

## SPATIO-TEMPORAL ANALYSIS OF ACCIDENTAL WATER POLLUTION EVENTS IN ROMANIA BETWEEN 2017-2022

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**Abstract.** The present study is focused on the assessment of “accidental water pollution” using the database generated through Romanian Waters National Administration and National Environmental Protection Agency. The result will emphasize the spatial distribution on settlements, counties and regional level. The most affected area are along the middle sector of Mureş River, Târnava Mare, around some great cities like: Oradea, Iaşi, Constanţa, Ploieşti. The most common pollutants are wastewaters, hydrocarbons and chemical substances.

**Keywords:** accidental water pollution events, spatial distribution, temporal analysis.

### 1. INTRODUCTION

Pollution means the direct or indirect introduction, as a result of human activity, of substances or heat into the air, water or land which may be harmful to human health or the quality of aquatic ecosystems or terrestrial ecosystems directly depending on aquatic ecosystems, which result in damage to material property, or which impair or interfere with amenities and other legitimate uses of the environment (WFD, 2000).

Water pollution is defined by the increased trend of human pressures on this resource and due to the growing trend of challenges related to both water scarcity and poor water distribution. Statistics have shown that "point" pollution sources from cities and factories that are discharged into the emissary through discharge mouths represent only 35% of the total pollution sources, while "non-point" sources, have a share of 65%.

Accidental water pollution represents the discharge of pollutants from point sources, in high concentrations, unintentionally, due to an accident or under special circumstances, which leads to the impairment of water quality and causes damage to aquatic ecosystems. One of the important measures for maintaining the quality of water resources is the activity of preventing and combating accidental pollution.

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The plan to prevent and combat accidental pollution is drawn up by each utility potentially polluting or where events may occur that may lead to accidental pollution a water resources.

Accidental water pollution events can be caused by technological and human negligence, pollution of water beds in localities and lands with oil or chemical products, by breaking the transport pipes of these products, pollution due to traffic accidents and pollution caused by natural factors.

Romanian network responsible for monitoring potential accidental pollution events for all components of the environment is coordinated by the Ministry of the Environment, through a wide spread centers located in every county, with special departments that are focused on these types of events. The basic legislation for evaluation/monitoring and specific interventions to diminish the effects of pollution events are presented in Environmental Protection Law no. 137 from 1995 and in Ministerial Order 2579 from 2012. The main authority on the national level is The National Environmental Protection Agency (NEPA) with is territorial county smaller agencies who are collecting the information regarding these events. Water pollution events are observed by Romanian Waters National Administration (RWNA) through a wide-spread monitoring stations connected into a controlled network.

In Romania the subject of accidental pollution events affecting water network was documented in many studies focused either on single events: Baia Mare cyanide incident (Schwabach, 2000), mining spots from Apuseni Mountains (Bird, 2009), large watersheds: Arieş basin (Bătinaş, 2003), Siret basin (Zait et al, 2021) or at country level (Galatchi, 2006) and (Breabăn, 2020).

## **2. DATA AND METHODS**

The raw data provided by the RWNA is expanded over seven consecutive years of monitoring (2017 -2022) and contains information regarding the spatial distribution on the 11 large watersheds – Water Basin Administrations, subsidiaries of RWNA, pollutant type and affected settlements. Data was collected by the local water management system offices spread around the country and correlated with information gathered by Regional Environmental Protection Agencies. In order to obtain the spatial distribution, we have used MS Excel and ArcGIS map software.

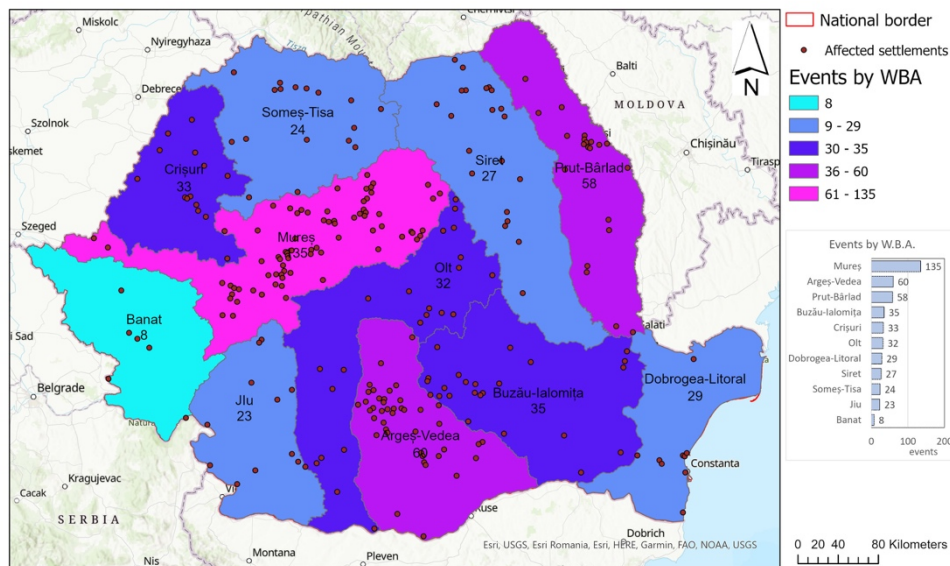
## **3. RESULTS**

In the last seven years (2017 - 2022), Romania has experienced and registered 464 accidental water pollution events. The distribution of these events based on the recorded year and appearance in the WBA large watersheds is presented in table 1. The yealy distribution shows a significant variability with a decreasing tendency for the first three years of the interval (2017-2019), followed by a sharp increase for 2020-2021. The last analyzed year has shown a signinficant drop in recorded events (62 incidents).

**Table 1. Records of accidental water pollution events in Romania displayed on WBA large watersheds (2017-2022)**

Water Basin Administration	Surface (km <sup>2</sup> )	2017	2018	2019	2020	2021	2022	Total
Argeş-Vedea	21919.1	8	10	11	10	12	9	<b>60</b>
Banat	18319.4	1	1	2	1	3	0	<b>8</b>
Buzău-Ialomița	26470.2	6	5	1	9	9	5	<b>35</b>
Crișuri	14941.8	1	0	0	13	15	4	<b>33</b>
Dobrogea-Litoral	15841.7	4	3	5	4	9	4	<b>29</b>
Jiu	16579.7	1	3	0	6	6	7	<b>23</b>
Mureș	28532.2	30	23	22	31	14	15	<b>135</b>
Olt	24960.9	6	7	8	2	4	5	<b>32</b>
Prut-Bârlad	20871.8	11	14	6	8	13	6	<b>58</b>
Siret	27944.2	3	7	1	4	8	4	<b>27</b>
Someș-Tisa	22450.6	5	4	1	7	4	3	<b>24</b>
<b>Romania</b>	<b>238831.6</b>	<b>76</b>	<b>77</b>	<b>57</b>	<b>95</b>	<b>97</b>	<b>62</b>	<b>464</b>

Based on the spatial distribution we have noticed that Mureș catchment area is by far, one of the most exposed with 135 recorded events (29 % of all events recorded), followed by Argeş-Vedea catchment (60 events) and Prut-Bârlad (58 events). The most "protected" catchment is Banat with only 8 records in the analyzed period.



**Fig. 1. Events of accidental water pollution recorded by development regions (2017-2022)**

Analyzing the nature of pollutants was the next criteria used to appreciate what are the most involved substances or process that have triggered the pollution.

The main accidental water pollution sources are: wastewaters (with domestic and industrial genesis); hydrocarbons, acid mine waters, chemical substances, etc. An overview of the recorded values is presented in table below.

*Table 2. Pollutant nature/type involved in accidental pollution events (2017-2022)*

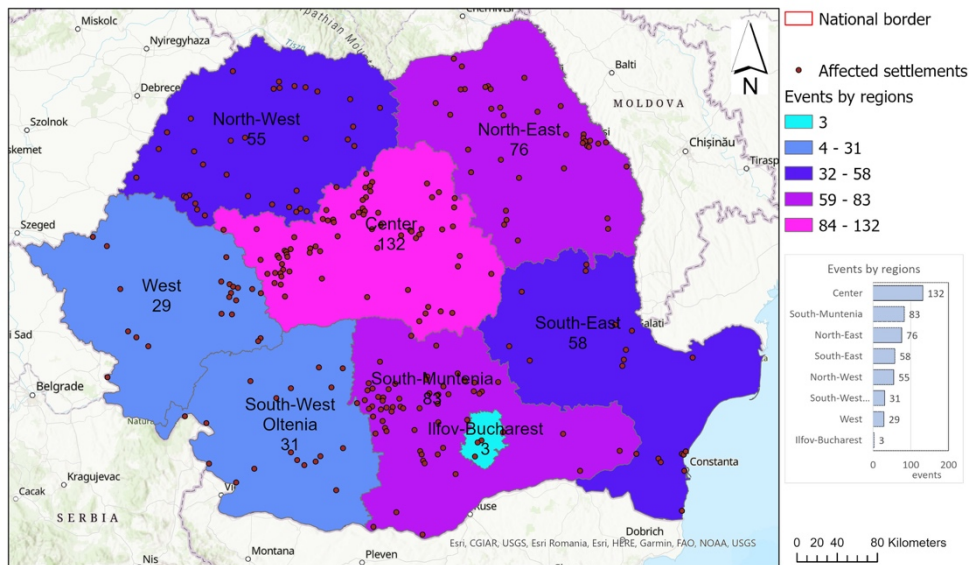
<b>Pollutant nature / type</b>	<b>2017</b>	<b>2018</b>	<b>2019</b>	<b>2020</b>	<b>2021</b>	<b>2022</b>	<b>Total</b>
Wastewaters	49	46	34	68	51	43	291
Hydrocarbons	17	27	20	23	29	13	129
Mine waters	1	1	3	1	5	1	12
Chemical substances		2		1	2	2	7
Unknown source	1				2	2	5
Mine tailings waste	1	1		1			3
Household waters					3		3
Ore				1	1	1	3
Leached wastefield waters	3						3
Mineral oils	2						2
Household waste					1		1
Expired medications					1		1
Animal waste	1						1
Whey	1						1
PET					1		1
Warm waters					1		1
<b>Total</b>	<b>76</b>	<b>77</b>	<b>57</b>	<b>95</b>	<b>97</b>	<b>62</b>	<b>464</b>

Organic pollutants, nitrogen and phosphorus-based compounds, heavy metals from mine drainage, untreated wastewaters from households, residual effluents with different origin are in general, the most common substances responsible for water pollution (Bătinaş, 2022).

Geographical approach was made by using the development regions, counties and territorial units. In order to obtain a harmonic politics of territorial development compared to those created in the European Union and financial support for the territorial profile development, Romania has created eight development regions, each one containing several counties (Surd et al, 2011).

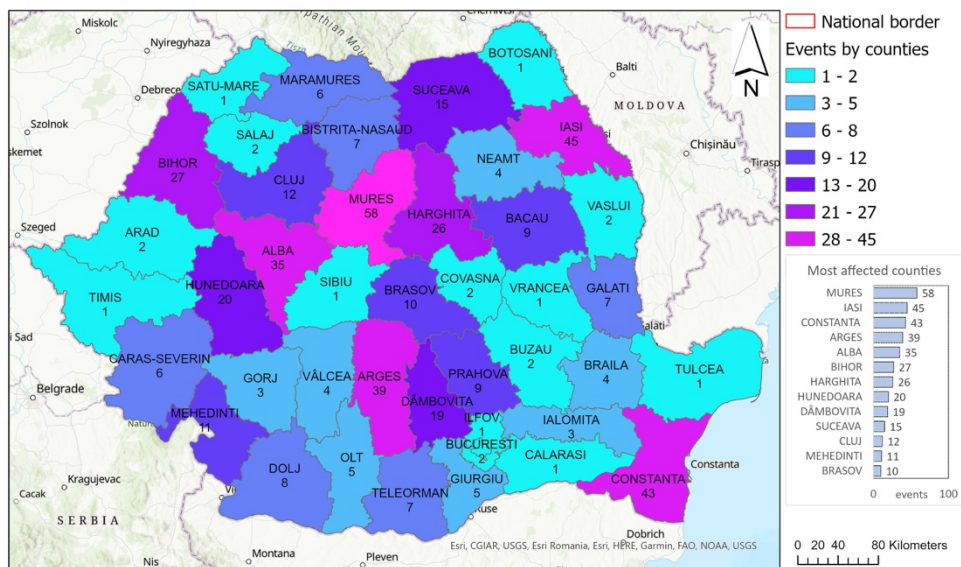
The analysis has shown that the most events are recorded in the Center region, which includes Mureş, Alba, Sibiu, Braşov, Harghita and Covasna counties with 132 events, followed by South-Muntenia region (Argeş, Dâmboviţa, Prahova, Teleorman, Giurgiu, Călăraşi and Ialomiţa counties) with 83 events and North-East region (Suceava, Botoşani, Iaşi, Neamţ, Vaslui and Bacău counties) with 76 events.

The least exposed to water pollution events were the two of the western regions of Romania: South-West Oltenia with 31 events and West Development Region with 28 events.



**Fig. 2. Events of accidental water pollution recorded by development regions (2017-2022)**

On a county level the spatial distribution of these events shows that the most exposed are Mureş county (58 events), followed by Iaşi county (45) and Constanţa (43 events). A significant number of events were recorded (more than 20) also in Argeş, Alba, Bihor, Harghita and Hunedoara counties.



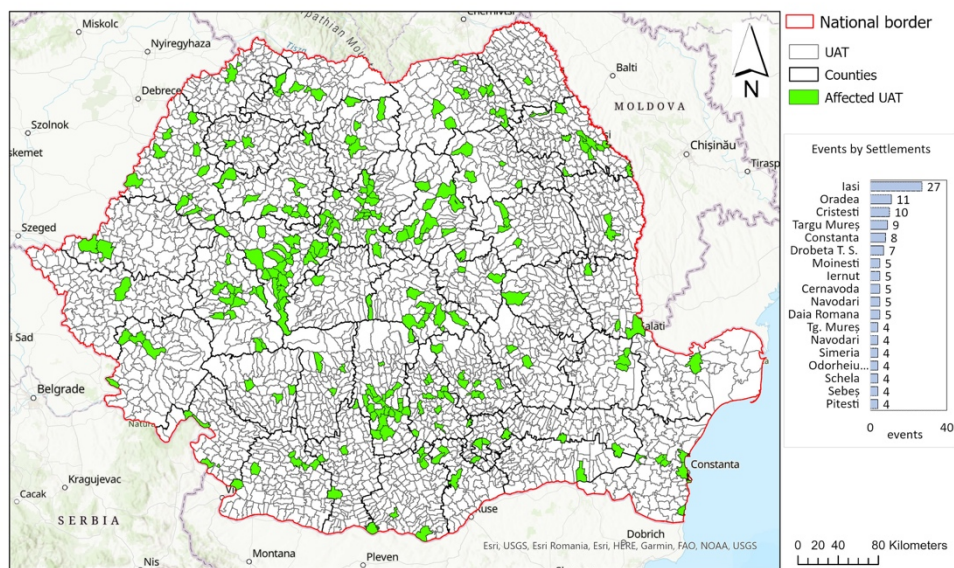
**Fig. 3 Events of accidental water pollution recorded by counties (2017-2022)**



The most "protected" counties were those where the number of water pollution incidents has a very low value, in some cases with only one event: Botoșani, Satu Mare, Timiș, Sibiu, Vrancea, Tulcea, Călărași counties. A comprehensive situation on this matter is presented in figure 3.

For the settlements diagnosis, the raw data has emphasized that 280 localities in Romania were affected, involving either large city but also small villages. The usual cause of these pollution events was the raw evacuation of waste waters directly into the creeks and streams, without a proper treatment or due to a failure in the management of different substances or materials which in the end have reached the river network or the underground waters.

The analysis has shown that the largest occurrence for the entire interval was observed for Iași (27), Oradea (11), Cristești (10), Târgu Mureș (9), Constanța (8) and Drobeta Turnu Severin (7). The geographical distribution of the settlements that have been affected by accidental pollution events is presented in map below (figure 4).



**Fig. 4. Total accidental water pollution events by settlements in Romania (2017-2022)**

Despite their relative scattered distribution on the national territory, it can easily be observed that some clusters have been formed (Bătinaș, 2022). Thus, the most obvious clusters are those developed around Mureș valley, from the eponymous county through Alba and Hunedoara. Another important area is the one associated with Târnava Mare river. Cities like Iași and Oradea have unfortunately records of reports associated with water pollution events. The area around Constanța, as a main sea-harbour of Romania, the southern part of Prahova county, the eastern part of Brăila county, some settlements around Bucharest and those in the center part of Argeș county are other vulnerable areas to be considered.

#### 4. CONCLUSIONS

Accidental water pollution events are occurring based on non-predictable scenarios and can affect the quality of water resources for long time. The uni-directional transmission of pollution events across river length moves the process to different settlements, considered usually in a "safe zone". Generated independent of human will and triggered sparsely in time, these events can lead to a significant change in the state of the environment. The analysis of these events in the last seven years (2017-2022) has shown that the most affected regions are those situated in the middle of the country. Most vulnerable counties and settlements to these events have either an economical profile that can be sensitive for the environment (oil refineries and related activities that involve hydrocarbons) or they have recorded disruptions, structure failures, insufficient maintenance or mis behavior of different activities that manage wastewaters and can lead to environmental pollution. The management of these events should be responsive with fast actions to limit the polluted area and mitigate the phenomena with their possible effects on social side. It is important to take measures to prevent accidental pollution and to respond quickly and effectively to any incidents that do occur to minimize their impact.

#### REFERENCES

1. Bătinaş, R., (2003), *Fenomenul de poluare accidentală a apei în bazinul hidrografic al râului Arieş*, Revista Riscuri și catastrofe, vol. 2, Edit. Casa Cărții de Știință, Cluj-Napoca.
2. Bătinaş, R., Șerban, Gh., Sabău, D., (2020), *Water Resources from Apuseni Mountains—Major Coordinates*, In: Negm, A., Romanescu, G., Zeleňáková, M. (editors) *Water Resources Management in Romania*. Springer Water. Springer, Cham. DOI: 10.1007/978-3-030-22320-5\_16
3. Bătinaş, R., Corleciuc, M., Ioniță, I.-L., Piticari, B.G., Nacu, S. (2022), *Multi-Criterial Analysis of Environmental Accidental Pollution Events in Romania Between 2019-2021*. "Air and Water – Components of the Environment" Conference Proceedings, Cluj-Napoca, Romania, p. 154-163, DOI: [https://doi.org/10.24193/AWC2022\\_15](https://doi.org/10.24193/AWC2022_15)
4. Breabăn, I.G., Breabăn, A.I. (2020). *Causes and Effects of Water Pollution in Romania*. In: Negm, A., Romanescu, G., Zeleňáková, M. (editors) *Water Resources Management in Romania*. Springer Water. Springer, Cham. [https://doi.org/10.1007/978-3-030-22320-5\\_3](https://doi.org/10.1007/978-3-030-22320-5_3)
5. Galatchi, L., (2006) *The Romanian National Accidental And Intentional Polluted Water Management System*. In: Dura G., Kambourova V., Simeonova F. (eds) *Management of Intentional and Accidental Water Pollution*. NATO Security through Science Series. Springer, Dordrecht. [https://doi.org/10.1007/1-4020-4800-9\\_16](https://doi.org/10.1007/1-4020-4800-9_16)
6. Surd, V., Kassai, I., Giurgiu, Laura, (2011), *Romania disparities in regional development*, The 2<sup>nd</sup> International Geography Symposium GEOMED2010, Procedia Social and Behavioral Sciences 19, pages 21-30.

7. Zait, R.; Sluser, B.; Fighir, D.; Plavan, O.; Teodosiu, C., (2021), *Priority Pollutants Monitoring and Water Quality Assessment in the Siret River Basin, Romania*. *Water* 2022, 14, 129. <https://doi.org/10.3390/w14010129>
8. \*\*\* raw data provided by National Environmental Protection Agency, Bucharest
9. \*\*\* raw data provided by Romanian Waters National Administration, Bucharest
10. \*\*\* ORDIN nr. 278 din 11 aprilie 1997 emis de Ministerul Apelor, Pădurilor Și Protecției Mediului, Publicat în MONITORUL OFICIAL nr. 100 bis din 26 mai 1997
11. \*\*\* Water Frame Directive 2000/60/EC emitted by the European Parliament and of the European Council of 23 October 2000.  
[https://eur-lex.europa.eu/resource.html?uri=cellar:5c835afb-2ec6-4577-bdf8-756d3d694eeb.0004.02/DOC\\_1&format=PDF](https://eur-lex.europa.eu/resource.html?uri=cellar:5c835afb-2ec6-4577-bdf8-756d3d694eeb.0004.02/DOC_1&format=PDF)