

Systematic searches under turbines (Table 1) in the 2016-2017 winter resulted in one set of remains being found which may have been associated with a collision with the turbine blades: a Skylark (*Alauda arvensis*) (Figure 13). This species is of least concern according to the IUCN criteria and is not listed in Bulgarian Red Data Book.

Other remains which were found included two records of single feathers of GWFG (*Anser albifrons*), two feathers of Grey Partridge (*Perdix perdix*) in two different days and one set of feathers of domestic pigeon. None of these remains or the circumstances of their discovery indicated that they were the result of collision with turbines.

No body parts or intact remains of geese which could be considered as collision victims were detected after an accumulation of 449 searches under different turbines in the period 1st December 2016 – 30th March 2017 (Table 1). Therefore, no evidence for collision of any goose species, including RBG, has been found in the winters 2010 - 2017 when geese were present and turbines were operating.

Figure 13. *The carcass of Skylark (A. arvensis) found on 08 March 2017*

The TSS in the 2016-17 winter was activated in situations where White-tailed Eagles (*Haliaeetus albicilla*) were observed hunting the wintering geese in SNWF.

All of the turbine stops associated with the bird observations and the reasons why they were enacted are given in Table 7.

Table 7. Circumstances of turbine stops under the TSS associated with minimizing collision risk of sensitive bird species during the winter 2016-2017 in SNWF.

Date	Stop time	Re-start time	Species	Species	Number of birds	WTG	Ordered by	Remarks
15.01.2017	11:40	11:45	*Haliaeetus albicilla*	White-tailed eagle	1	E	M. Marinov, K. Ivanova	flying in low altitude 50-100 m between the turbines
15.01.2017	11:40	11:53	*Haliaeetus albicilla*	White-tailed eagle	1	D	M. Marinov, K. Ivanova	flying in low altitude 50-100 m between the turbines
15.01.2017	11:45	11:53	*Haliaeetus albicilla*	White-tailed eagle	1	B	M. Marinov, K. Ivanova	flying in low altitude 50-100 m between the turbines
26.01.2017	14:23	14:35	*Haliaeetus albicilla*	White-tailed eagle	2	D	M. Marinov, Y. Yankov	flying in low altitude 50-100 m between the turbines

Conclusions

As in some of the previous relatively cold winters with a long and cold period in January there were more records of wintering geese using SNWF in winter 2016-2017.

Daily observations from December 2016 to March 2017 (inclusive) revealed that the recorded presence of geese in and around SNWF was compressed into a short time period within the winter, which was essentially the same as already established in studies 2008 – 2016.

The time period when geese are present in SNWF and the wider coastal Dobroudzha region is probably determined by constraints between the season when geese have to be in this part of the species' range, and low ambient temperatures triggering their spatial distribution over the wider wintering range of the species.

The number of wintering geese observed in SNWF during winter broadly corresponds to the total number of wintering geese in the larger region of coastal Dobroudzha region; but is lower, in keeping with SNWF being a fundamentally less-preferred area (grossly and intrinsically, irrespective of the wind farm's presence).

SNWF is not a source of collision mortality for wintering geese, even though they fly through or feed within SNWF (with varying regularity but sometimes frequently – as in previous winters). The evidence for this is that no remains of geese that could be attributed to collision with SNWF's turbines were found during systematic searches under operational turbines in any of the seven winters when SNWF has been operational. Many hundreds of thousands of geese flights have been recorded over several winters through the wind farm, which have presented a risk of collision from turbine blades at SNWF. Despite this, and many hundreds of searches under turbines, however, there has been no record of any goose being a collision victim. While the predominant focus on goose studies concerns the less common RBG, this finding refers also to the far more common GWFG. As the two species routinely flock together, the lack of, even, any GWFG casualty adds further confidence that the wind farm has had no detectable effect on RBG mortality.

This absence of any collision mortality of RBG due to SNWF is in sharp contrast to how much of a demonstrable threat that hunting poses directly to RBG mortality through shooting. Prior to the recent LIFE Project (European Commission 2015) shooting of RBG was deemed to be a threat (Cranswick *et al*. 2012), and was especially highlighted in a graphically descriptive paper by Rusev (2008). More recent results from the fate of tagged RBG (Harrison *et al*. 2015) and other studies funded by the LIFE Project (European Commission 2015) have re-sounded this alarm bell rung earlier by Rusev (2008) and others, on the potential severity of illegal hunting mortality.

No gross displacement (disturbance) reaction from geese has been observed for the period 2008 – 2017 as a result of SNWF's construction and operation. Observed numbers of geese of all three species as well as observed spatial distribution of flying and feeding geese does not indicate gross displacement from the operational SNWF or its immediate environs.

A minor small-scale displacement of feeding geese around wind turbines has been described by a recent preliminary report (Harrison & Hilton 2014) as part of the LIFE Project using a multi-variate analysis which included several other landscape features, and with the fine-scale distribution of feeding geese being sampled by recording of goose droppings. This study concluded that current wind turbines in coastal Doubroudzha, notably those as part of SNWF, amounted to only a small loss of potential feeding areas through fine-scale displacement (to tens of metres of habitat loss around a turbine).

We present several arguments, including information from other studies from the same LIFE Project, which propose that even this conclusion of minimal displacement impact is probably exaggerated. We posit that any fine-scale displacement effect at SNWF, if it occurs, is likely of no material consequence, based on: a) other studies under the LIFE Project; b) our suggested revisions and factors that should have been (but were not) considered by the 'fine-scale displacement' studies; c) earlier research such as those of Dereliev, and; d) previous AES monitoring studies at SNWF. We also point to the indirect impact of hunting on feeding and roosting geese, not considered by the 'fine-scale displacement' study, as a far more serious problem through gross displacement effects.

While there may be legitimate concern over some cumulative displacement effects from potential wind farm construction close to the roosting lakes of Shabla and Durankulak, we suggest that such concern does not apply materially to wind farms in the south of coastal Doubroudzha, such as SNWF. SNWF may actually offer a safe haven for feeding geese away from the more serious threat of hunting. Hunting is not only a threat to RBG directly through killing birds, but also indirectly by routinely displacing birds from preferred feeding areas, potentially stable roost sites and sources of fresh drinking water.

From research associated directly with SNWF described in the present report (and see previous SNWF winter reports on the AES website, and earlier surveys) the core study area remains a feeding ground for RBG as well as GWFG, but it also remains an unimportant area for both species, as indicated in pre-construction studies. Consequently, and based on other studies, SNWF presents no material threat through preventing use of food supplies (and especially in light of other agricultural practices such as crop type and field size of the preferred crop of geese). SNWF also poses no material risk of mortality to geese through collision with turbine blades.

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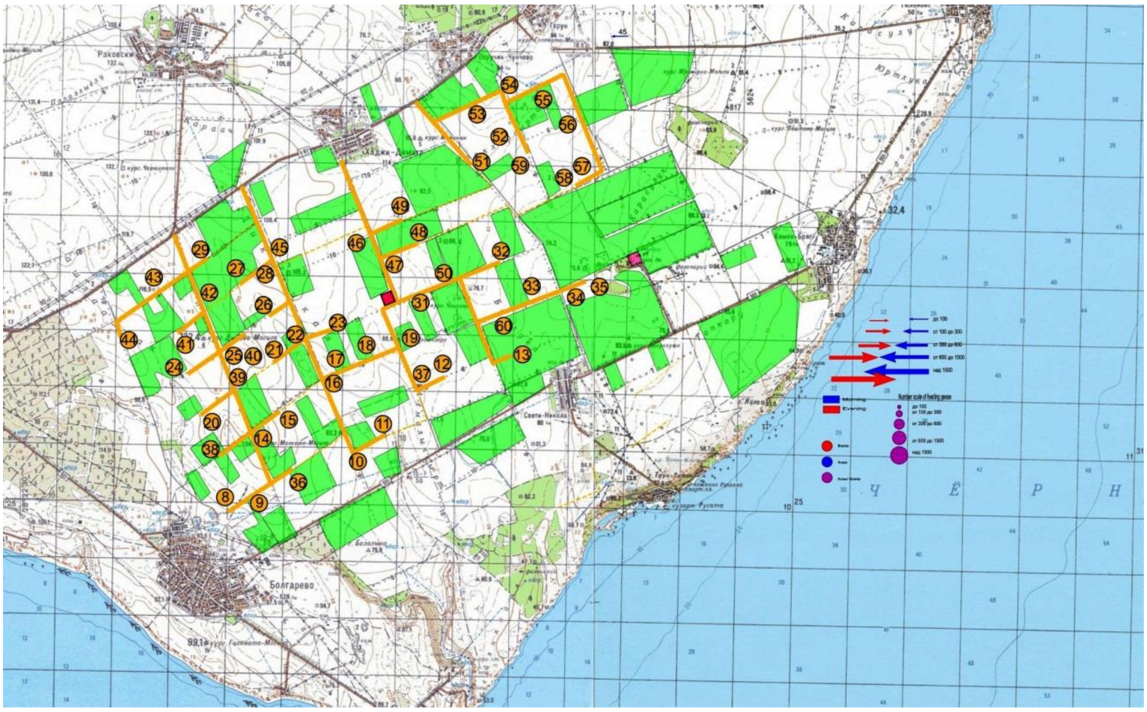
ANNEX 1. Day by day movements of geese as observed in winter 2006 – 2017. Green fields indicate crops suitable for feeding geese.



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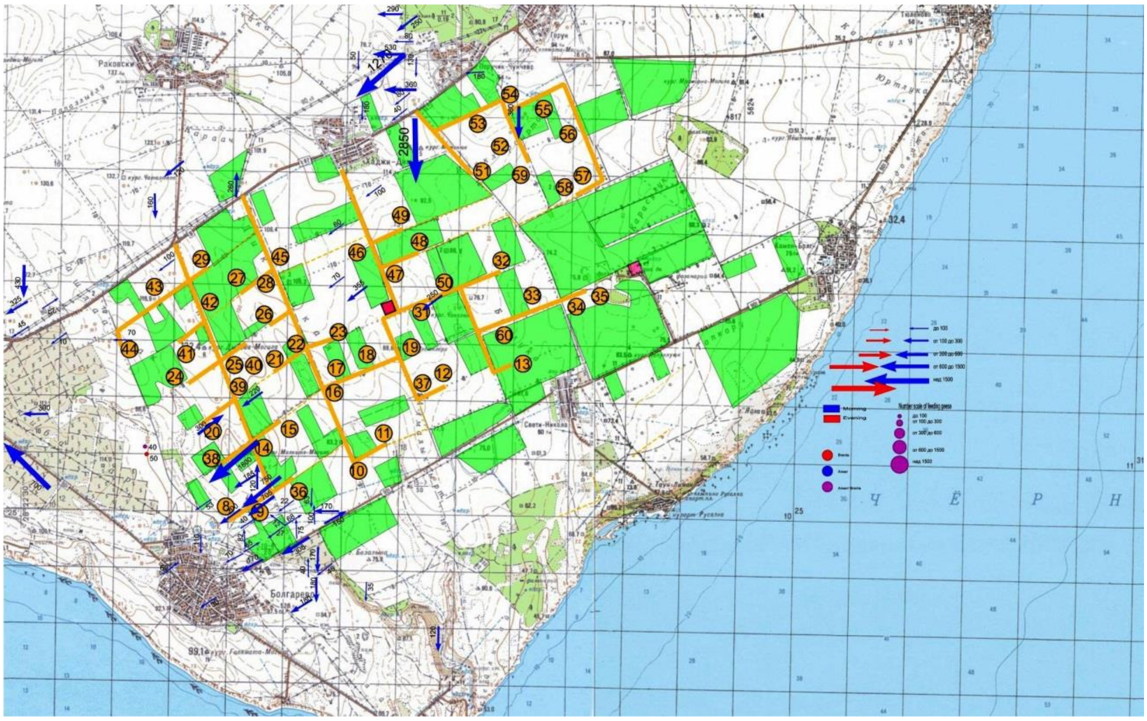

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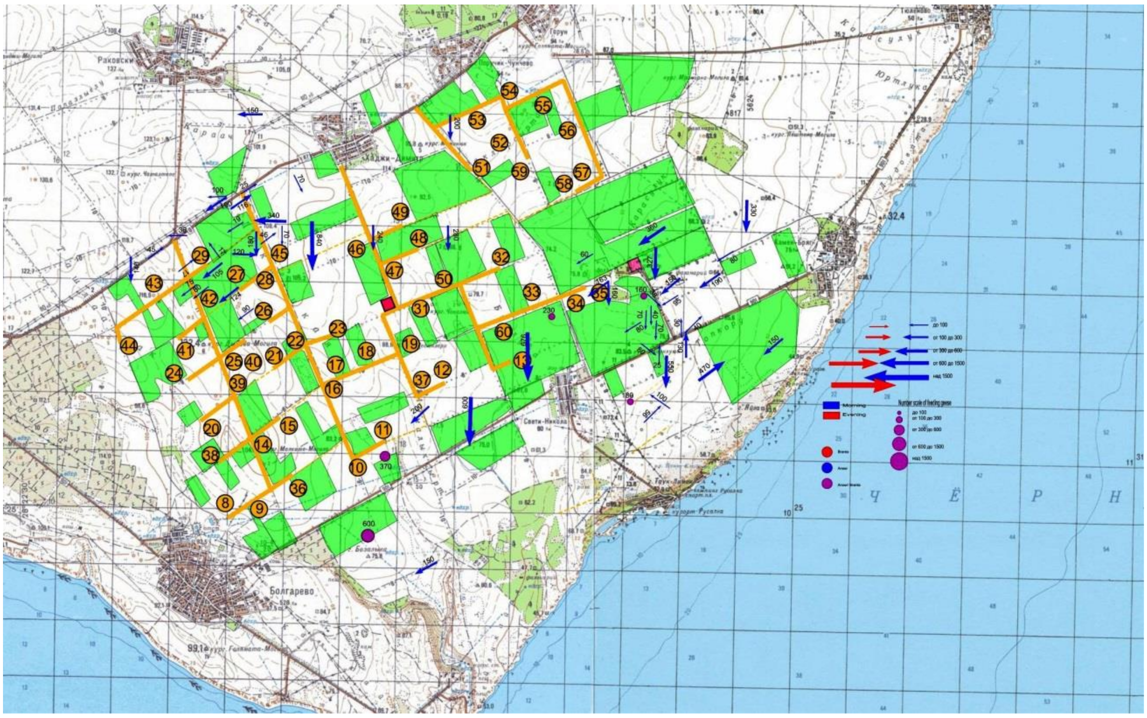

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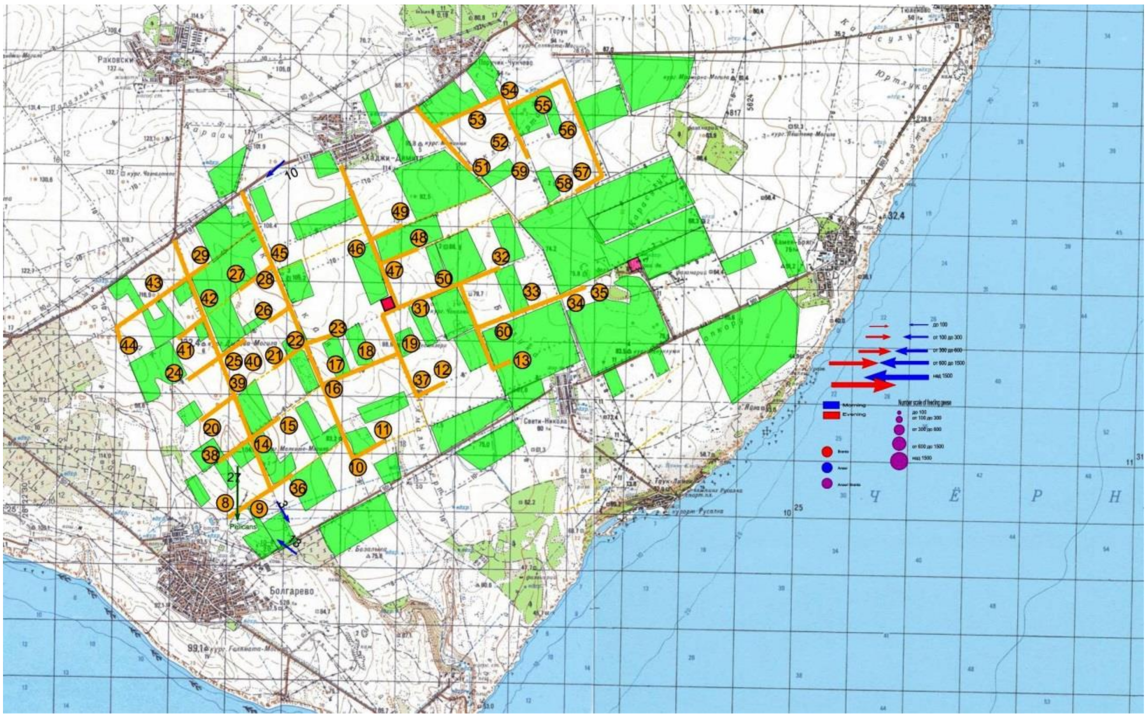

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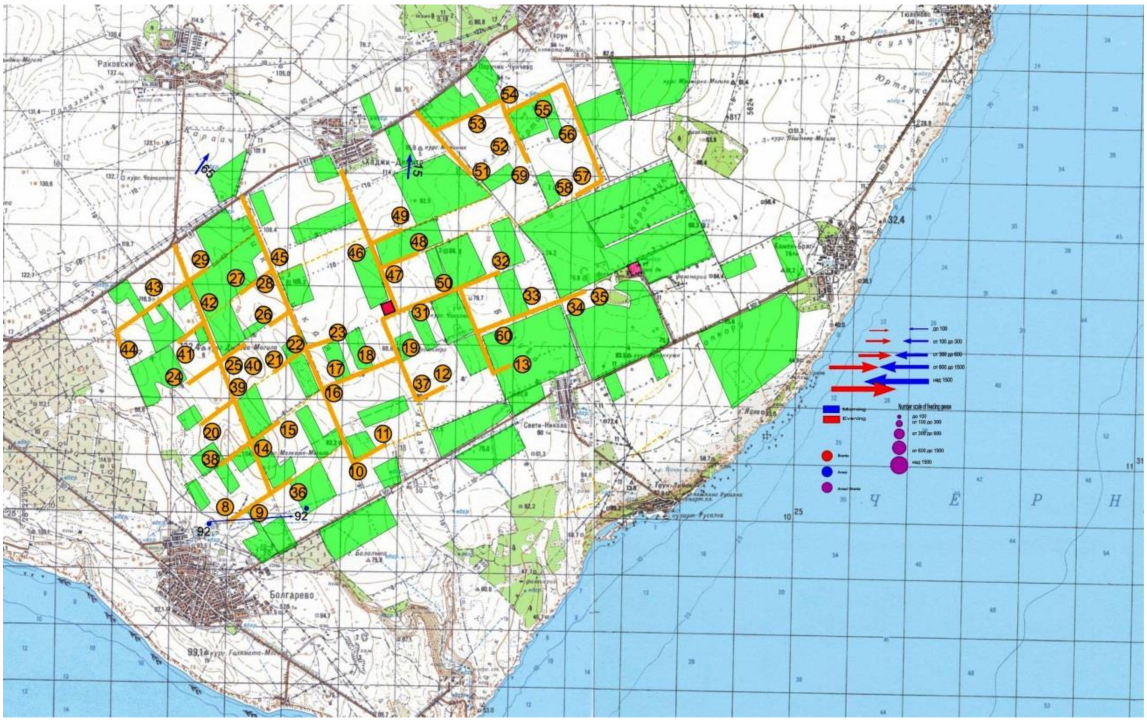

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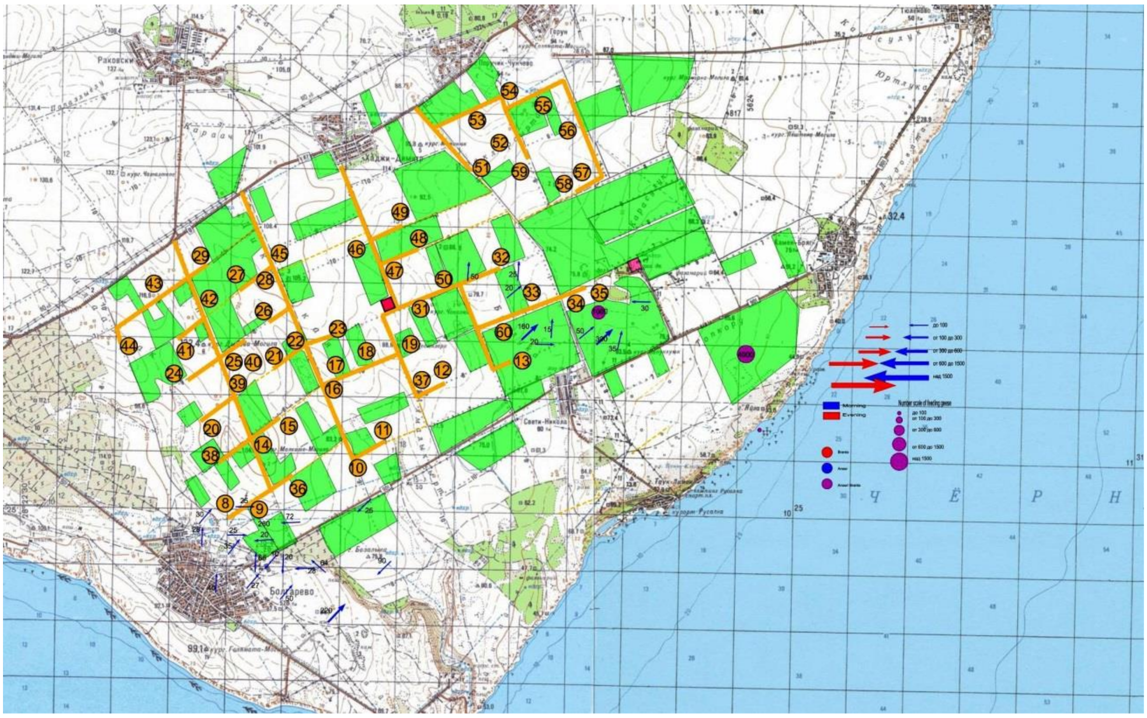

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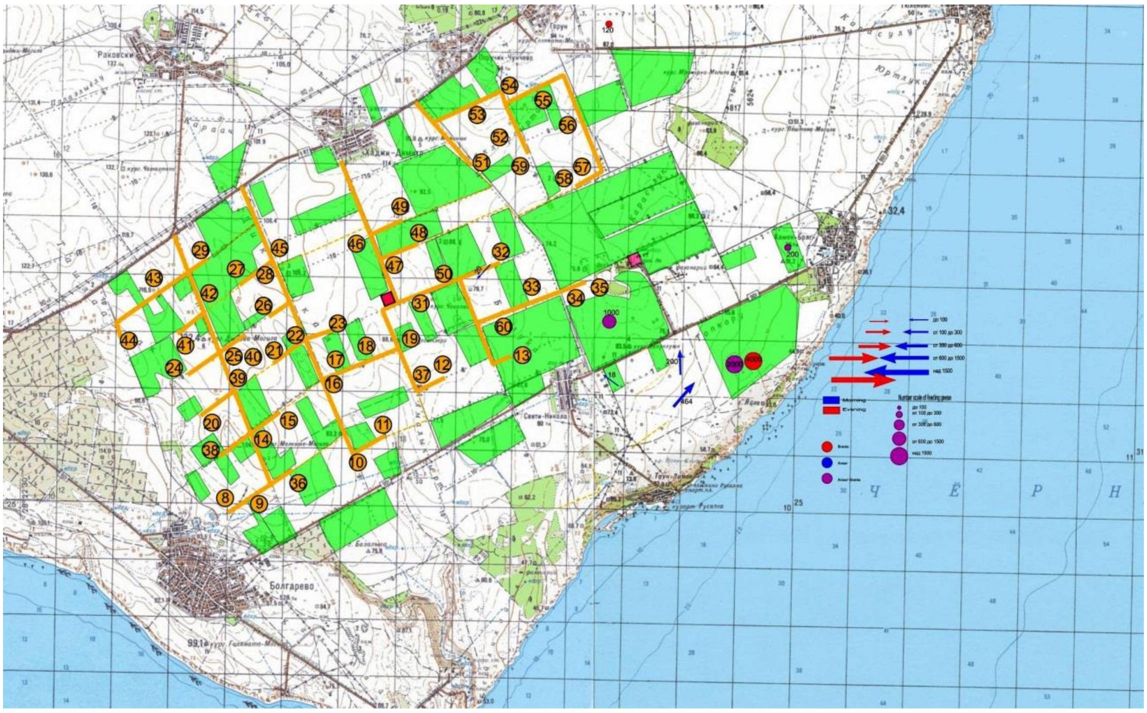

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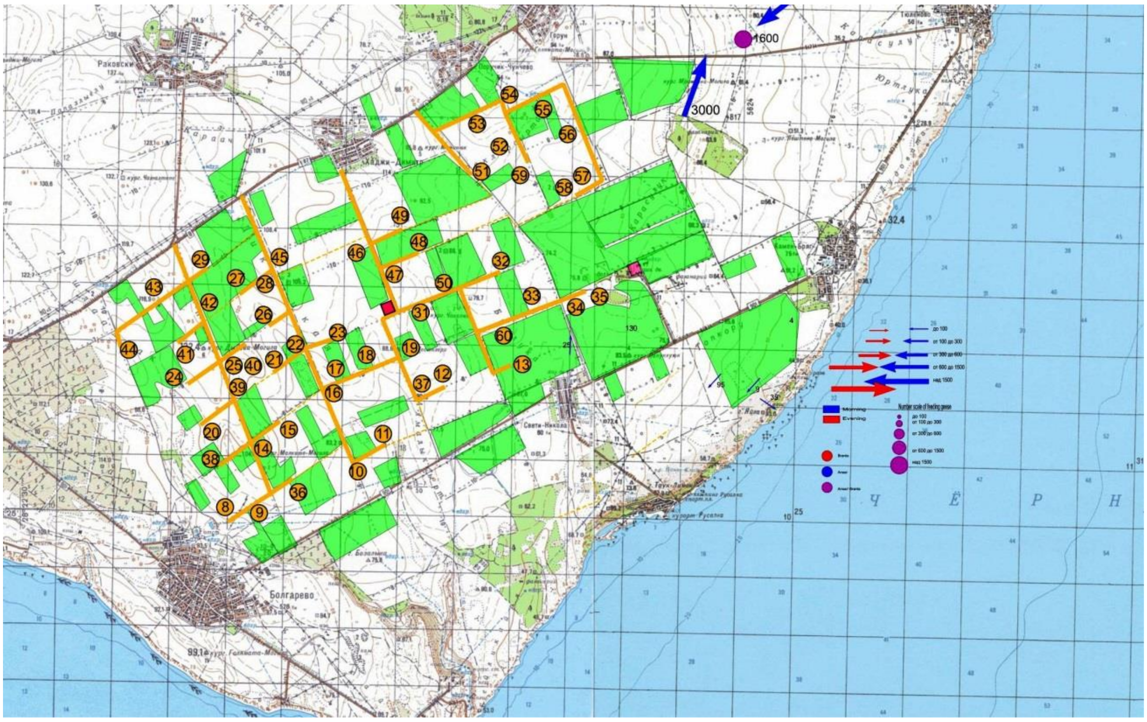

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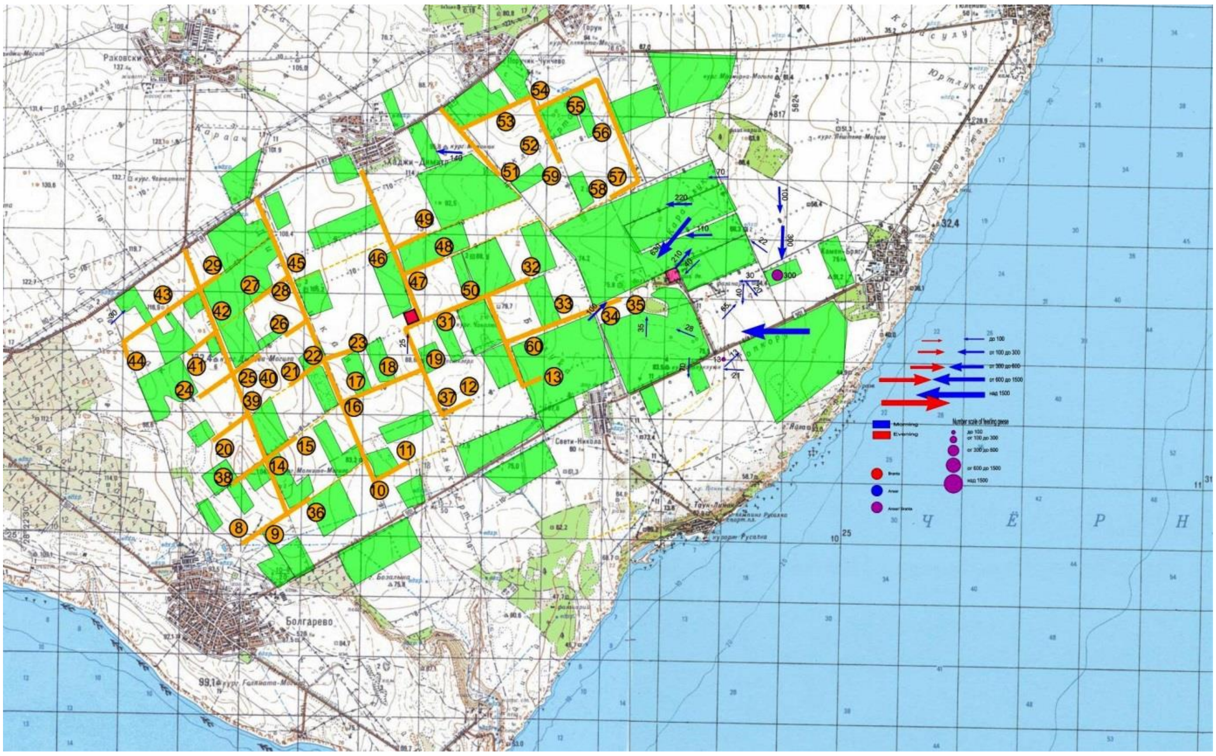

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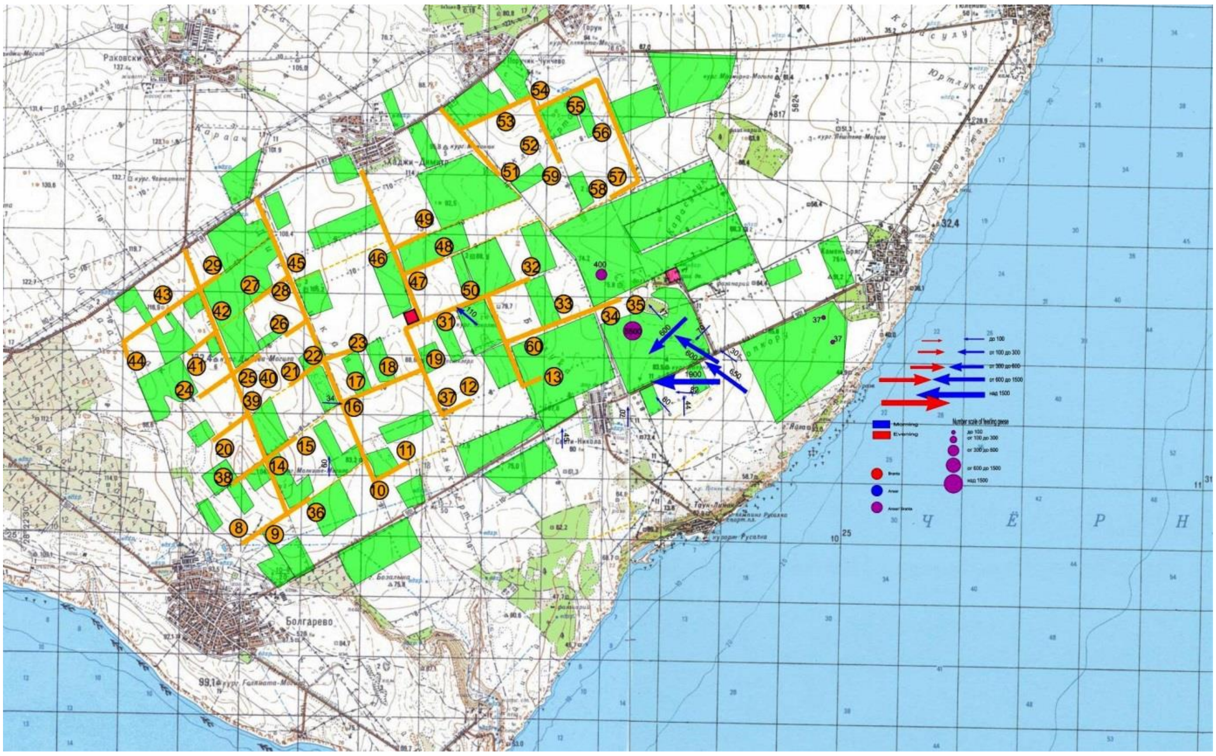

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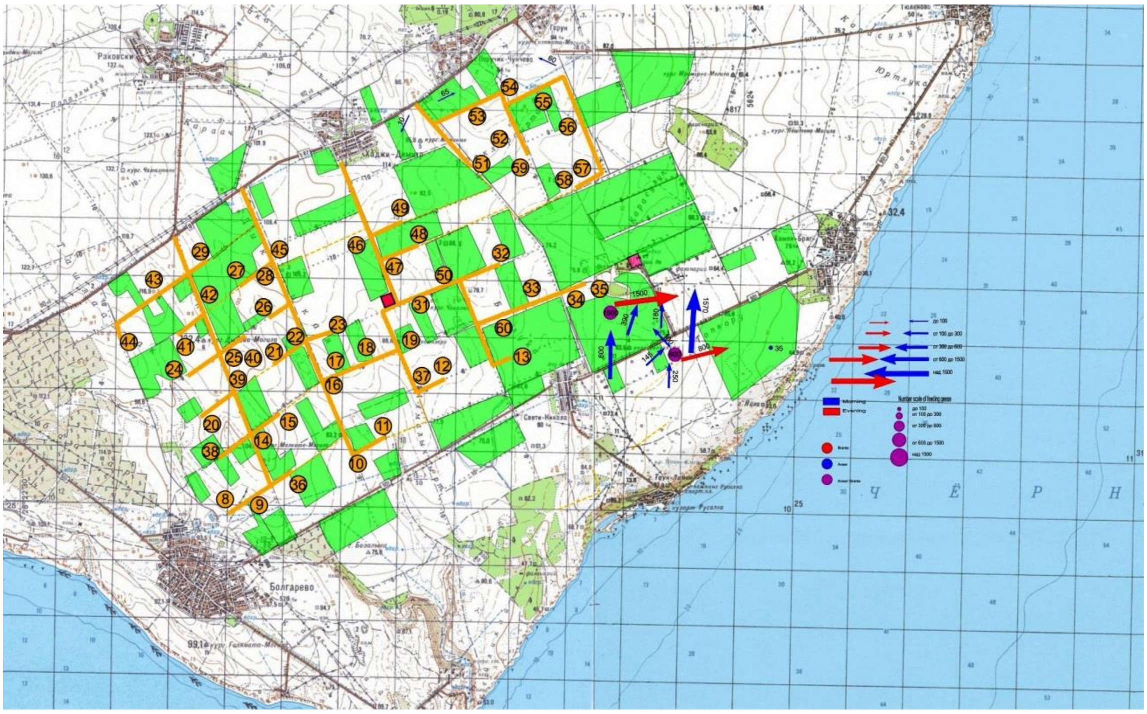

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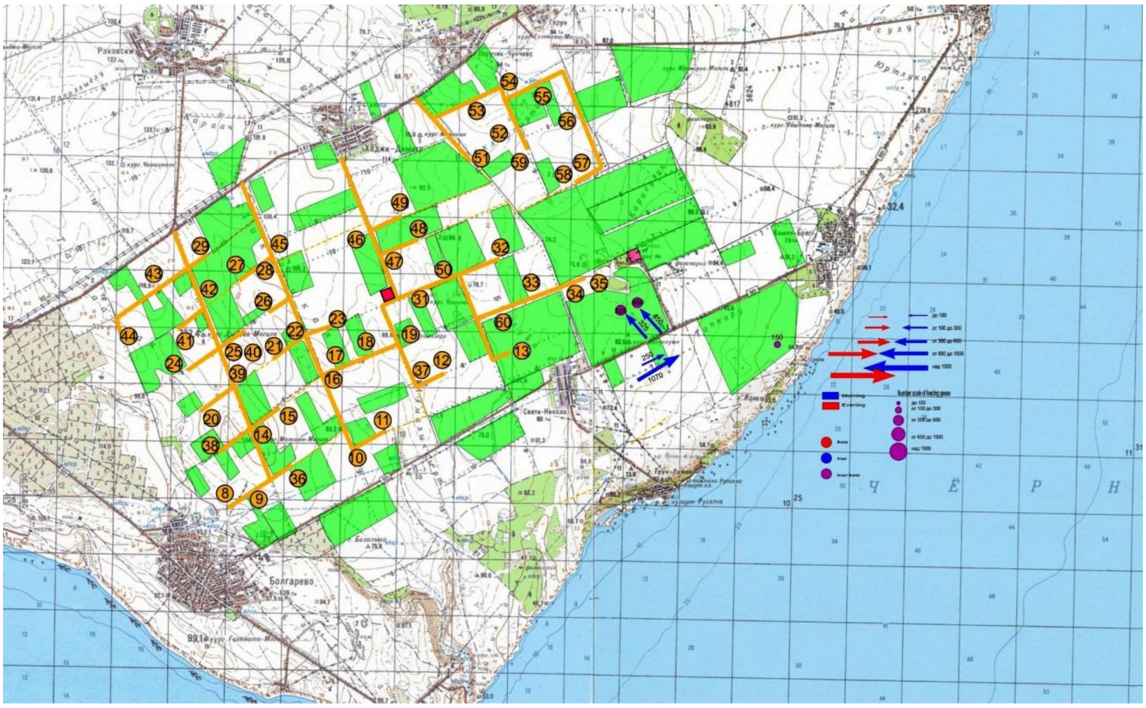

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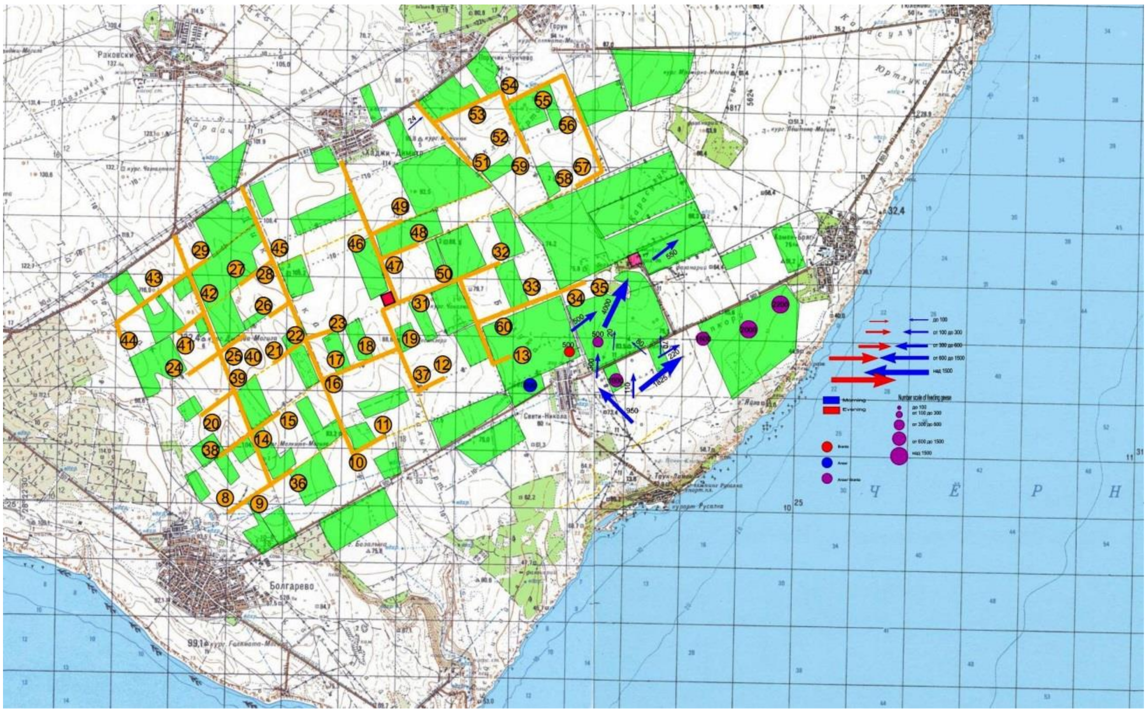

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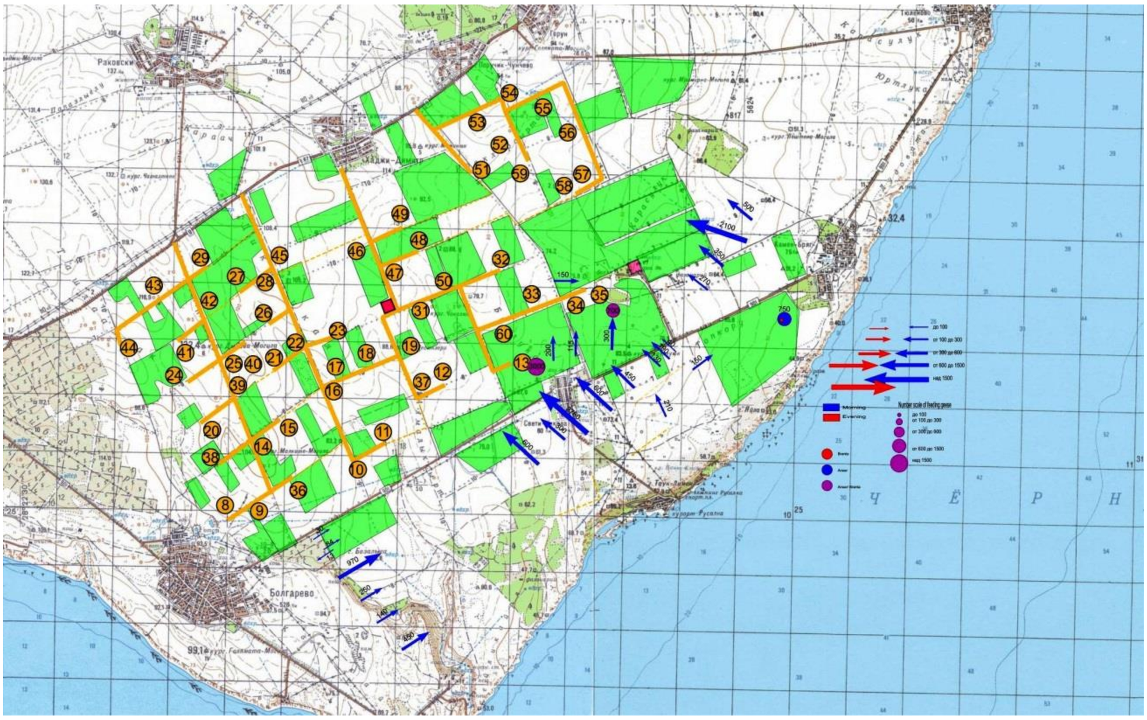

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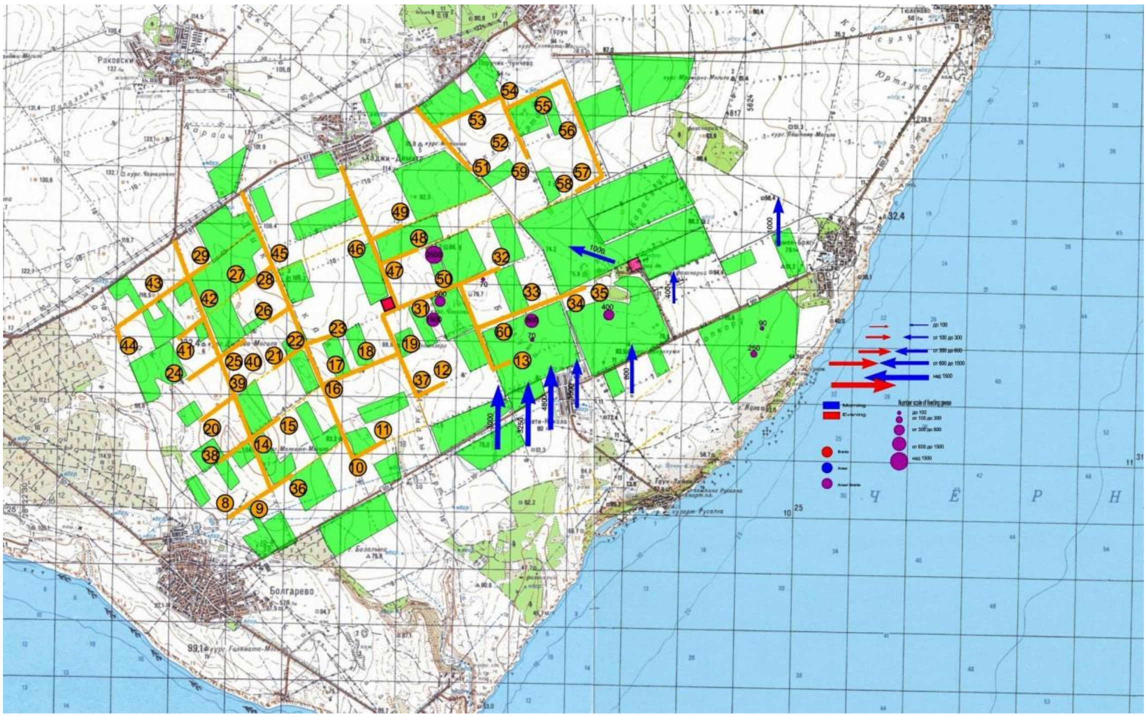

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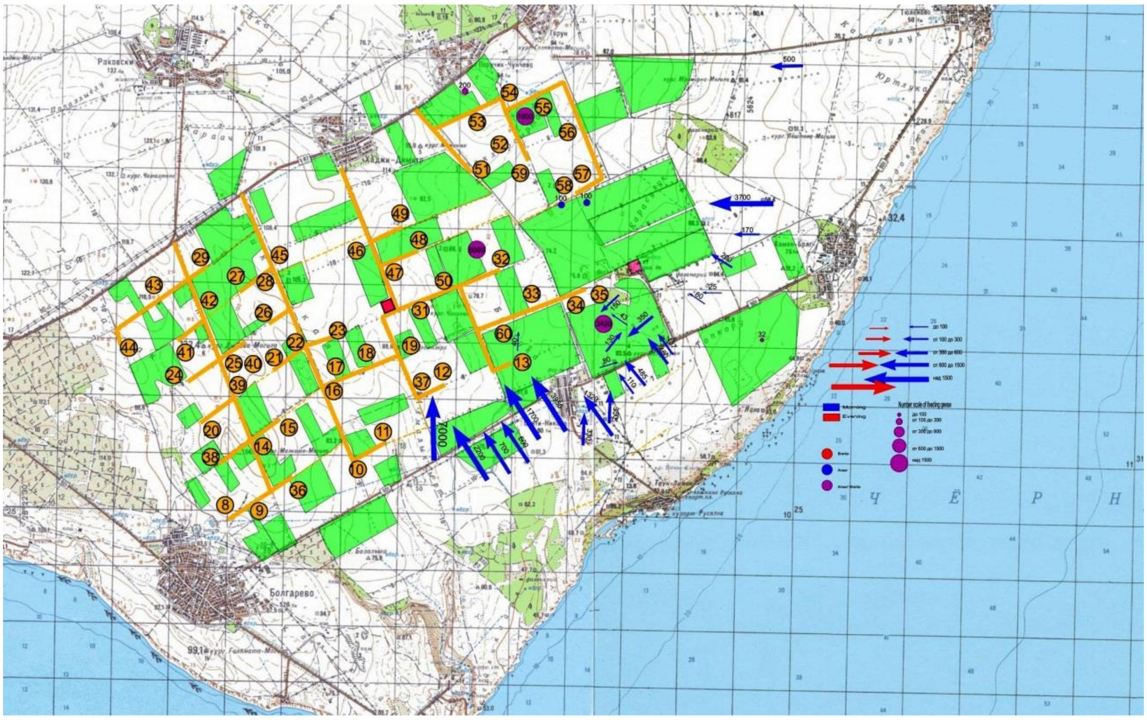

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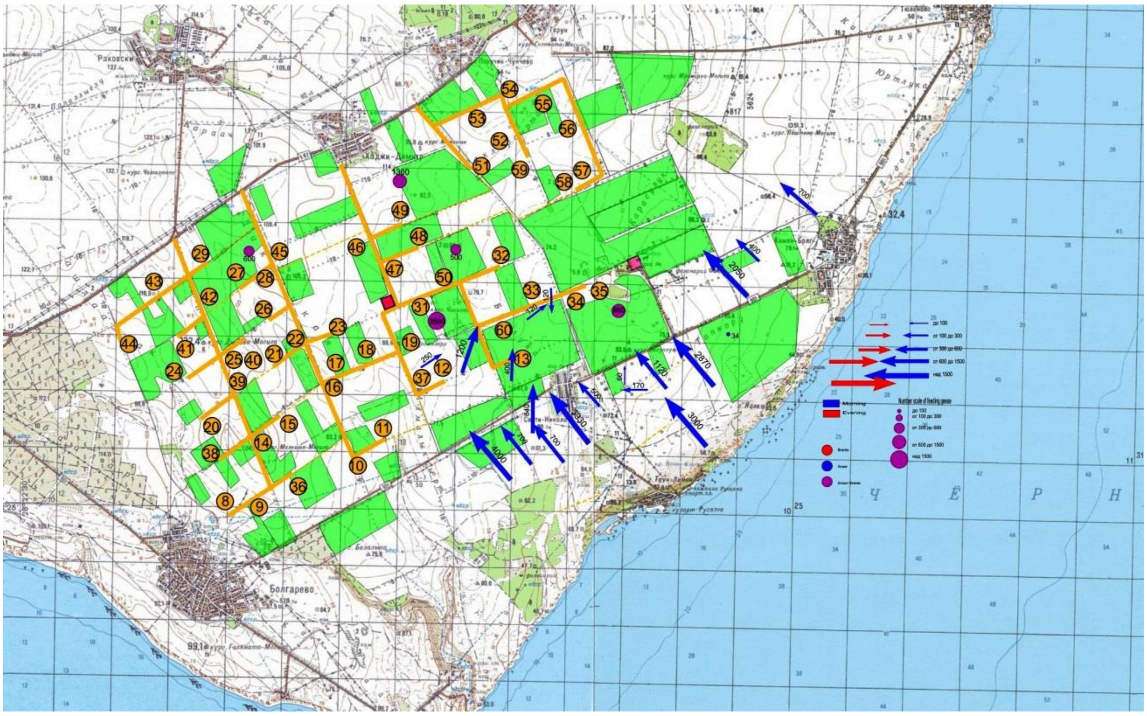

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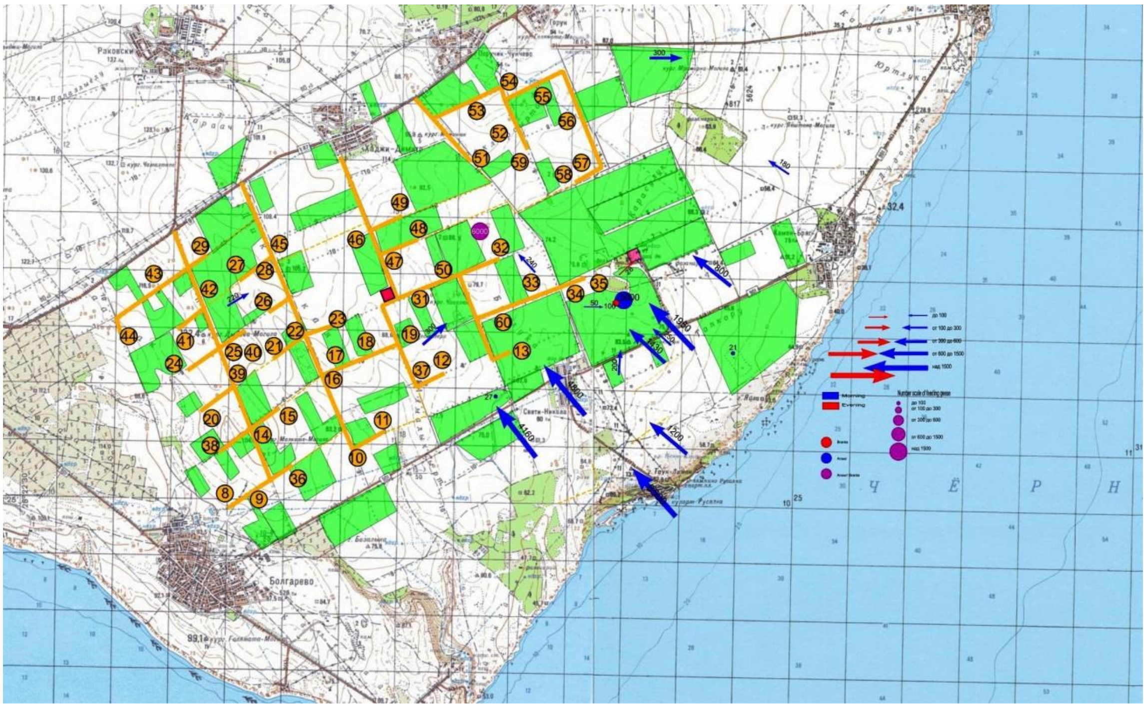

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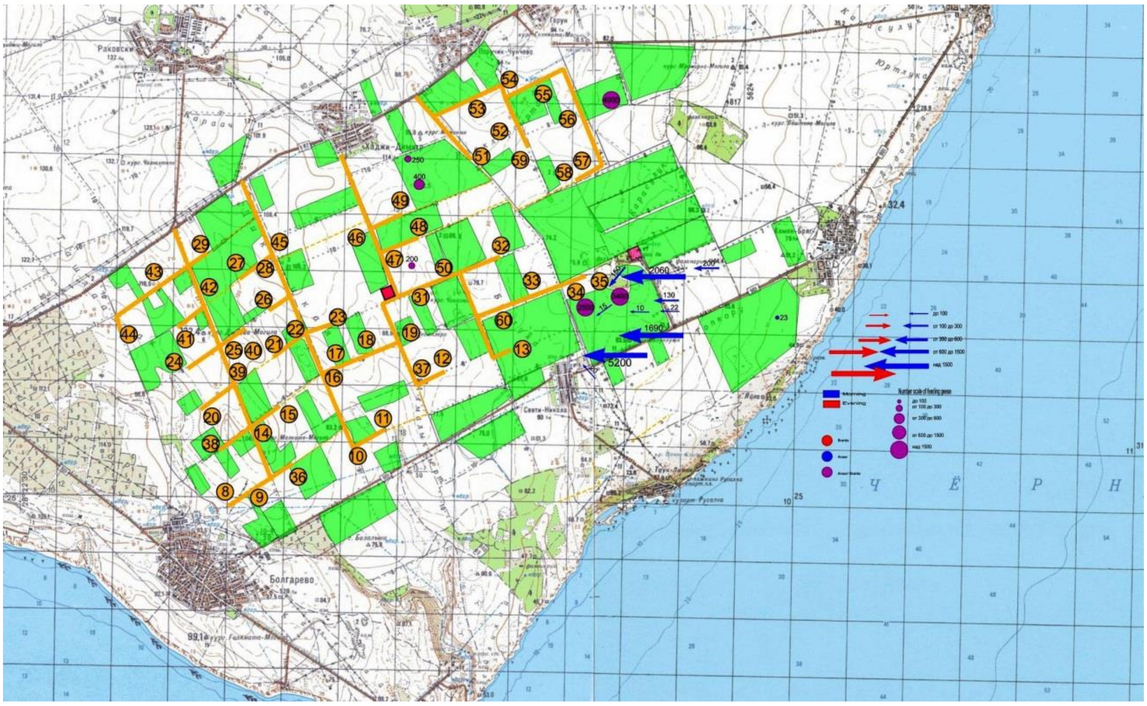

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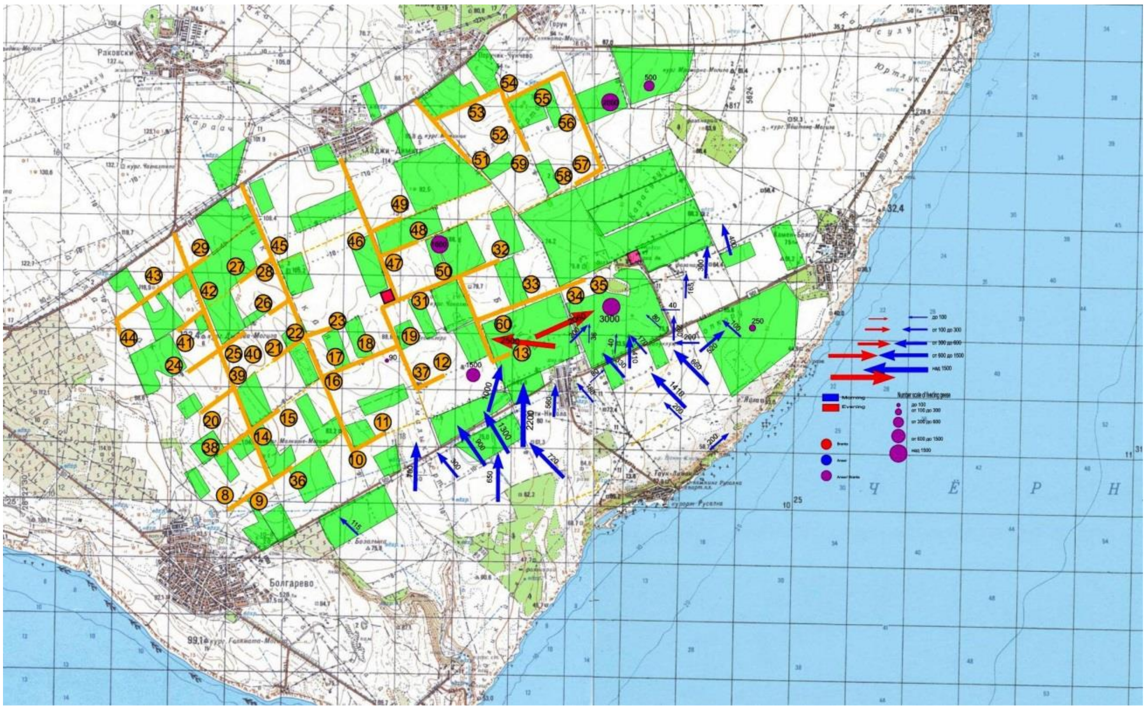

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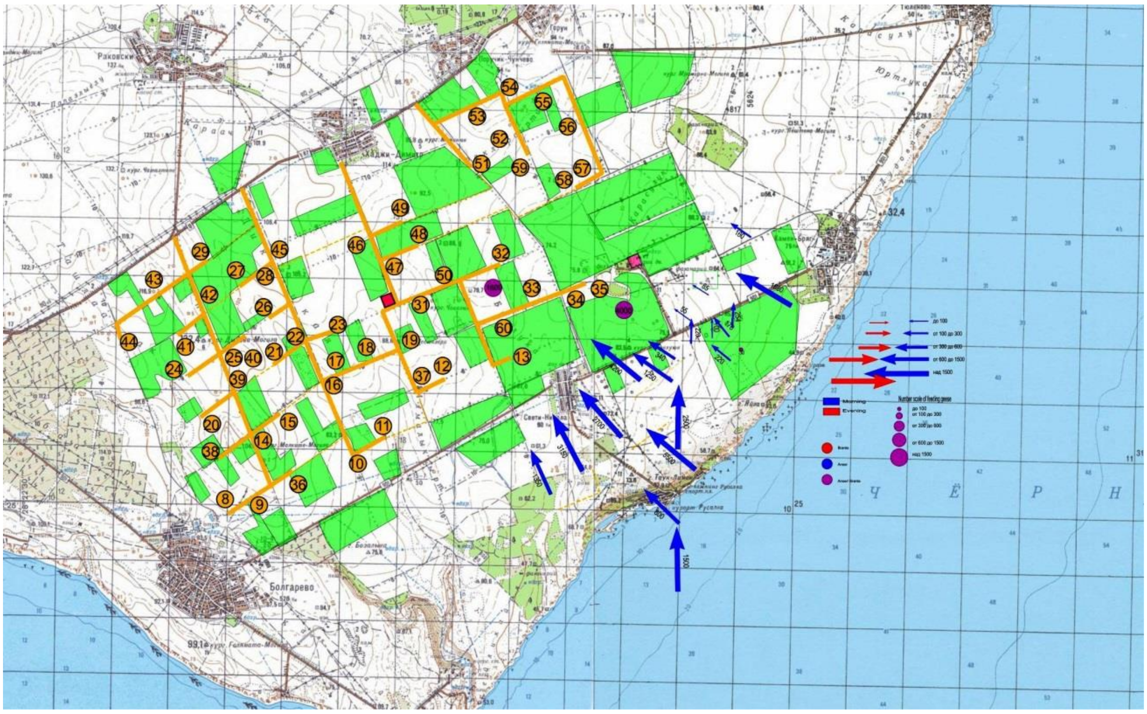

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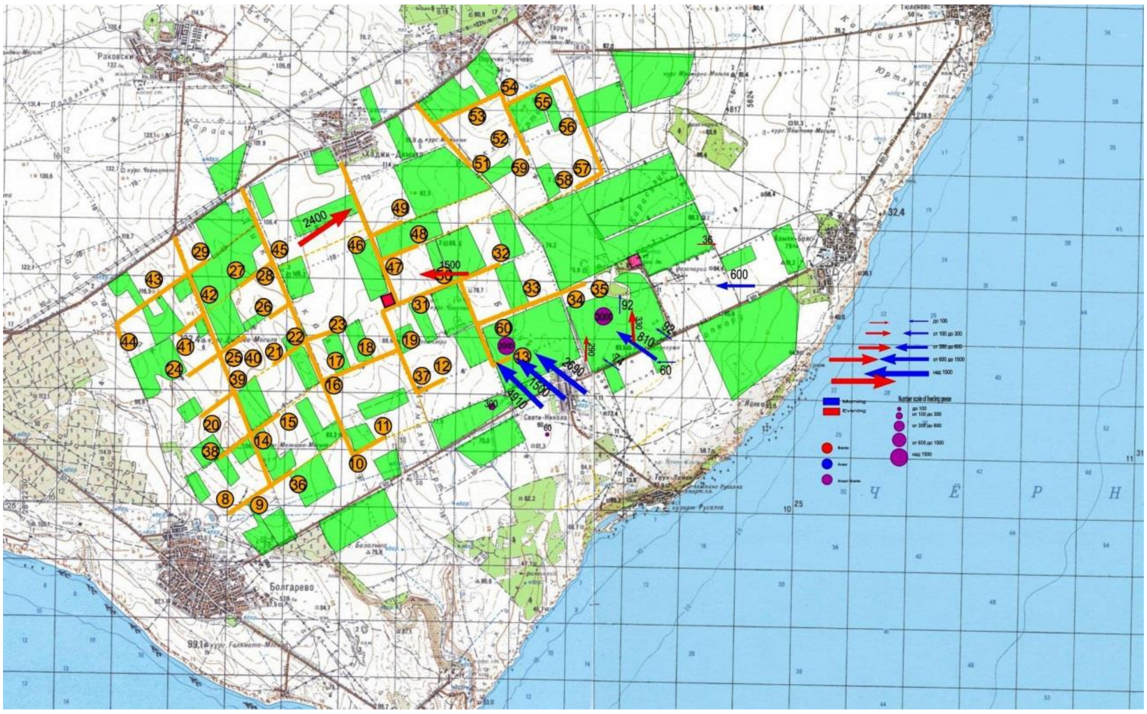

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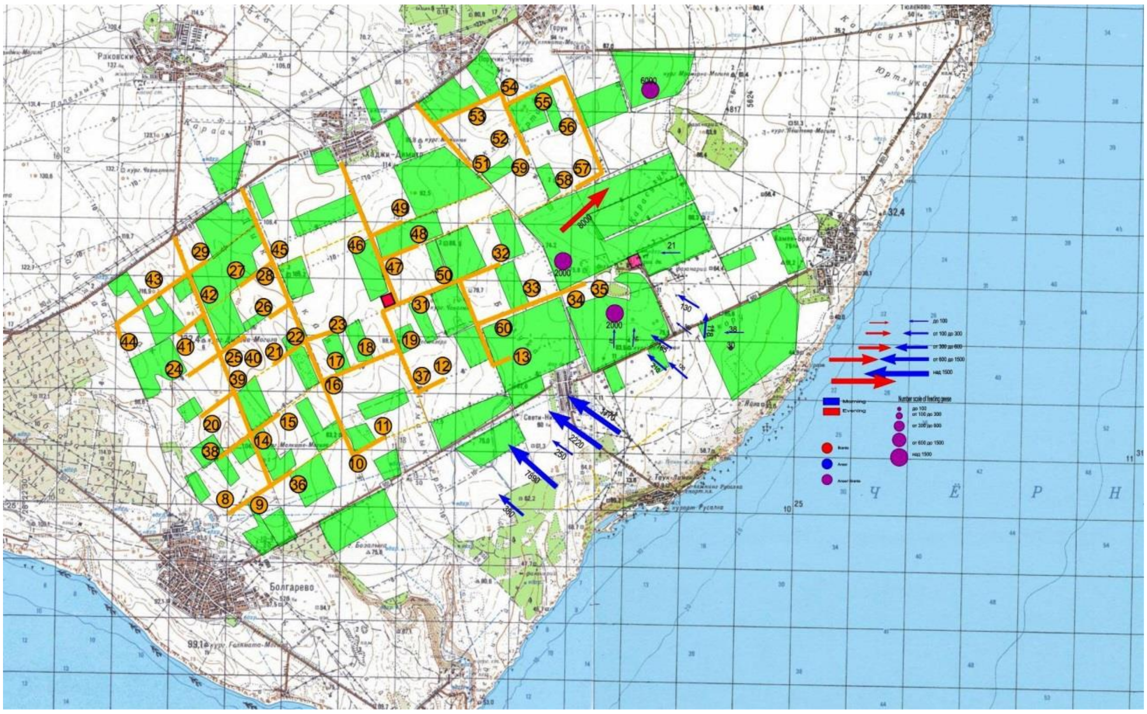
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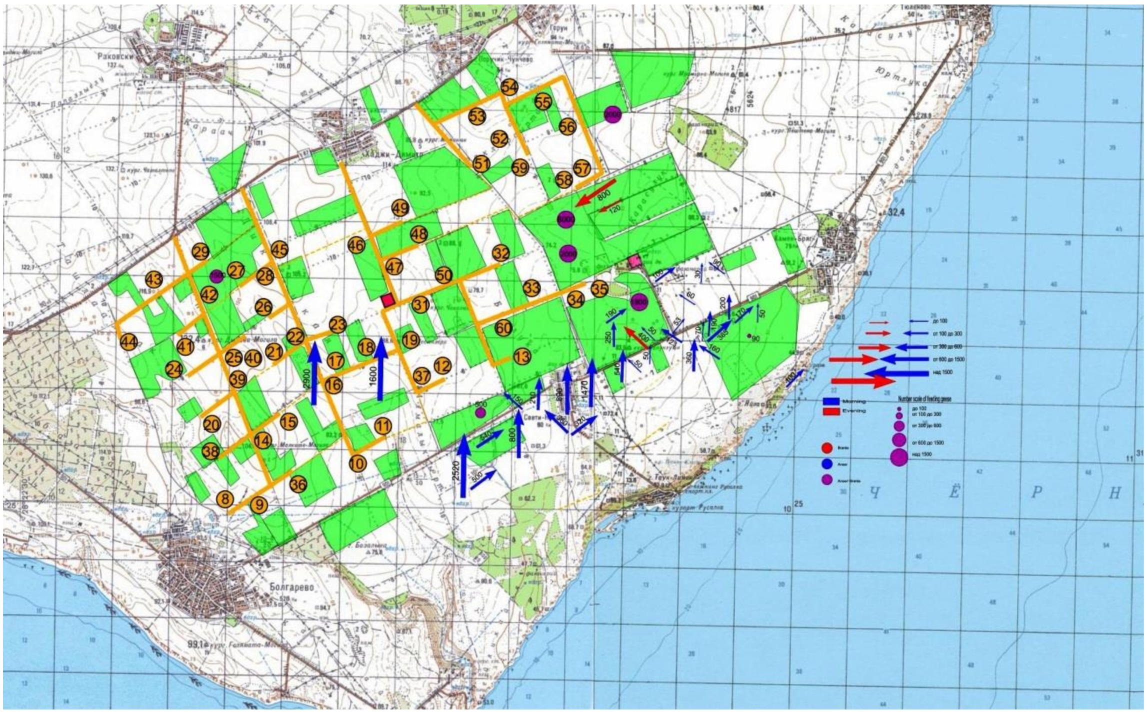
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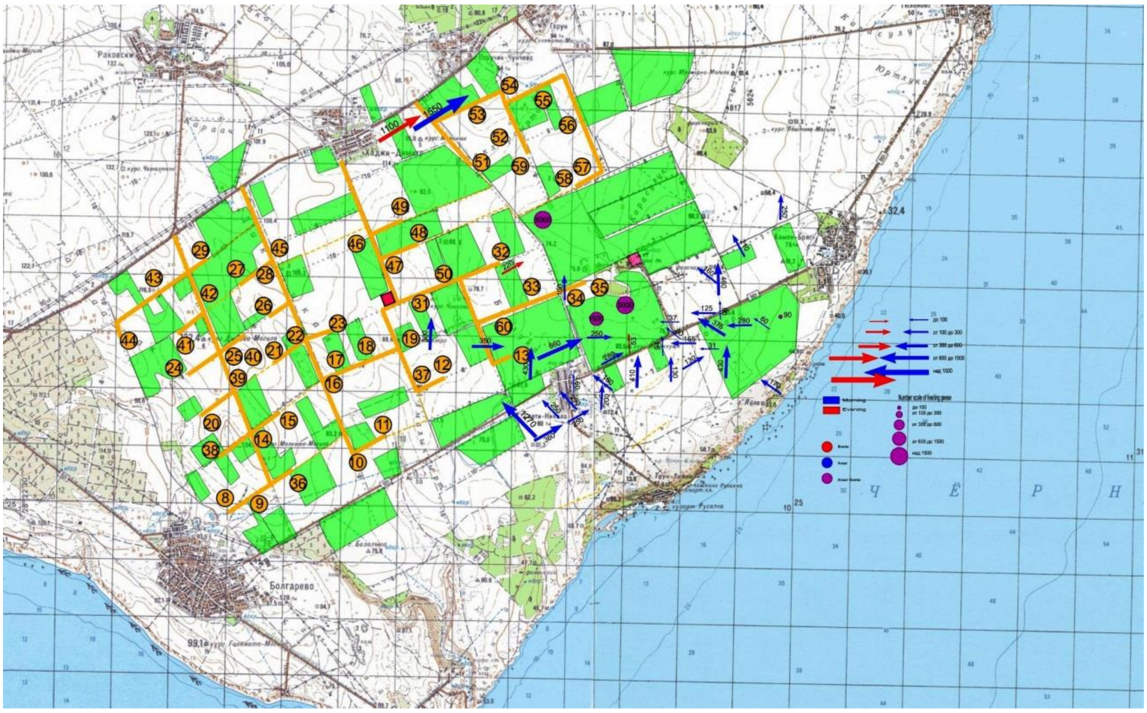

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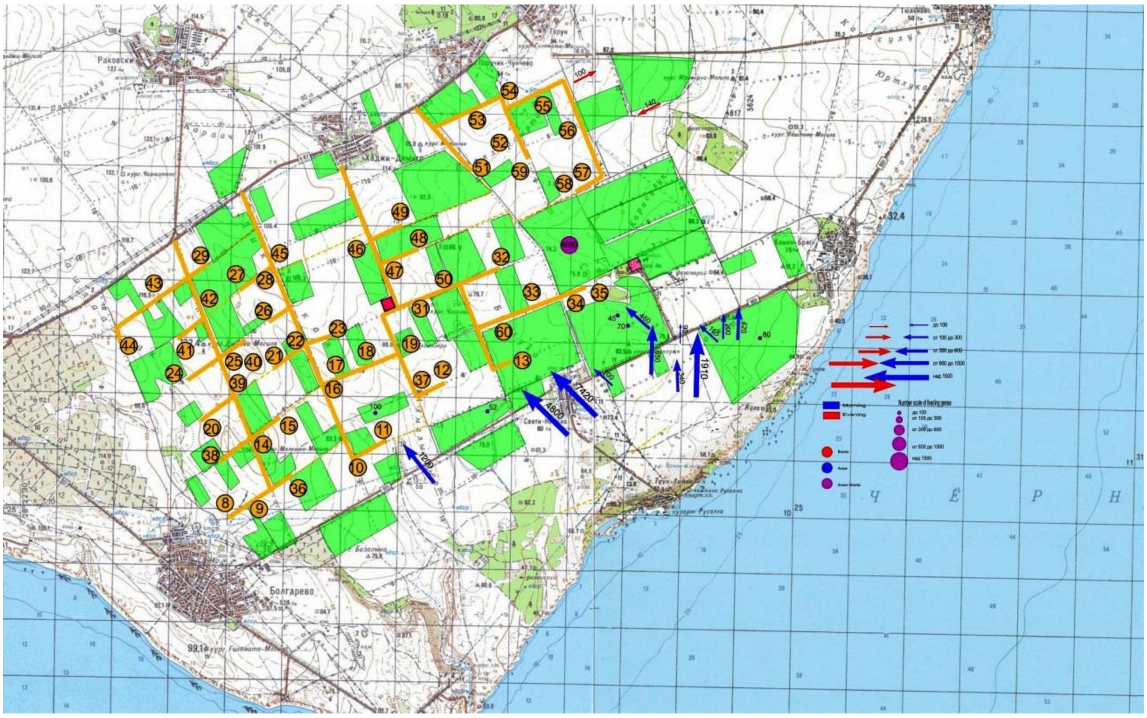

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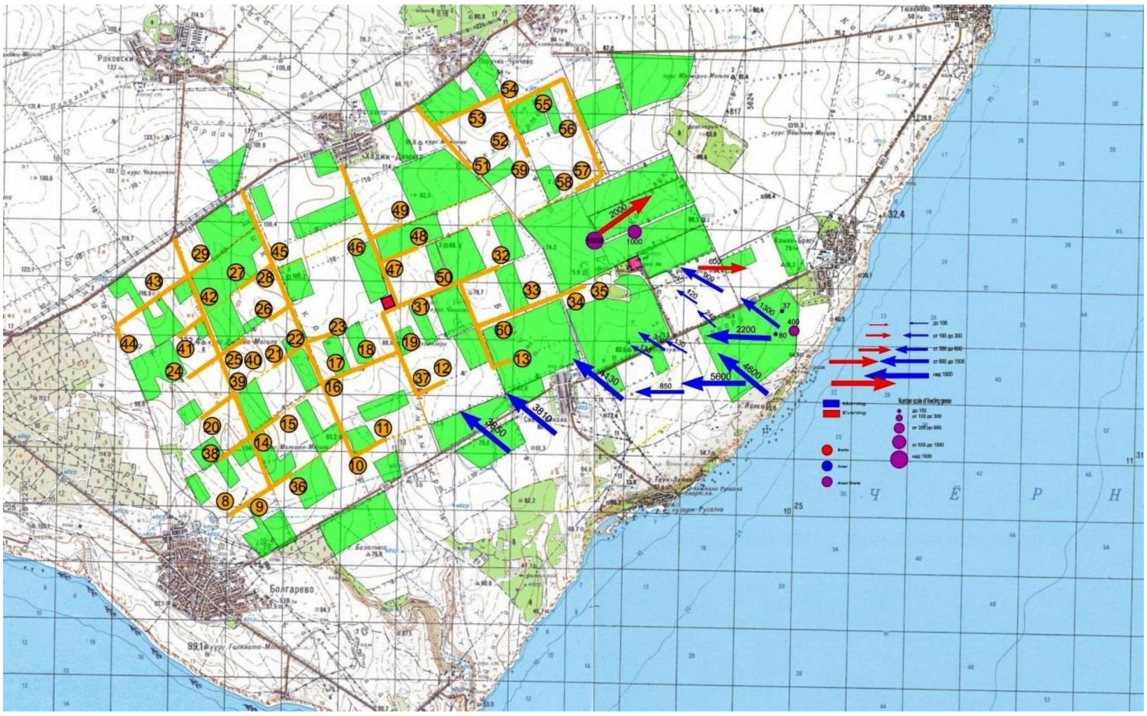

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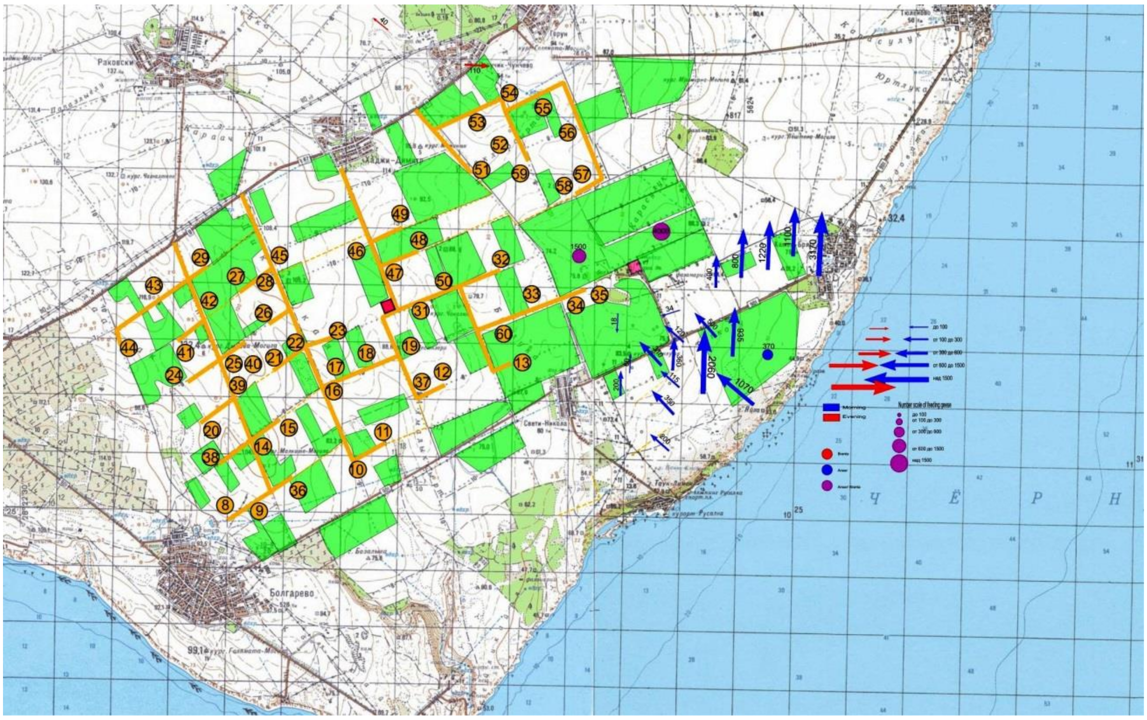

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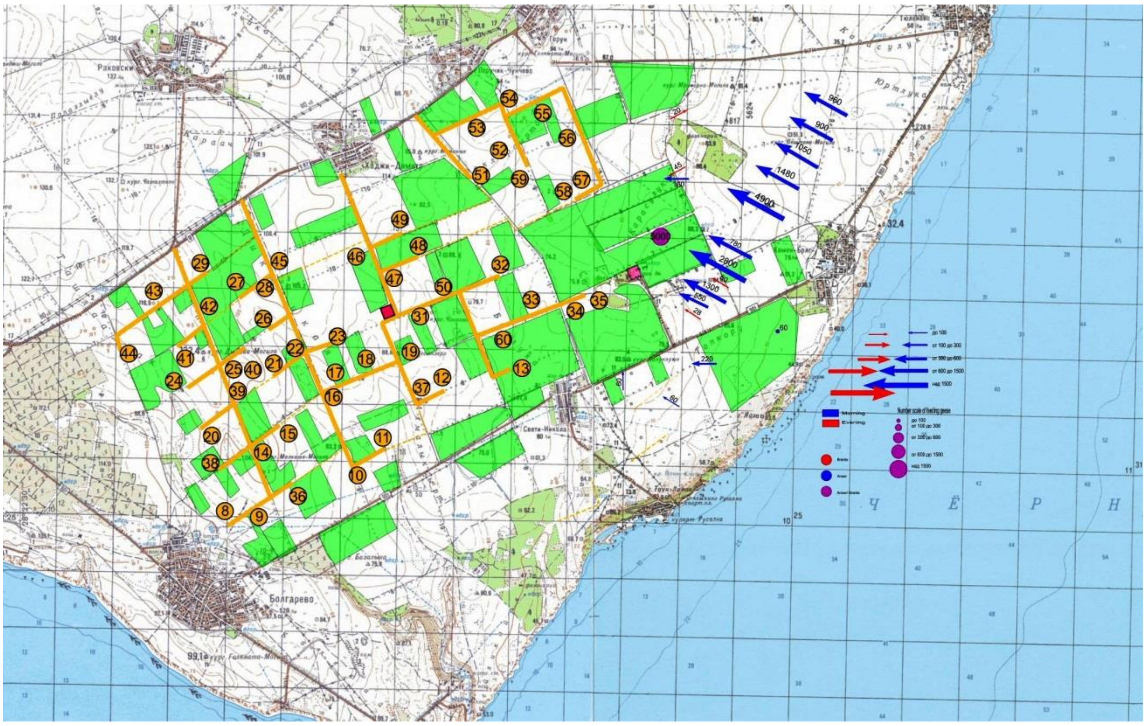

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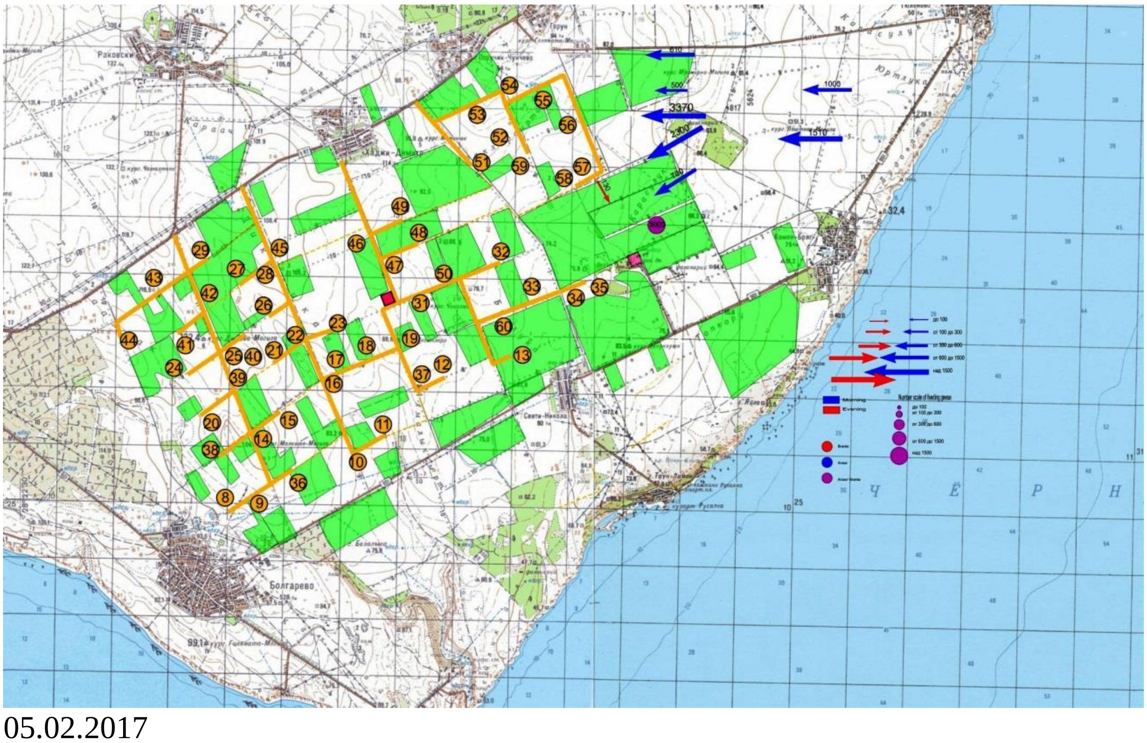

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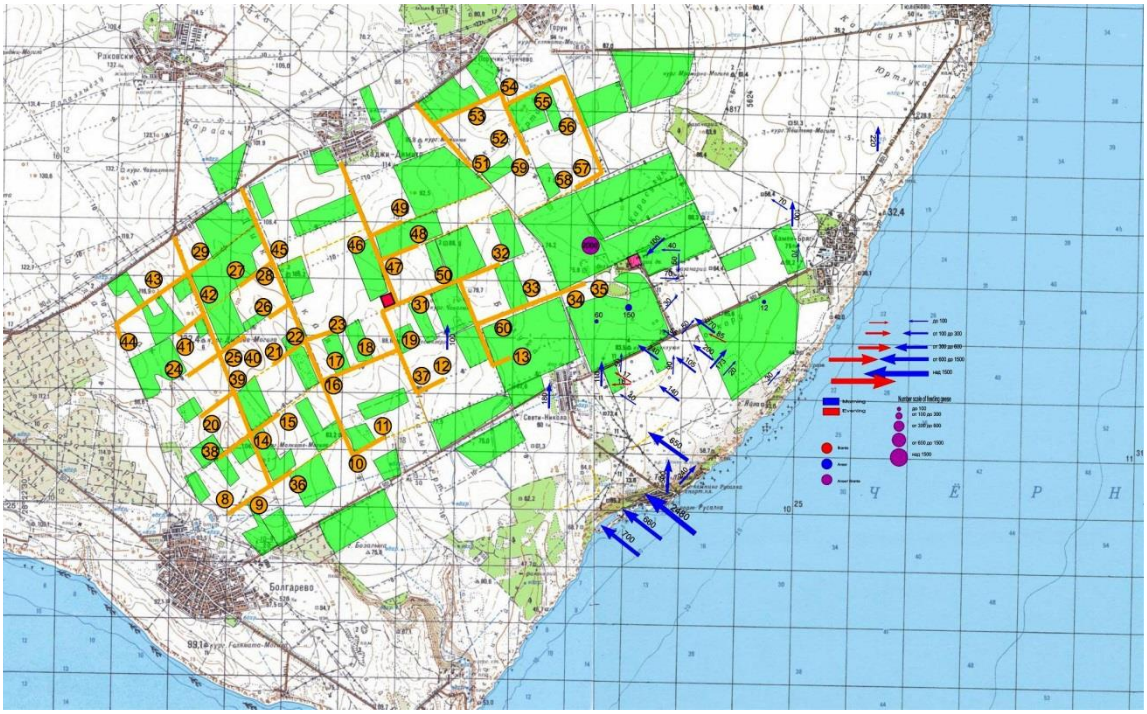

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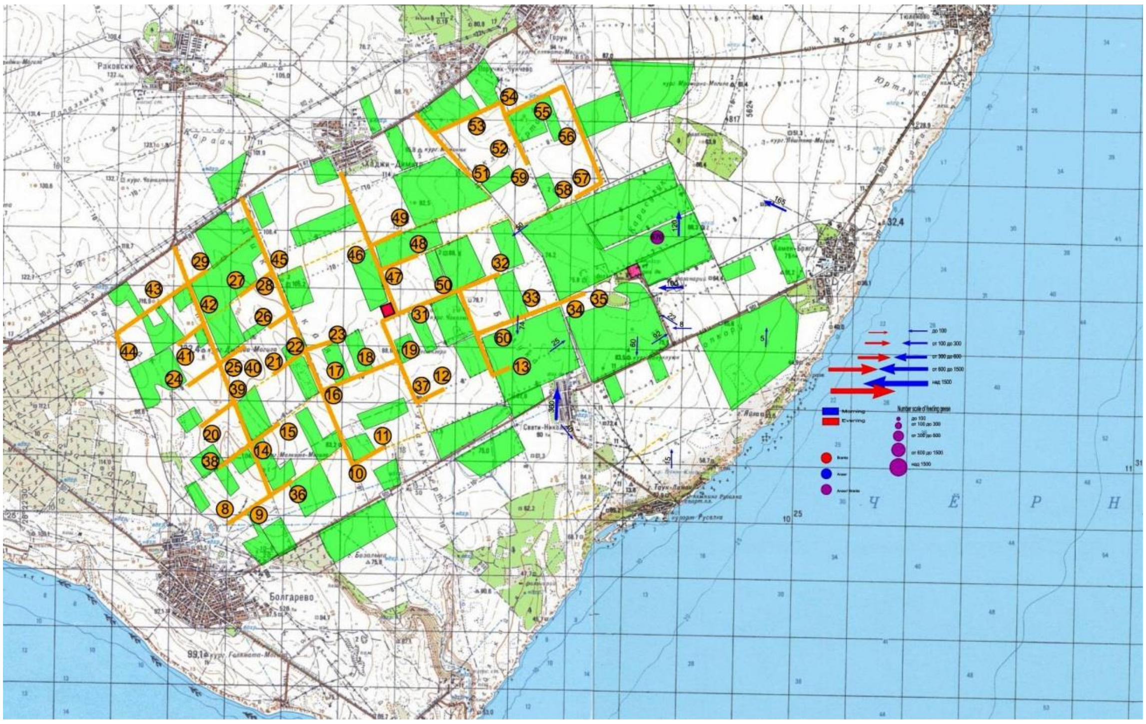

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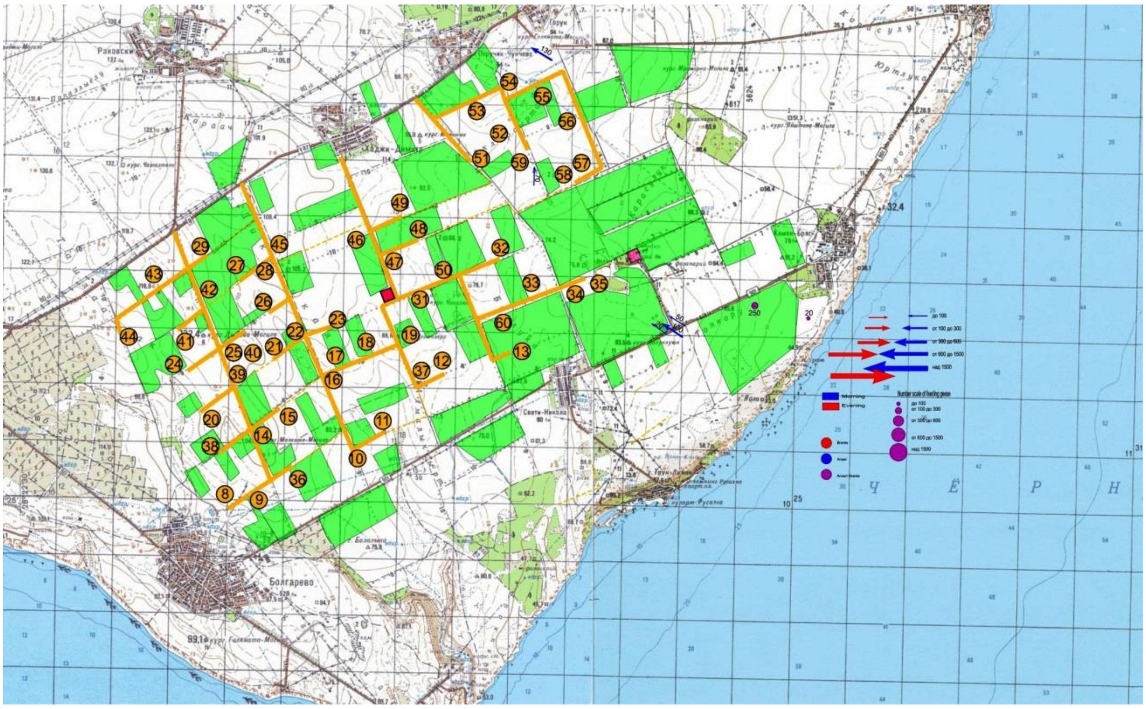

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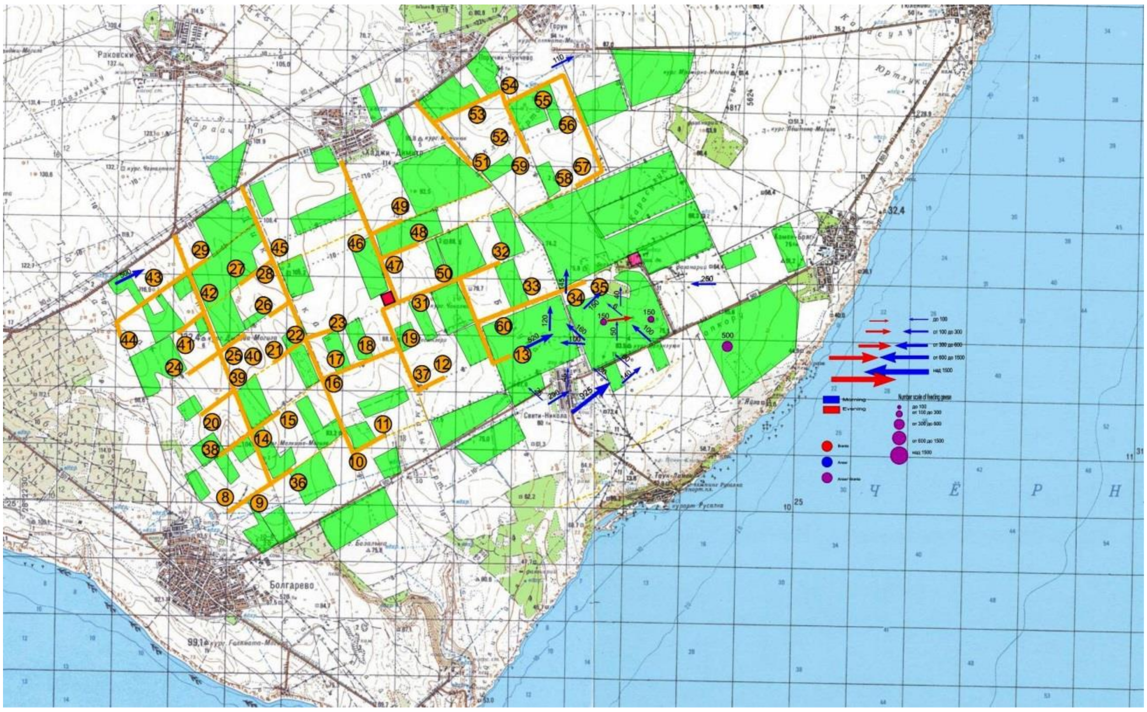

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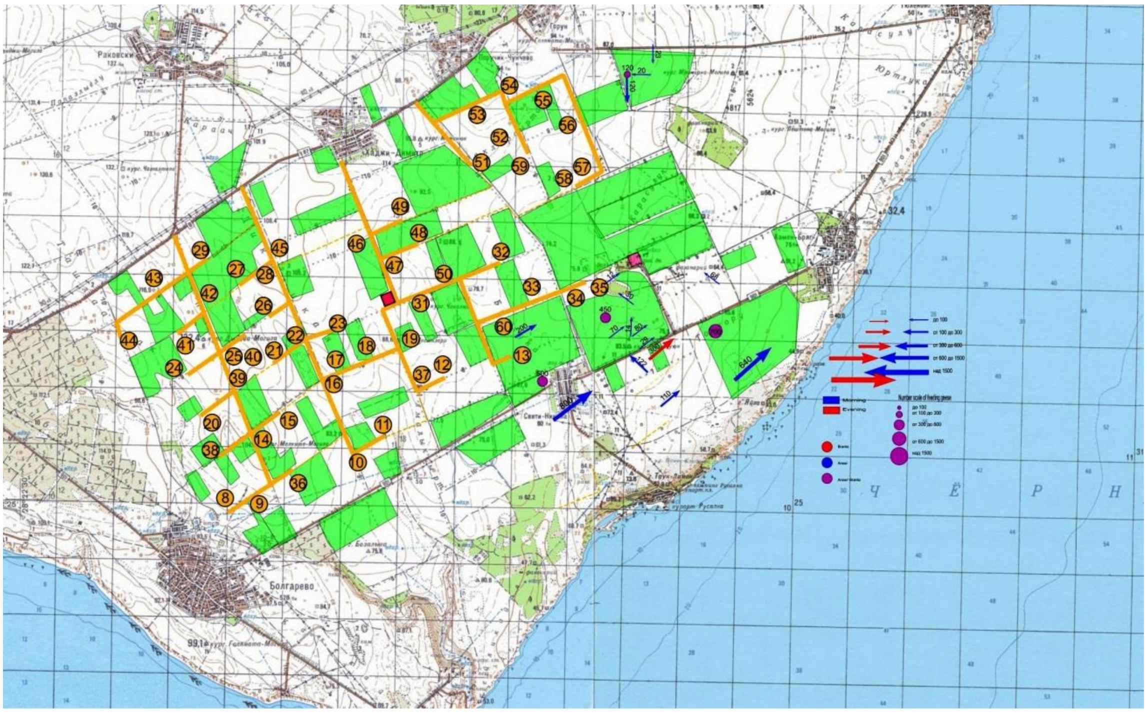

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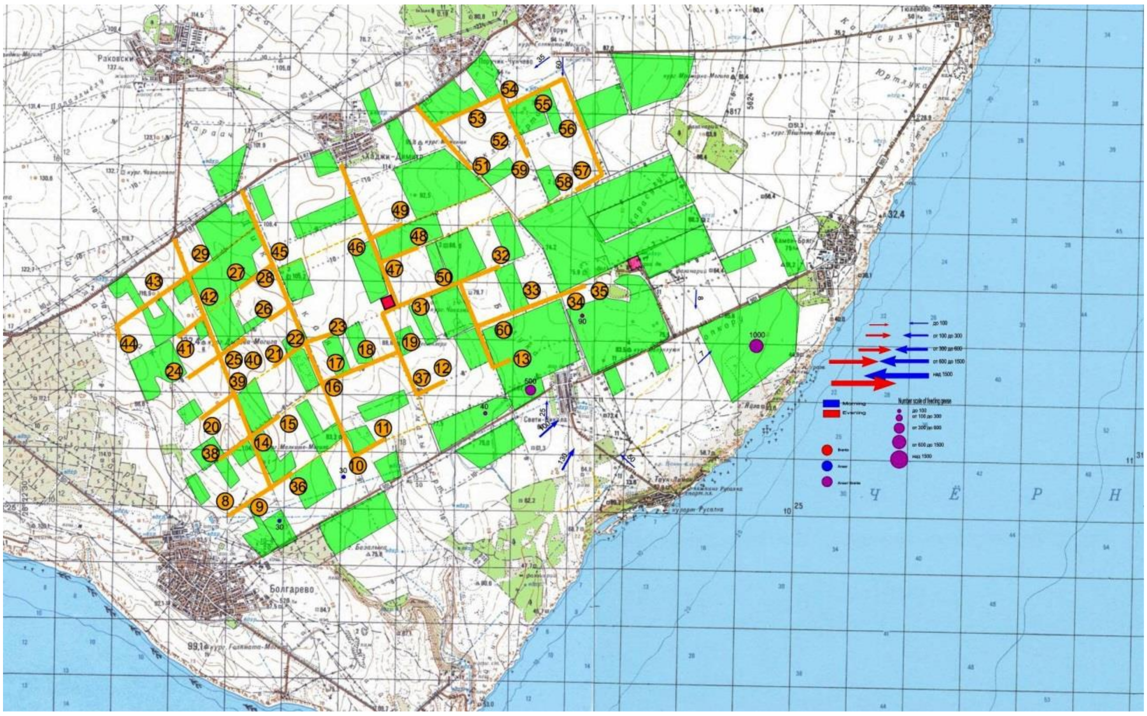

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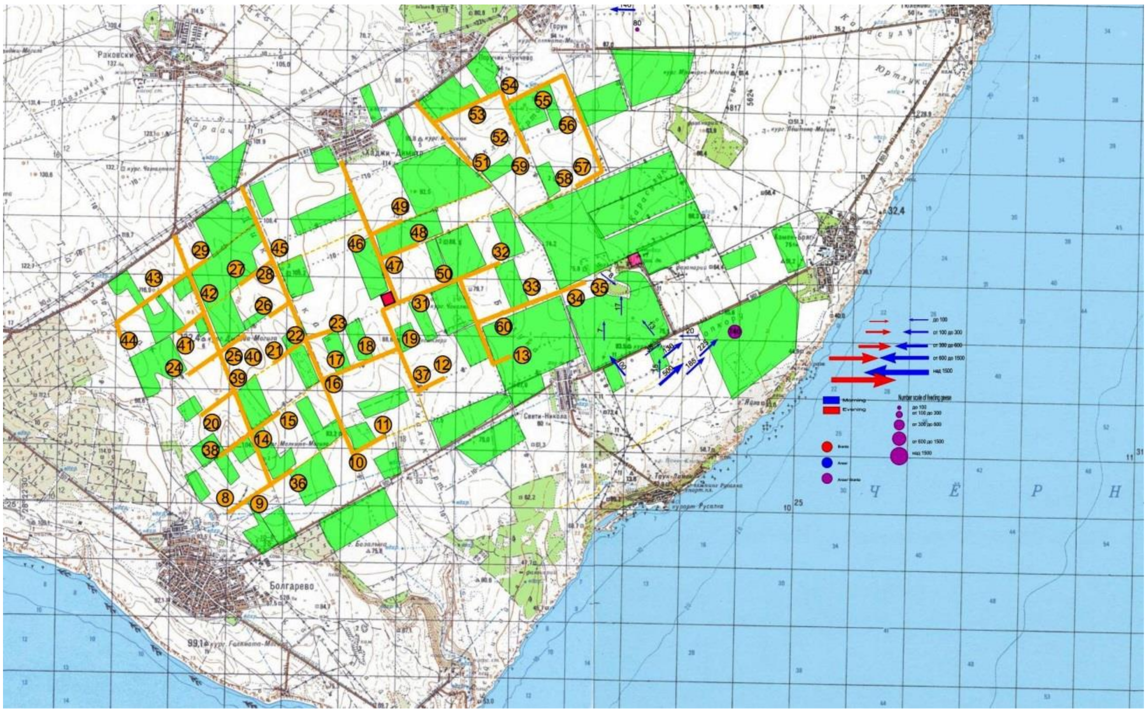

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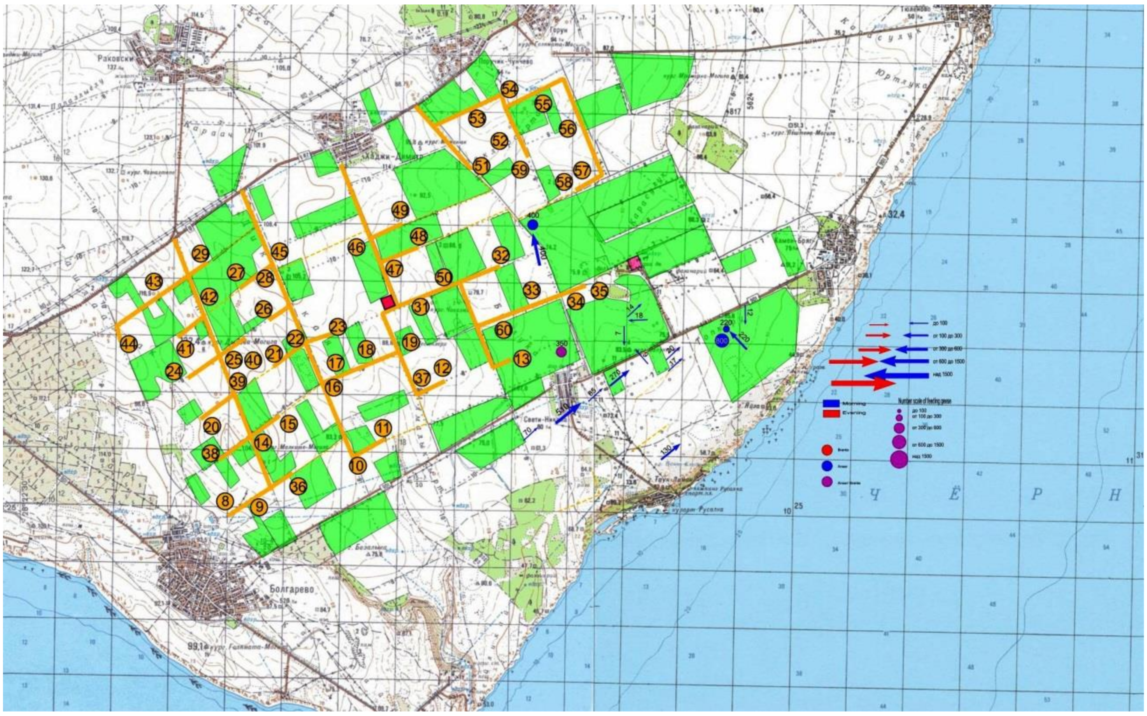

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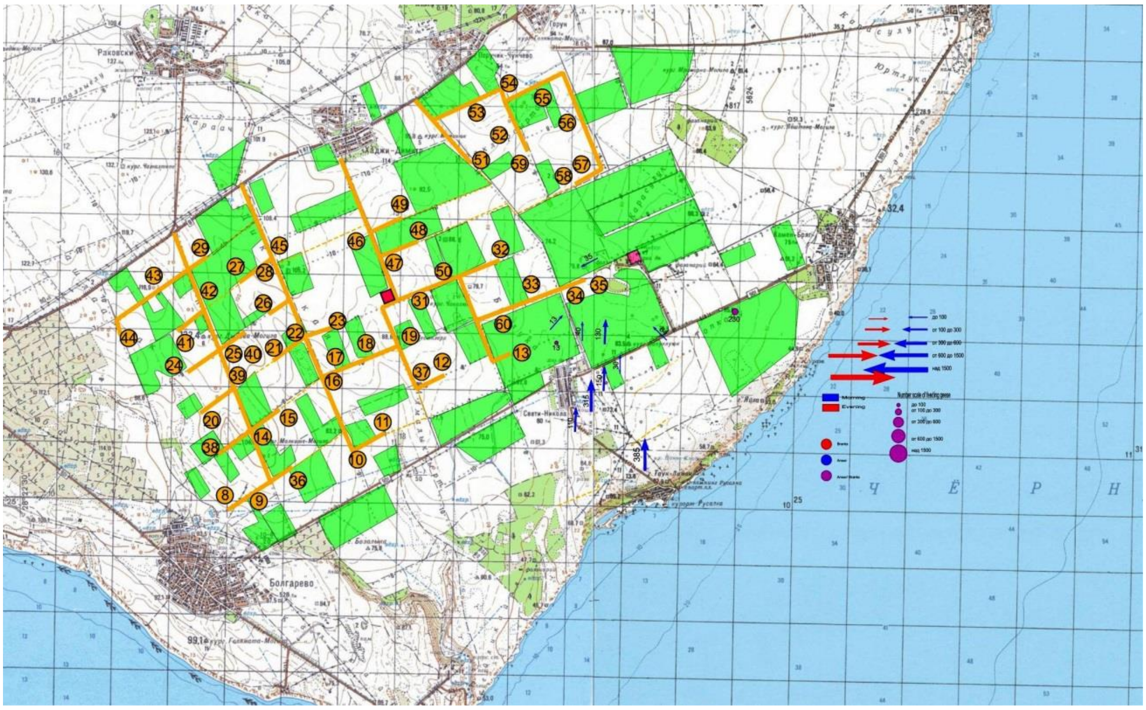

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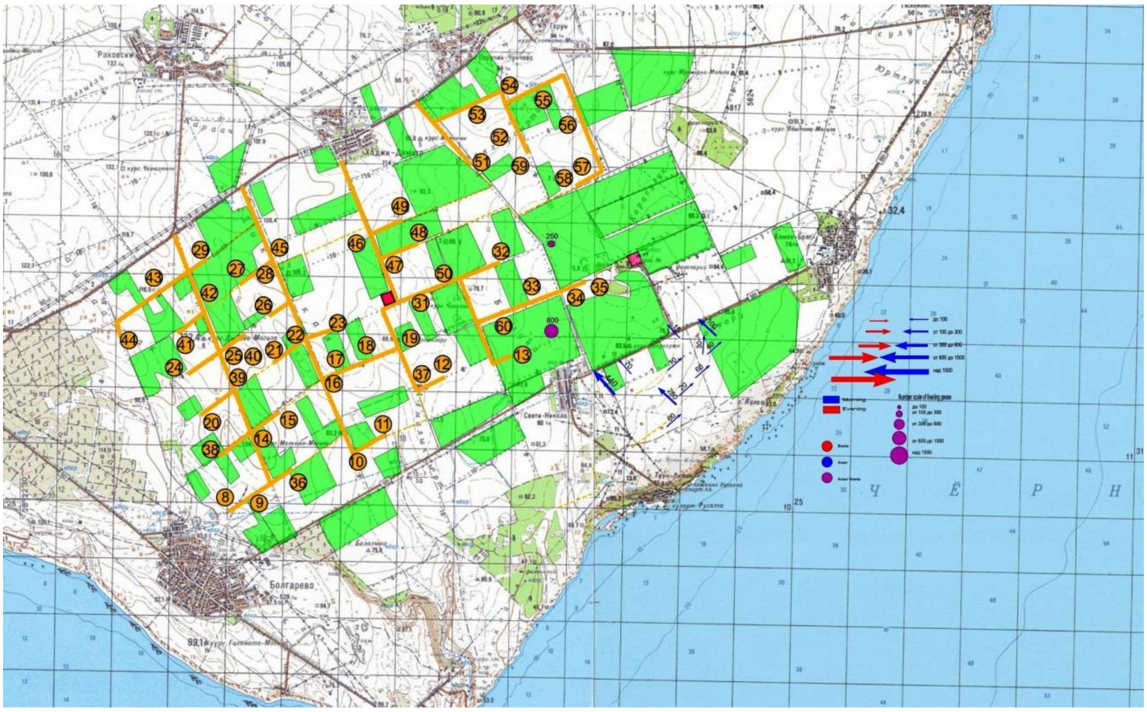

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