FOREST BIOGEOCENOLOGY

I. A. Tarakhkalo✉

O. Honchar Dnipropetrovsk National University,
Gagarin ave, 72, 49010, Dnipropetrovsk, Ukraine

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SEASONAL DYNAMICS OF CLIMATIC INDICES AS ONE OF THE MANIFESTATION FACTORS OF PYROGENIC PHENOMENA ON THE TERRITORY OF LUGANSK REGION

Abstract. The analysis on the effects of pyrogenic Lugansk region for the period from 2001 to 2005 was conducted using the service «FIRMS». Established seasonal dynamics of pyrogenic phenomena and specific influence of climatic factors on the pyrogenic effects in the Luhansk region.

Keywords: *pyrogenic succession, local thermal anomalies.*

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І. О. Тарахкало

Дніпропетровський національний університет ім. О. Гончара,
просп. Гагаріна, 72, 49010, м. Дніпропетровськ, Україна,
тел.: + 38050-614-41-50, e-mail: illia.tarakhkalo@gmail.com

СЕЗОННА ДИНАМІКА КЛІМАТИЧНИХ ПОКАЗНИКІВ ЯК ОДИН З ФАКТОРІВ ВИНИКНЕННЯ ПІРОГЕННИХ ЯВИЩ НА ТЕРИТОРІЇ ЛУГАНЩИНИ

Як відомо, щорічні пірогенні процеси завдають серйозних економічних збитків. На частоту їх виникнення, крім антропогенних, впливають кліматичні чинники, сила впливу яких розрізняється залежно від регіону, що зумовлено його зональними особливостями.

За весь період (2001–2005 рр.) проаналізовано 4163 теплових аномалії на території Луганської області, які безпосередньо пов'язані з кількістю пірогенних явищ та їх масштабом. Виділено два основних періоди пірогенної активності: з квітня по травень і з липня по вересень. За досліджуваний період в першому піку пірогенної активності кількість теплових аномалій становить у середньому 79, а в другому – 198.

Отримано коефіцієнт кореляції між змінними – температурою повітря і кількістю теплових аномалій, що говорить про середню позитивну залежність між цими двома змінними. Також отримано негативний коефіцієнт кореляції між змінними кількістю опадів і теплових аномалій, який найбільш слабо виражений в місяці з найменшою кількістю опадів.

Ключові слова: *пірогенні сукцесії, локальні теплові аномалії.*

✉ Tel.: +38050-614-41-50. E-mail: illia.tarakhkalo@gmail.com

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И. А. Тарахкало

Днепропетровский национальный университет им. О. Гончара,
просп. Гагарина, 72, 49010, г. Днепропетровск, Украина,
тел.: + 38050-614-41-50, e-mail: illia.tarakhkalo@gmail.com

СЕЗОННАЯ ДИНАМИКА КЛИМАТИЧЕСКИХ ПОКАЗАТЕЛЕЙ КАК ОДИН ИЗ ФАКТОРОВ ПРОЯВЛЕНИЯ ПИРОГЕННЫХ ЯВЛЕНИЙ НА ТЕРРИТОРИИ ЛУГАНЩИНЫ

Как известно, ежегодные пирогенные процессы наносят серьезный экономический ущерб. На частоту их возникновения, помимо антропогенных, оказывают влияние климатические факторы, сила влияния которых различается в зависимости от региона, что обусловлено его зональными особенностями.

За весь период (2001–2005 гг.) проанализировано 4163 тепловых аномалии на территории Луганской области, которые напрямую связаны с количеством пирогенных явлений и их масштабом. Выделено два основных периода пирогенной активности: с апреля по май и с июля по сентябрь. За исследуемый период в первом пике пирогенной активности количество тепловых аномалий составляет в среднем 79, а во втором – 198.

Получен коэффициент корреляции между переменными – температурой воздуха и количеством тепловых аномалий, что говорит о средней положительной зависимости между этими двумя переменными. А также получен отрицательный коэффициент корреляции между переменными количеством осадков и тепловых аномалий, который наиболее слабо выражен в месяцы с наименьшим количеством осадков.

Ключевые слова: *пирогенные сукцессии, локальные тепловые аномалии.*

INTRODUCTION

Annual pyrogenic processes cause severe economic damage (Goncharova, Kovalchik, 2013). Besides anthropogenic, climate indeces affect the frequency of occurrence of this processes. The power of climate indeces influence vary depending on region due to zonal features (Flannigan, Van Wagner, 1991; Houghton, 1991; Kasischke et al., 1995).

The purpose of the work is identification of the share of some leading factors participation, that are typical for South-Eastern Ukraine.

METHOD

For receiving information about pyrogenic processes we use service «The Fire Information for Resource Management System» (FIRMS) (NASA Earth Data), that is enable to get information about pyrogenic processes on all the territory of Lugansk region during the investigate period, as distinct from official sources, that register only subordinated territory data. We use hotspots archives of Lugansk region between 2001 and 2005 for investigation (NASA Earth Data). Archives were received using FIRMS.

To determine the dependence of occurrence of pyrogenic processes on climate factors we use the correlation analysis.

Hotspots means pyrogenic process presented in the form of pixel 1 × 1 km, received after processing of data from the MODIS radiometer on the Terra and Aqua satellites. Actually, it is a separate flashpoints.

DELIVERABLES

As a result of analysis we received the following data (Fig.1). We`ve analyzed it below in chronological order.

During 2001, were registered 851 thermal anomalies. The first anomaly was registered in February in a single number that is probably an erroneous decoding. Subsequent groups of hotspots were registered since March, 12. During the period from May till June there were recorded only 11 thermal anomalies. The largest number of thermal anomalies in 2001 were registered in August, their number were 587.

Another situation was in 2002. During 2002 there were registered 1120 local thermal anomalies. Peak activity fell on the period from March till April, during this time there were registered 83 hearths. The peak of the summer thermal anomalies occurred in the period from July till August. The largest number of local points was recorded in July – 555, in August – 397 and also in September – 60.

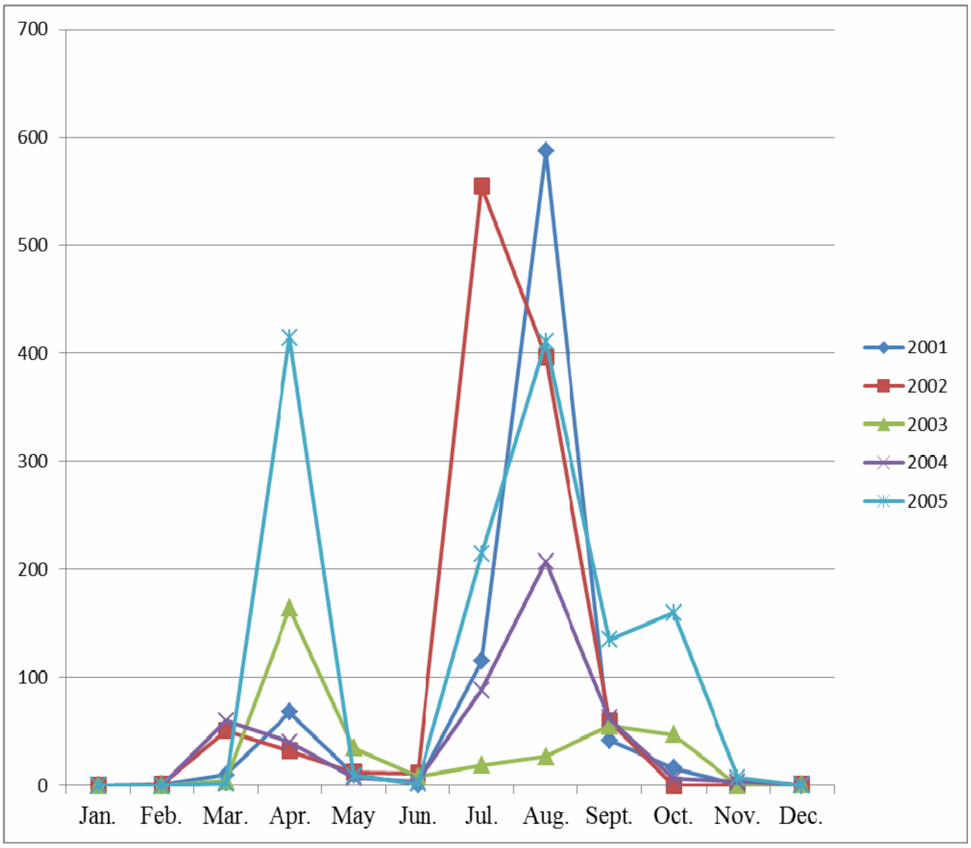

Fig. 1. **Distribution of thermal anomalies during 2001-2005 (Lugansk region)**

There were registered 360 flashpoints in 2003. Peak activity was observed in the period from April till May and from August till October. The greatest number of local thermal anomalies were registered in April – their total number amounted to 164 hearths, in September – 55 and in October – 47. The rest of the year the number of thermal anomalies ranged from 0 to 30. Analysis of the data for 2003 showed the least amount of local thermal anomalies during the study years.

For the whole of 2004 there were registered 477 thermal anomalies. The greatest number of flashpoints in 2004 during the period from March till April is 100, and from July till September – 357. Thermal anomalies peak was occurred in August, there were fixed 207 local points this month.

Year 2005 was the most rich in pyrogenic events. There were registered 1355 thermal anomalies. There were awarded two periods with the highest number of flashpoints. The first period was registered in April. There were posted 415 local thermal anomalies this month. The second peak activity fell on the period from July till October. Total number of flashpoints amounted to 920 during these months.

Thus, there were registered 4163 thermal anomalies over the analyzed period. On average, for each year we have 832,6 thermal anomalies. Registration of the first anomalies begins in February. The largest number of thermal anomalies falls on two peaks: the first is from

April till May and the second – from June till September, rarely – in October. On average for the period from March till May were registered 183,8 hotpots. And during the second peak period – 645,6. Starting from October, the number of thermal points is reduced. Their total amount in the period from October till December is from 1 to 16 hotspots.

Also in the study of local thermal anomalies, we used the data on temperature and precipitation, which were obtained from official sources. Such information summarized in table 1.

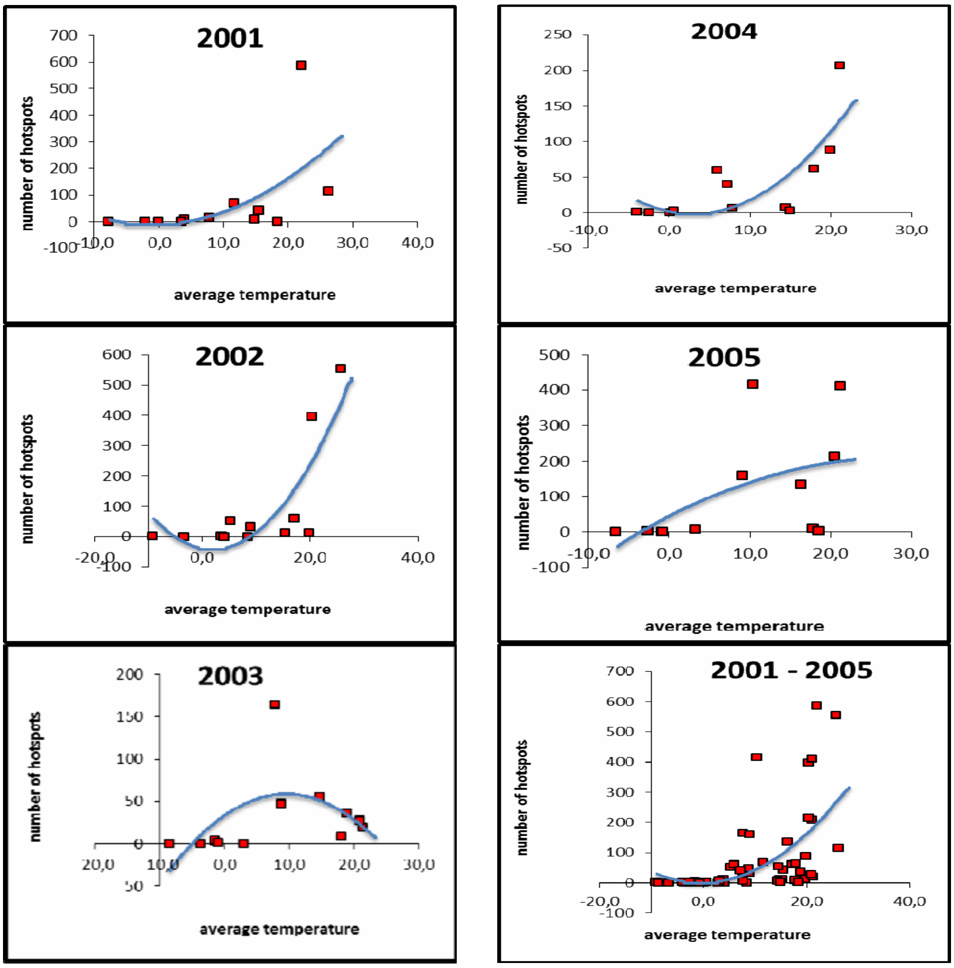

Fig. 2 *a*. **The dependence of pyrogenic phenomena number from an average monthly temperature (*a*, °C) and the precipitation during one month (*b*, mm) in the period 2001–2005 (background climate indicators information – in Table 1)**

Based on these data, correlation analysis was performed. The correlation coefficient between the air temperature and the frequency of pyrogenic phenomena occurrence by the data service FIRMS (NASA Earth Data; MODIS Active Fire), shows the positive relationship in periods with high temperatures, while in periods with low temperatures, this dependence is mild. Calculation of correlation between precipitation and the frequency of occurrence of thermal anomalies gave a negative coefficient, which indicates the opposite relationship between variables. This means, that the higher the value of one, the lower the value of another variable. At the same time we can see similar temperatures picture, periods of small amount of precipitation does not demonstrate the dependence unlike the months with the higher amount of precipitation.

Table 1

Climatic indicators in Luhansk region during 2001–2005

Year	2001			2002			2003			2004			2005		
Month	Average t,°C **	amount of precipitation, mm***	number of points*	Average t,°C **	amount of precipitation, mm***	number of points*	Average t,°C **	amount of precipitation, mm***	number of points*	Average t,°C **	amount of precipitation, mm***	number of points*	Average t,°C **	amount of precipitation, mm***	number of points*
Jan.	0,00	41	0	-3,40	23,5	0	-3,70	92,5	0	0,07	122,7	0	-0,93	86	0
Feb.	-2,10	33	1	3,60	41,8	1	-8,60	48,7	0	-2,46	141,1	0	-6,62	56	0
Mar.	3,90	40	10	5,20	57,5	51	-1,50	23	4	6,00	25,7	60	-2,58	56	2
Apr.	11,60	87	68	9,00	21,2	32	7,80	31,1	164	7,14	20,2	40	10,39	27	415
May	14,80	114	10	15,40	27,4	12	18,90	9,4	35	14,38	61,3	7	17,80	17	9
Jun.	18,40	92	1	19,80	37,4	11	18,10	57,8	8	15,00	90,2	3	18,57	93	2
Jul.	26,30	34	115	25,80	39,2	555	21,30	79,6	19	19,94	63,4	88	20,48	57	214
Aug.	22,00	9	587	20,40	71,2	397	21,00	36,7	27	21,11	44,9	207	21,20	69	411
Sept.	15,50	82	42	17,20	76,3	60	14,70	28,3	55	17,90	40,6	62	16,31	12,4	135
Oct.	7,80	47	16	8,40	75,2	0	8,80	42,6	47	7,80	55,3	6	9,00	55	160
Nov.	3,50	124	1	4,00	75,6	0	3,00	52,2	0	0,60	54,5	3	3,17	63	7
Dec.	-7,80	82	0	-9,20	50,7	1	-1,00	44	1	-4,00	79,3	1	-0,78	82	0
correlation coefficient	0,51	-0,52		0,65	0,08		0,24	-0,36		0,66	-0,44		0,53	-0,28	

* The average monthly number of anomalous thermal points during the period 2001–2005
** The average air temperature during the study period;
*** The average amount of precipitation during the study period

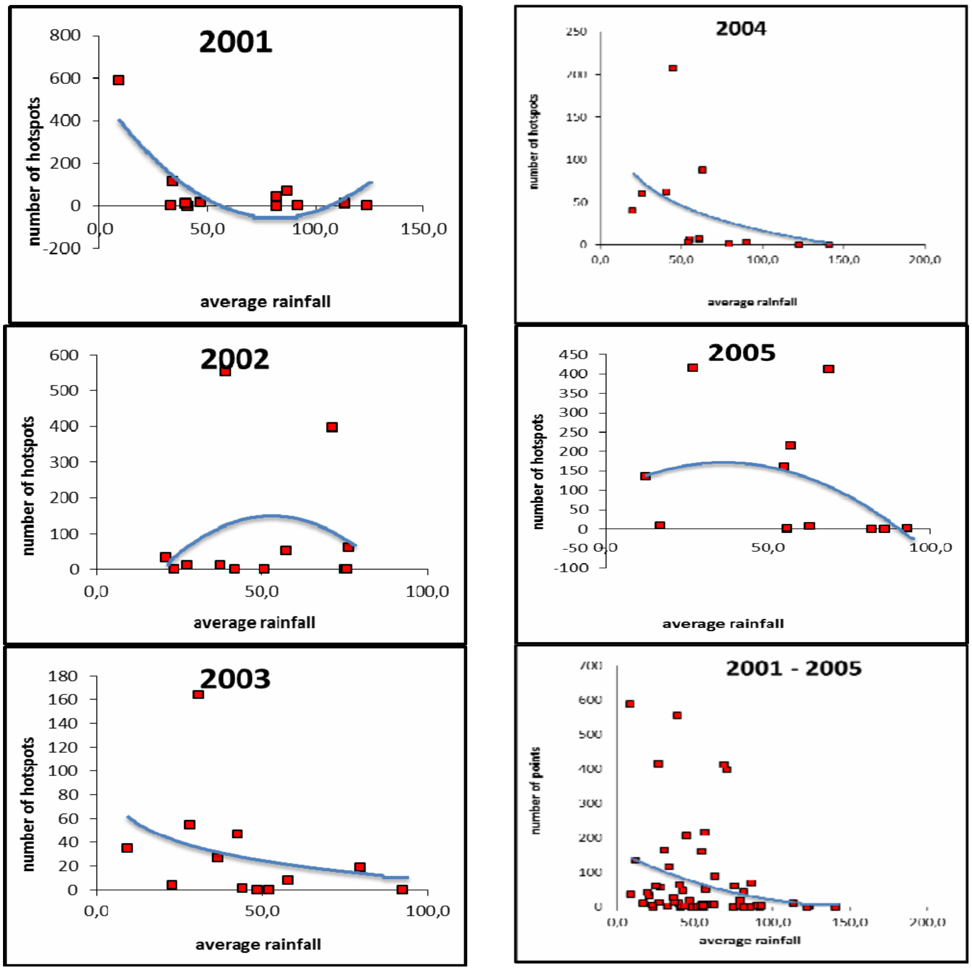

Fig. 2 *b*. **The dependence of pyrogenic phenomena number from an average monthly temperature (*a*, °C) and the precipitation during one month (*b*, mm) in the period 2001–2005 (background climate indicators information – in Table 1)**

There was also a non-random link in the number of anomalies over the years. We see in the schedule (Fig. 2) that the dependence of quantity of thermal anomalies from climatic factors in various from years, that is connected with the power and intensity of climatic factors. Also the main annual peaks of fire activity were allocated (table 2).

Table 2

The distribution of thermal anomalies number by years

Year	The amount of anomalies	The first peak	The second peak	The peak months
1	2	3	4	5
2001	851	68	587	April (68), August (587)
2002	1120	83	1012	March (51), April (32), July (555), August (397), September (60)
2003	360	164	102	April (164), September (55), October (47)

Ending of table 2

1	2	3	4	5
2004	477	100	357	March (60), April (40), July (88), August (207), September (62)
2005	1355	415	920	April (415), July (214), August (411), September (135), October (160)

CONCLUSIONS

1. For the entire study period (2001–2005) there was analyzed 4163 thermal anomalies on the territory of the Lugansk region (Fig. 1), which are directly related to the number of pyrogenic phenomena and their scale.

2. Two main periods of pyrogenic activity was found: from April till May and from July till September. During the study period in the first peak of pyrogenic activity the number of thermal anomalies is on average 79, and in the second peak – 198.

3. The correlation coefficient between two variables – temperature and quantity of thermal anomalies was obtained (table 1). It indicates the average positive correlation between these two variables. Also a negative correlation coefficient between variable amount of precipitation and thermal anomalies was received, that is most poorly expressed in months with the smallest amount of precipitation.

REFERENCES

Flannigan, M. D., Van Wagner, C. E., 1991. Climate change and wildfire in Canada. Can. J. For. Res. 21, 66–72.

Giglio, L., Csiszar, I., Justice, C. O., 2006. Global distribution and seasonality of active fires as observed with the Terra and Aqua MODIS sensors. Journal of Geophysical Research. Ser. Biogeosciences. 111, 12 p. DOI: 10.1029/2005JG000142.

Giglio, L., Descloitres, J., Justice, C. O., Kaufman, Y., 2003. An enhanced contextual fire detection algorithm for MODIS. Remote Sensing of Environment. 87, 273–282.

Goncharova, A. V., Kovalchik, N. V., 2013. Analiz raspredeleniya teplovykh anomaliy na territorii Belarusi po dannym distantsionnogo zondirovaniya Zemli [GIS technology in geoscience: Submissions GIS projects and graduate students of universities of the Republic of Belarus]. BSU, Minsk. 16–20 (in Russian).

Houghton, R. A., 1991. Biomass burning from the perspective of the global carbon cycle. Global biomass burning: Atmospheric, climatic, and biospheric implications. The MIT Press, Cambridge University Press, Cambridge. 129 p.

Kasischke, E. S., Christensen, N. L., Stocks, B. J., 1995. Fire, global warming, and the carbon balance of boreal forests. Ecol. 5, 437–451.

MODIS Active Fire [Electronic resource]. Access mode: http://modis-fire.umd.edu/Publications.html

NASA Earth Data [Electronic resource]. Access mode: https://earthdata.nasa.gov/data/near-real-time-data/firms

Travleev, A. P., 1988. Monitoringovyie issledovaniya lesnyih ekosistem stepnoy zonyi, ih ohrana i ratsionalnoe ispolzovanie [Monitoring studies in forest ecosystems of the steppe zone, their protection and rational use]. DSU, Dnepropetrovsk (in Russian).

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