

## Use of Landsat Space Images to Assess Wildfire Areas in the Dniester Delta in 2010-2020

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### SUMMARY

Assessment of wildfire traces' area using LANDSAT multispectral satellite images in the Dniester Delta as in general and on the territory of the Lower Dniester NNP in 2010 – 2020. Data and Methods. LandSat 7 and LandSat 8 multispectral satellite images of for 2010-2020 processed with ARCGIS software package have been used to assess the fire traces' area. Results. Information on the areas of the wildfires observed in the entire Dniester Delta and on the territory of the Lower Dniester NNP annually from 2010 to 2020 has been presented, analyzed and discussed. Conclusions. It has been shown that maximal wildfire areas were observed in the Dniester Delta in 2019-2020 and 2015-2016, at that the burnt areas made 13010.6 hectares and 11092.8 hectares respectively, which made about 28% of the total Lower Dniester NNP territory. Minimal burnt down areas were registered in 2014-2015 – 326.2 hectares. Maximal wildfire areas were registered on the Lower Dniester NNP territory in 2015-2016 - 6049.2 hectares (28.4% of the NNP area). No wildfires were registered in the NNP in 2014-2015. The methodology of wildfires mapping using space images to establish the boundaries and areas of wildfire traces has been recommended, which in combination with field data facilitates objective assessment of environmental and economic damage from the wildfires on the territory of the nature reserve fund.



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## Introduction

It is known [Kovalova et al, 2010; Medinets & Korzun, 2011] that one of the main environmental problems in the Dniester reed-bed area, especially the territory of the Lower Dniester National Nature Park (LDNNP), which was established by the Decree of the President of Ukraine No. 1033/2008 of 13.11.2008, are wildfires that occur almost every year in the winter-spring period [Medinets & Korzun, 2011]. Fires on large territories are damaging biodiversity of waterfowl, as well as mammal, reptile, insect and other species population. In addition to damage to flora and fauna biodiversity, the wildfires also lead to significant environmental impacts and economic losses. The causes of fires are careless human activities or purposeful arson. Remote sensing data is the main component of monitoring and mapping of wildfires. In recent years, the field of remote sensing of the Earth has been developing very rapidly, spatial and spectral resolution of images is increasing, and the number of satellites of high and ultra-high resolution is growing. Development of means and methods for thematic processing of remote sensing data makes it possible to obtain a wide range of initial products [Space Images, 2005; Classifier, 2008; Yaroshenko, 2001], and introduction of satellite navigation systems helps to determine the location of study and monitoring objects with high accuracy. *Purpose of the work* was assessment of the areas of fire traces using multispectral satellite images for the Dniester delta in general and for the territory of the Lower Dniester NNP in 2010 – 2020.

## Data & Methods

Multispectral satellite images LandSat 7 and LandSat 8 [Medinets & Pavlik, 2012] for 2010-2020 [USGS, 2012] were used to assess the wildfire traces' area. Processing of satellite images and digitization of the boundaries of wildfire zones were performed using the ARCGIS software. The methodology of space images processing and wildfire traces mapping is described in our works [Medinets & Korzun, 2011; Medinets & Pavlik, 2012; Medinets et al., 2014].

## Results

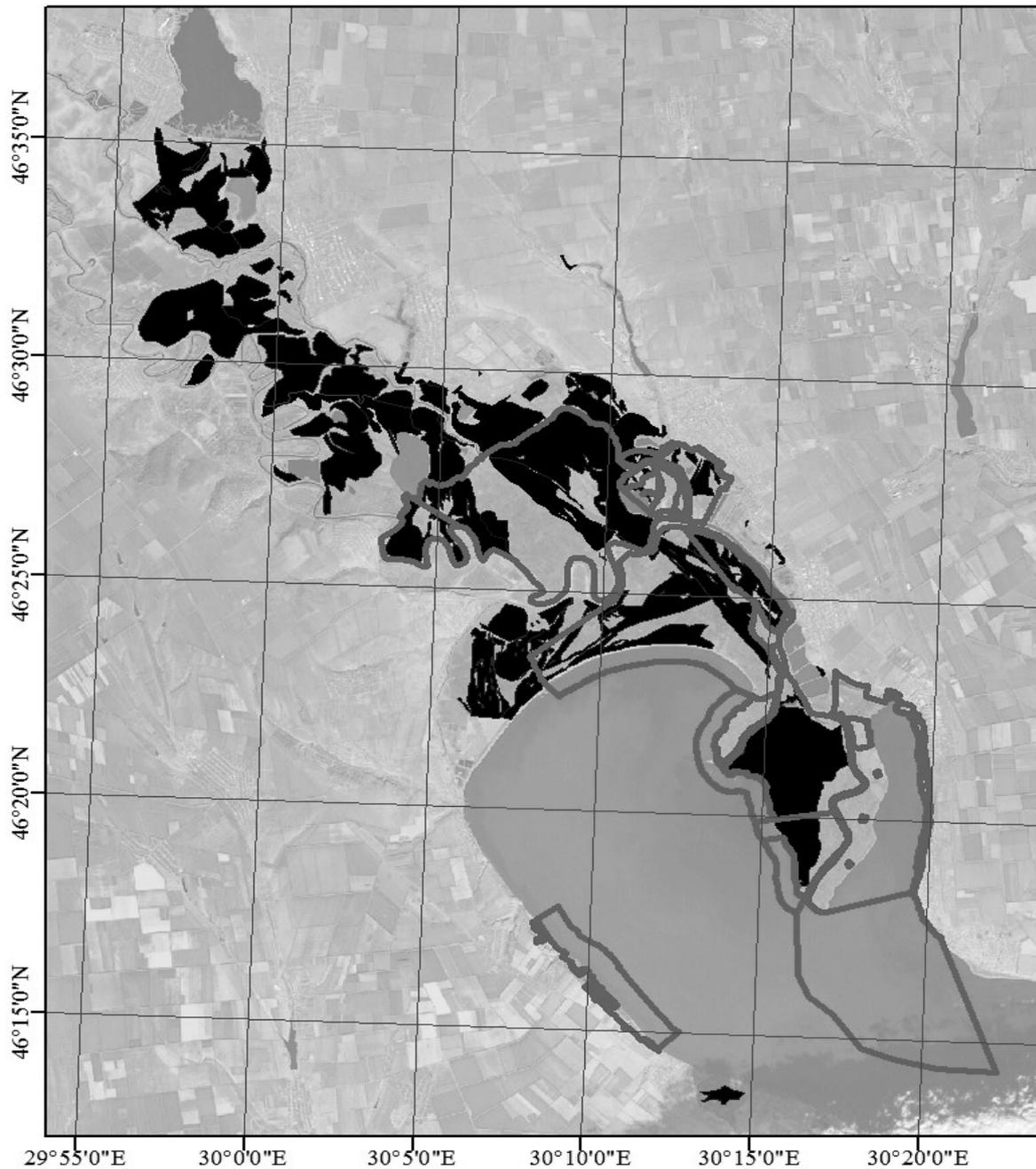
The information on wildfire areas all over the Dniester Delta and in the Lower Dniester NNP in 2010-2020 is presented in Table 1.

**Table 1** Wildfire Traces Area (hectares) in the Dniester Delta in 2010-2020

Season	Wildfire Area in the Entire Dniester Delta, Hectares	Wildfire Area on the LDNNP Territory, Hectares
Autumn 2010 - spring 2011	2883.0	2694.7
Autumn 2011 - spring 2012	5851.7	4061.7
Autumn 2012 - spring 2013	1201.5	676.9
Autumn 2013 - spring 2014	6891.6	3179.7
Autumn 2014 - spring 2015	326.2	0
Autumn 2015 - spring 2016	11092.8	6049.2
Autumn 2016 - spring 2017	4053.9	2668.6
Autumn 2017 - spring 2018	1183.3	618.3
Autumn 2018 - spring 2019	5662.7	2159.4
Autumn 2019 - spring 2020	13010.6	5990.34

Analysis of the results presented in Table 1 showed that the maximum areas of wildfires were observed in the Dniester Delta in 2019-2020 and 2015-2016 was 13010.6 and 11092.8 hectares respectively; wildfire area in the Lower Dniester NNP equalled to about 28% of the total territory of the Park. An example of digitalization of wildfire traces' area (zones) in the Dniester Delta performed in the period autumn-spring 2019-2020 is shown on Fig.1. Keeping in mind that most of wildfires in the Dniester delta are registered in winter-spring period we took into consideration the areas of wildfire traces for the autumn-winter-spring period - from September of the previous year to April of the following year.

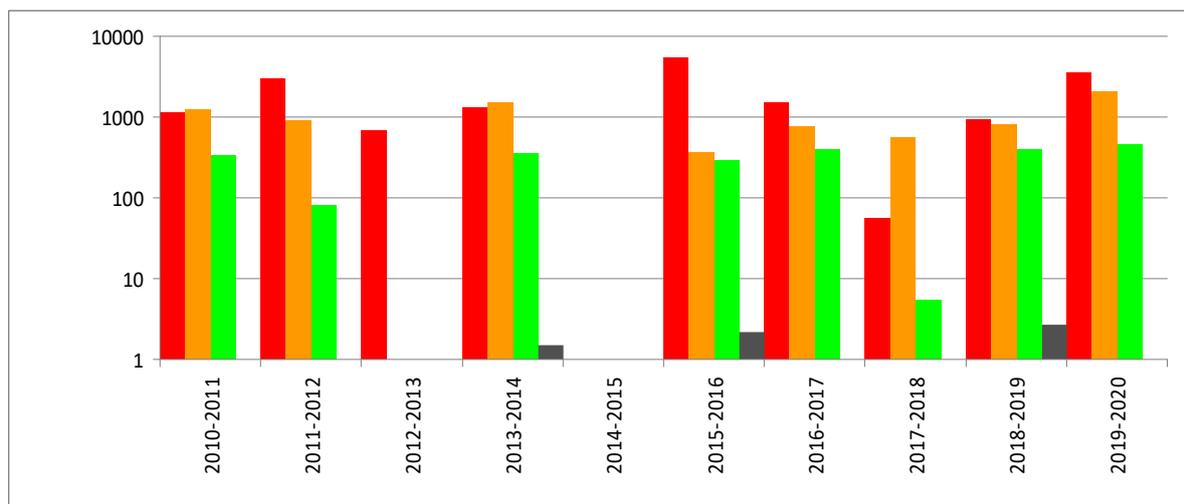




**Figure 1** Example of schematic map of the wildfire traces mapped using space images of the Dniester Delta for autumn-spring periods of 2019-2020

Information about wildfire areas (hectares) on the territory of the LDNNP zone by zone for 2010-2020 is presented on Fig.2.





**Figure 2** Annual wildfire traces Square (hectares) on the territory of the LDNNP in different protection zones in 2010-2020. ■ - Core area zone, ■ - Regulated Recreation zone, ■ - Stationary Recreation zone ■ - Economic Activities zone

The minimal area of wildfires in the Dniester Delta for all the years of observation was registered in autumn-spring periods of 2014-2015 (326.2 hectares), 2017-2018 (1183.3 hectares) and 2012-2013 (1201.5 hectares). No wildfires were registered in the Lower Dniester NNP in 2014-2015; in 2017-2018 wildfire area made 2.9 % of the LDNNP territory, in 2012-2013 – 3.2%.

The total area affected by wildfire in the Dniester Delta made 521573 hectares for the decade from 2010 to 2020, out of them 28098.84 hectares were located in the Lower Dniester NNP, which totalled to almost 132% of the LDNNP territory. Analysis of the results presented on Fig. 3 and their comparison with total areas of separate LDNNP zones had shown the following: the zone affected by wildfires the most in 2015-2016 was the Core Area - 5391.9 hectares were burned down, making about 66% of the zone territory. It should be noted that number of wildfires in the Park Core Areas was high in the periods 2019-2020 and 2011-2012 when ca. 42% (3460.78 hectares) and 37% (3053.4 hectares) were affected in the zone respectively.

The minimum area affected by fires in the Core Zone was registered in the periods 2014-2015 (no fires registered) and 2017-2018 (0.7% of the territory of the zone or 940.7 hectares burned down). In the Zone of Regulated Recreation the maximal number of wildfire-affected areas was observed in 2019-2020 when about 24% of the zone's territory was burned down (2075.85 hectares) and in 2013-2014 when 17.8% of the territory of the zone (1516.7 ha) were affected. In the periods of 2012-2013 and 2014-2015 no fires were observed on the territory of the zone. In the periods from 2016 to 2019 no more than 10% of the zone was burned out for each period. In the Zone of Stationary Recreation the maximal area affected by wildfires was registered in 2019-2020 when about 10% of the zone's territory (453.7 hectares) was burned down. In the periods of 2013-2019 from 6 to 8% of the territory burned down annually. In 2012-2013 and 2014-2015 no fires were recorded in the zone.

Practically no wildfires were observed on the territory of the Economic Activities Zone: in the periods of 2013-2014, 2015-2016 and 2018-2019 no more than 1% of the zone's territory was affected, and no wildfires happened during other periods. Analysing the data, we should point out that for the entire decade from 2010 to 2020 Core Zone was affected by wildfires the most, next came the Zone of Regulated Recreation. Wildfire areas in the Zone of Stationary Recreation did not exceed those in the Zone of Regulated Recreation and the least affected was the Zone of Economic Activities.

## Conclusion

For the period of 2010-2020 the largest wildfire areas in the Dniester Delta were registered in 2019-2020 when 13010.6 hectares were burned down. Minimal wildfires were registered in 2014-2015 when 326.2 hectares were affected. Maximal burnt down areas on the territory of the LDNNP were



registered in 2015-2016 when 6049.2 hectares were burned down (28.4% of the Park territory). In the period of 2010-2020 maximal wildfire areas in the Dniester Delta were observed in 2019-2020 when 13010.6 hectares were burned down. Minimal wildfires were registered in 2014-2015 affecting 326.2 hectares. Maximal wildfire areas on the Park territory were registered in 2015-2016 affecting 6049.2 hectares (28.4% of the Park territory). As to minimal areas affected, we should point out the period of 2014-2015 when no wildfires happened in the Park. Space images and modern software use is an effective method to establish boundaries and areas of wildfire traces, which combined with field observations facilitates an objective assessment of environmental and economic damage done by wildfires to a territory of nature reserve fund. For objective assessment of the environmental and economic damage from wildfires special scientific studies should be planned and conducted, the applied results of which should be a modern method of environmental and economic losses calculation, improvement of monitoring system, as well as mapping of the number of flora and fauna species, especially those included into the Red Book of Ukraine.

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