EFFECTS AND IMPACT OF MISUSE OF PESTICIDES ON HUMAN HEALTH

BALKAN DETOX LIFE: STRENGTHENING NATIONAL CAPACITIES TO FIGHT WILDLIFE POISONING AND RAISE AWARENESS ABOUT THE PROBLEM ACROSS SEVEN BALKAN COUNTRIES
(LIFE19 GIE/NL/001016)

Prepared by: Vulture Conservation Foundation

Project Partners:

Funded by:

Subject and purpose of the report

This document is prepared within the framework of the BalkanDetox LIFE project (LIFE19GIE/NL/001016) and relates to the deliverable “Study of the effects and impact of misuse of pesticides on human health”, defined under *Action A.4: Study of the impact of misuse of pesticides on human health*. This study is designed to provide a preliminary overview into the current circumstances regarding the misuse of pesticides and similar plant protection products and the detrimental effects it has on human health in Albania, Bosnia and Herzegovina, Croatia, the Republic of North Macedonia, and Serbia.

Authors

The Vulture Conservation Foundation, Albanian Ornithological Society, Association BIOM, Bird Protection and Study Society of Serbia, Macedonian Ecological Society, Ornitološko društvo “Naše Ptice”.

Contributors

Regional Hospital of Durres, Albania
Center for Informatics and Biostatistics in Health of Vojvodina province, Serbia
Association BIOM
Macedonian Ecological Society

Geographical scope

This study reflects on the negative effects that misuse of plant protection products has on human health in the following countries of the Balkan Peninsula: Albania, Bosnia and Hercegovina, Croatia, the Republic of North Macedonia and Serbia.

Date of production

April 2022.

Recommended citation for the report

Pantović, U., Duro, K., Dervović, T., D., Fabijanić, N., Petrovski, N., Vukićević, A. (2022): Effects and impact of misuse of pesticides on human health. Technical report for Action A.4 of the BalkanDetox LIFE project (LIFE19 GIE/NL/001016). Vulture Conservation Foundation.

About the project

The BalkanDetox LIFE project is a five-year endeavour with a €1.8 million budget, which aims to raise awareness and strengthen national capacities to fight the problem of wildlife poisoning across Albania, Bosnia & Herzegovina, Bulgaria, Croatia, Greece, the Republic of North Macedonia and Serbia. It received funding from the EU's LIFE Programme *with a contribution of 1.004.792€ (54,82%) to the total project budget*, and it is co-financed by the Vulture Conservation Foundation, the MAVA Foundation and Euronatur, as well as by the Whitley Fund for Nature and Environmental Protection and Energy Efficiency Fund for specific actions. Project partners are the Vulture Conservation Foundation as the coordinating beneficiary, and the Albanian Ornithological Society, Association BIOM, Bird Protection and Study Society of Serbia, Fund for Wild Flora and Fauna, Hellenic Ornithological Society, Macedonian Ecological Society, Ornitološko društvo NAŠE Ptice and the Protection and Preservation of Natural Environment in Albania as associated beneficiaries. Furthermore, this project is based on Spanish best practice experience and counts with the support from the Junta de Andalucía and the Spanish Ministry for the Ecological Transition and the Demographic Challenge.

Learn more at www.balkandetoxlife.eu

Table of Contents

1. INTRODUCTION

Pesticides are one of the few toxic substances released deliberately into the environment to kill living organisms (e.g., weeds (herbicides), insects (insecticides), fungus (fungicides), and rodents (rodenticides)). Although the term pesticide is often misunderstood to refer only to insecticides, it is also applicable to herbicides, fungicides, and various other substances used to control pests (Matthews 2006).

Agriculture is the largest consumer (around 85% of world production) of pesticides to chemically control various pests. Moreover, pesticides are also used in public health activities to control vector-borne diseases (e.g., malaria and dengue) and unwanted plants (e.g., grass and weeds) in ornamental landscaping, parks, and gardens. They are also useful in suppressing or avoiding the proliferation of insects, pests, bacteria, fungi, and algae in electrical equipment, refrigerators, paint, carpets, paper, cardboard, and food packaging materials. However, unintended exposure to pesticides can be extremely hazardous to humans and other living organisms as they are designed to be poisonous (Sarwar 2015). The physical makeup, behavior, and physiology of children make them more susceptible to pesticides than adults.

Pesticide exposure is linked with various diseases including cancer, hormone disruption, asthma, allergies, and hypersensitivity A line of evidence also exists for the negative impacts of pesticide exposure leading to birth defects, reduced birth weight, fetal death, etc. On the basis of scientific evidence, the real, predicted, and perceived risks that pesticides pose to human health (occupational and consumer exposure) and the environment are fully justified (Ki-Hyun et.al. 2017).

1.1 Classification of pesticides

Pesticides can be classified by various criteria such as chemical classes, functional groups, mode of action, and toxicity. The active ingredients of most pesticides are either organic (contain carbon) or inorganic (copper sulfate, ferrous sulfate, copper, lime, sulfur, etc.). Organic pesticides can be additionally subdivided into two groups: natural (produced from naturally occurring sources) and synthetic (artificially produced by chemical synthesis). Pesticides have different modes of action or ways to control the target pest.

Pesticides are sometimes classified by the type of target pest for which they are applied. Insecticides are capable of killing insects by penetrating into their bodies via direct contact (dermal entry), oral, and/or respiratory entry. Herbicides are used to kill plants by direct contact and/or by killing the weeds when they are absorbed through the leaves, stems, or roots. Some pesticides are capable of moving into untreated tissues after being absorbed by plants or animals. Such insecticides or fungicides can penetrate throughout the treated plants to kill certain insects or fungi. Other pesticides have also been developed to influence the nervous system or to act on the endocrine or hormone systems of pests for their control.

Table1. Classification of pesticides based on toxicity criteria (World Health Organization, WHO 2009)

Type	Toxicity level	LD50* for the rat (mg/kg bodyweight)	
		Oral	Dermal
Ia	Extremely hazardous	<5	<50
Iu	Highly hazardous	5-50	50-200
II	Moderately hazardous	50-2000	200-2000
U	Unlikely to present acute hazard	5000 or higher	

* LD50 – the amount of the substance required to kill 50% of the test population.

Table 2. Classification of pesticides based on target pest (Aktar et al. 2009)

Pesticide type	Target pest
Algicide	Algae
Avicide	Birds
Bactericide	Bacteria
Fungicide	Funghi
Herbicide	Weeds
Insecticide	Insects
Miticide	Mites
Molluscicide	Snails, slugs
Nematicide	Nematodes
Piscicide	Fish
Rodenticide	Rodents

1.2 Exposure to pesticides

Exposure to pesticides can occur directly from occupational, agricultural, and household use, while they can also be transferred indirectly through diet. The main routes of human exposure to pesticides are through the food chain, air, water, soil, flora, and fauna. There are four common ways pesticides can enter the human body: dermal, oral, eye, and respiratory pathways. The toxicity of pesticides can vary depending on the type of exposure such as dermal, oral, or respiratory (inhalation). As would be generally expected, the danger of pesticide contamination usually increases on the dosage (concentration).

Dermal exposure is one of the most common and effective routes through which pesticide applicators are exposed to pesticides. Dermal absorption may occur as a result of a splash, spill, or spray drift, when mixing, loading, disposing, and/or cleaning of pesticides. Absorption may also result from exposure to large amounts of residue. Pesticide formulations vary broadly in physicochemical properties and in their capacity to be absorbed through the skin (Beard et al., 2014), which can be influenced by the amount and duration of exposure, the presence of other materials on the skin, temperature and humidity, and the use of personal protective equipment. In general, solid forms of pesticides (e.g., powders, dusts, and granules) are not as readily absorbed through the skin and other body tissues as liquid formulations.

The most severe poisoning may result when a pesticide is introduced through oral exposure. Oral exposure of a pesticide usually arises by accident due to carelessness or for intentional reasons, such as suicide and homicide. There are many cases in which people have been poisoned by drinking pesticides kept in soft drink bottles or after drinking water stored in pesticide-contaminated bottles. Workers handling pesticides or equipment for their application can also consume pesticides if they do not wash their hands prior to eating or smoking (U.S. Environmental Protection Agency, USEPA,2007).

Due to the presence of volatile components of pesticides, their potential for respiratory exposure is great (Amaral 2014). Inhalation of sufficient amounts of pesticides may cause serious damage to nose, throat, and lung tissues. However, the risk of pesticide exposure is in general relatively low when pesticides are sprayed in large droplets with conventional application equipment. However, if low-volume equipment is used to apply a concentrated material, the potential for respiratory exposure is increased due to the production of smaller droplets. It is recognized that respiratory exposure to pesticides can be significant if applied in confined spaces (e.g., an unventilated storage area or greenhouse). In addition, with increased temperature, vapor levels of many pesticides increase to worsen such exposures. Thus, it is recommended that pesticides should not be applied at air temperatures above 30°C.

The potential for chemical injury is high for tissues of the eye. Some pesticides were reported to be absorbed by the eyes in sufficient quantities to cause serious or even fatal illness (Gildenetal 2010). Granular pesticides pose a particular hazard to the eyes depending on the size and weight of individual particles. If pesticides are applied with power equipment, the pellets may bounce off vegetation or other surfaces at high velocity to cause significant eye damage. Eye protection is also needed when measuring or mixing concentrated or highly toxic pesticides.

1.3 Impacts of pesticides use on human health

Available published studies suggest that pesticides may be related to various diseases including cancers, leukemia, and asthma. The risk of health hazards due to pesticide exposure depends not only on how toxic the ingredients are but also on the level of exposure. In addition, certain people such as children, pregnant women, or aging populations may be more sensitive to the effects of pesticides than others.

The link between pesticides and cancer has been reported by many studies. Exposure to pesticides exhibits a significant association with brain tumors and gliomas. It was demonstrated that Chlorpyrifos in pesticides induced a redox imbalance that altered the antioxidant defense system in breast cancer cells (Ventura et al. 2015). The main mechanism involved in the inhibition of cell proliferation induced by CPF is an increment of pERK1/2 levels mediated by H2O2 in breast cancer cells. Some OCs was found to be individually linked to breast cancer through their potential to exert oestrogenic effects on mammary cells (Rivero et al., 2015). In a study covering a female population from Tunisia, possible association between serum concentrations of organochlorine pesticides (polychlorinated biphenyls) and xenoestrogenic effects was investigated; accordingly, their positive link with breast cancer risk was observed (Arrebola et al., 2015).

Pesticide exposure may contribute to the exacerbation of asthma by irritation, inflammation, immunosuppression, or endocrine disruption (Hernández et al. 2011; Amaral 2014).

Emerging scientific evidence suggests that diabetes should be affected by exposure to environmental pollutants. Exposure to pesticides, particularly organochlorines and metabolites, is suspected to impart a higher risk of developing type 2 diabetes and its comorbidities (Azandjemeetal., 2013). A systematic review of the literature indicated a positive association between diabetes and serum concentrations of several pollutants (such as polychlorinated dibenzodioxins and dibenzofurans (PCDD/Fs), PCBs, and several organochlorine pesticides (DDT, DDE, oxychlordane, trans-nonachlor, hexachlorobenzene, and hexachlorocyclohexane)). Epidemiologic studies suggest that occupational exposure to pesticides might increase the risk of Parkinson's disease. The frequent use of any household pesticide increased the odds of development of Parkinson's disease.

Exposure to pesticides is one of the most important causes of acute leukemia. Exposures during pregnancy to unspecified residential pesticides, insecticides, and herbicides are positively associated with childhood leukemia.

Although pesticides are developed to prevent, remove, or control harmful pests, concerns of the hazards of pesticides towards the environment and human health have been raised by many studies. There are indeed many inherent problems in conducting large-scale experiments to directly assess the causation of the human health problems associated with the use of pesticides. However, the statistical associations between exposure to certain pesticides and the incidence of some diseases are compelling and cannot be ignored. Moreover, some members of the population have an inherent genetic susceptibility to pesticide associated diseases and are thus likely to be more at risk than others (Kim et al. 2017).

2. APPROACH AND METHODOLOGY

Information represented in this report about poisoning incidents that have occurred due to inadequate use of pesticides in agricultural practices, or intentional use, in the Balkan region have been acquired from Albania, Bosnia and Herzegovina, Croatia, North Macedonia and Serbia. Information was collected from relevant governmental institutions for public health, such as regional hospitals and medical centres, national public health institutes.

For this purpose, a questionnaire was prepared (Annex I), requesting any available information from 2000 onwards regarding: number of poisoned individuals, number of fatal outcomes, type of poisoning (accidental, misuse/improper use of poisonous substances, intentional poisoning) and what was the substance used.

The questionnaires about human poisoning incidents were distributed by the BalkanDetox LIFE project beneficiaries among relevant governmental institutions by means of formal requests for information, as this data represents information of public importance and therefore must be made available. Additionally, project beneficiaries have endeavored to obtain all publicly available data (official records and reports from relevant national institutions, published papers and project reports, internal databases of CSOs) relevant to human poisoning incidents.

It is important to highlight that the data obtained differs significantly among the different countries. Data from most countries, except Croatia and North Macedonia, is much less detailed, and provides almost no insight into the circumstances and reasons behind poisoning incidents. Additionally, not all institutions contacted for information responded to the questionnaire, while a smaller number responded of not having any relevant data.

3. OVERVIEW OF THE SITUATION WITH HUMAN POISONING IN THE BALKAN COUNTRIES

There is very little information from the Balkan counties about concrete incidents where humans were poisoned due to misuse of pesticides in any way available from media, published reports or papers. The most complete analysis of this occurrence and its effects on human health on a global scale can be found in Boedeker et. al. from 2020, in which additional data from Albania and Serbia could be found. The analysis systematically reviewed the scientific literature published between 2006 and 2018, supplemented by mortality data from WHO.

It is well documented that human poisoning by pesticides has long been seen as a severe public health problem. As early as 1990, a task force of the World Health Organization (WHO) estimated that about one million unintentional pesticide poisonings occur annually, leading to approximately 20,000 deaths. Only 30 years after a first up-to-date picture of global pesticide poisoning and estimations of annual number of poisoning events is made available. The analysis conducted by Boedeker et. al. covered 141 countries in total, including 58 by the 157 articles and an additional 83 by data from the WHO Mortality Database. Approximately 740,000 annual cases of unintentional pesticide poisoning were reported by the extracted publications resulting from 7446 fatalities and 733,921 non-fatal cases. On this basis, they were able to estimate that about 385 million cases of these incidents occur annually world-wide including around 11,000 fatalities. Based on a worldwide farming population of approximately 860 million this means that about 44% of farmers are poisoned by pesticides every year. The greatest estimated number of unintentional human poisoning cases is in southern Asia, followed by south-eastern Asia and east Africa with regards to non-fatal cases.

In Albania a study was conducted by Sulaj et al. in 2015 on Aluminum phosphide poisonings only, with total and fatal poisonings reported for Tirana from 2009-2013.

Most documented cases were suicidal. Of 140 poisoning incidents (fatal and non-fatal), 8 cases (6%) were found to not be suicides. However, the study focused on poisonings and fatalities from a single pesticide, aluminum phosphide. As this pesticide is commonly available and comes in a tablet form, many of the cases were via ingestion and the great majority were due to suicides, so only some of the data reported in this study relates to unintentional poisoning. The authors' focus was on the fatalities, and the non-fatal cases had no information on whether accidental poisonings were included. The study also focused on a limited area in Albania, a single university centre in the capitol city of Tirana.

Relevant data for human poisoning in Serbia was analyzed in Vučinić et. al. in 2018, where the focus was on poisoning that occurred as a result of misuse of Organophosphate insecticides from 1998-2014. The data originates from the National Poison Control Centre (NPCC) which operates within the Military Medical Academy of Serbia, which is the referent national institution for storing data about human poisoning. In the period 1998-2014, about 17.250 patients were hospitalized at the NPCC, there were around 14.000 patients treated for poisoning by various toxic agents, and among them 410 cases (3%) due to poisoning with Organophosphate insecticides. The limitation of this study is that it did not include data on poisonings from pesticides other than organophosphate insecticides and did not report these data by year.

This chapter of the study focuses on the current frequency and circumstances with poisoning that occurs from misuse of pesticides for each target country of the Balkan Peninsula. It provides a detailed overview of all available data relevant to human poisoning events that we were able to obtain from the relevant governmental authorities.

3.1 ALBANIA

According to the data that we were able to obtain, a total of 128 incidents were humans were poisoned by pesticides were recorded in Albania from 2018 to the end of 2020. None of the recorded incidents had fatal outcome. Fifty incidents were recorded both in 2018 and 2019, while the remaining 28 incidents were recorded in 2020. The data represented in this report was obtained from the Regional Hospital of Durres and relates only to poisoning incidents that occurred in Durres County, which was the only institution that responded to our information request with concrete data. Ten requests for information have been sent to ten different institutions, from which we received replies from two institutions. Therefore, it is evident that this occurrence must be much more common in Albania.

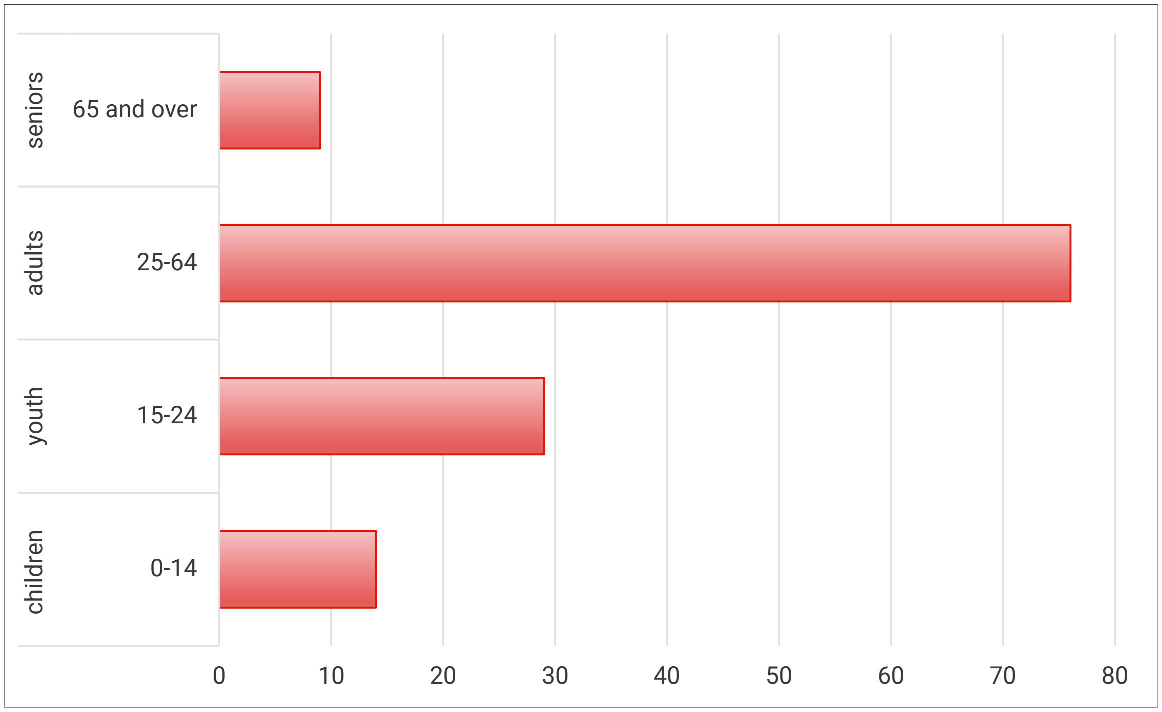

Figure 1. Distribution of poisoning incidents by different age groups in Albania

Among the people that got poisoned by misuse of pesticides the most dominant age group are adults (59,4%), followed by youth (22,4%) and children (11%). All poisoned children were under the age of 8.

Unfortunately, the data that we were able to obtain does not give any insight whether the human poisoning incidents registered in the hospital were accidental, whether they occurred because of improper use of pesticides or if it was a consequence of intentional poisoning. Additionally, the substances that caused these poisoning incidents were not identified and were listed just as "pesticides", apart from *Phostoxin.* Phostoxine is a common, legally sold pesticide in Albania which has Aluminum phosphide (AlP) as its active substance. AlP is used as a rodenticide, insecticide, and fumigant for stored cereal grains. It is used to kill small verminous mammals such as moles and rodents. The tablets or pellets typically also contain other chemicals that evolve ammonia which helps to reduce the potential for spontaneous ignition or explosion of the phosphine gas.

Ample evidence can be found in online media which indicates that AlP is used for suicide worldwide, including Albania. In the study conducted by Sulaj et al. in 2015 about human poisoning incidents from AlP in Tirana it can be found that 140 incidents (fatal and non-fatal) were recorded from 2009-2013, of which only 8 (6%) were not suicides. A total of 6 fatal outcomes occurred from AlP within that period.

Therefore, it is highly likely that those incidents with Phostixin recorded from 2018-2020 from Durres County also relate to suicide attempts. From the total number of recorded human poisoning incident within this period 29% relate to the use of this pesticide. The majority of casualties from the misuse of this pesticide are from the group of adults (73,7%), followed by youth (21%) and seniors (5,3%).

3.2 BOSNIA AND HERZEGOVINA

Information about human poisoning incidents due to accidental or intentional exposure to pesticides were not available from any of the health-care institutions from Bosnia and Herzegovina that we approached with official requests for information. A total of 53 health-care institutions were contacted with information requests, including the Federal Institute of Public Health, Institute od Public Health of Republika Srpska, which should be the two referent governmental institutions in the country for documenting these occurrences. Only one of the contacted institutions responded to the information request, Medical Centre of Brčko District, stating that it does not have any relevant data about human poisoning in their records. None of the other relevant institutions provided an answer to the request even though this data is information of public importance under the national legislation and should be made available upon request.

Additionally, we were not able to a quire any relevant information about humans being poisoned accidentally or intentionally from pesticides in any online media in Bosnia and Herzegovina. Therefore, were not able to assess the scope and severity of the misuse of pesticides and its effects on human health in the country. Further efforts are required to try to obtain the relevant data and in the end official Complaints for non-obtaining requested information could be submitted to the Commissioner for Information of Public Importance and Data Protection if the data requests remain unanswered.

3.3 CROATIA

Available data that we were able to obtain from the relevant institutions in Croatia for the purpose of this report is structured in a way that total numbers of poisoning incidents were reported annually across three different age groups: infants and preschool children, school children and adolescents, adults (Figure 2.). From 2006-2020 a total of 1713 human poisoning incidents related to the misuse of pesticides were recorded in Croatia by the national health-care institutions. On average, during this 15-year period 114 persons were poisoned annually, with highest numbers being recorded in 2008 (144 poisoning incidents).

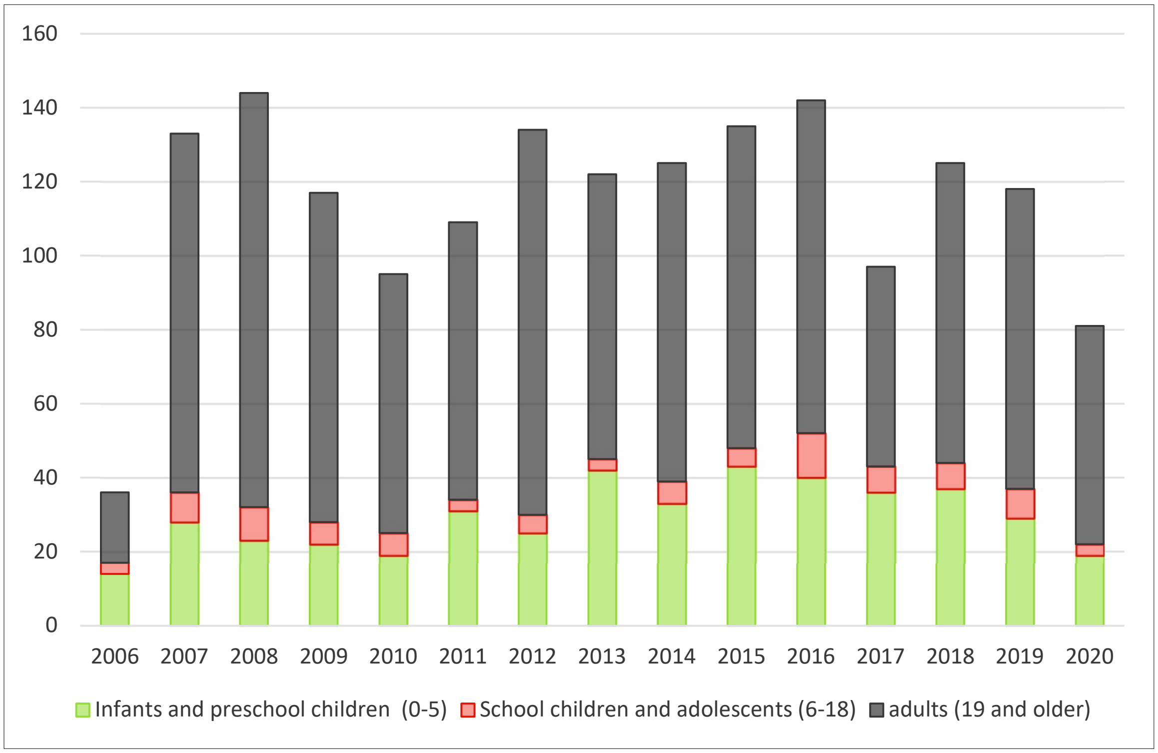

Figure 2. Distribution of poisoning incidents by different age groups in Croatia

From the people that got poisoned due to misuse of pesticides in Croatia the largest number is from the category of adults (69%), followed by category of infants and preschool children (25,7%) and category school children and adolescents (5,3%). The available data unfortunately does not provide information about the circumstances of individual poisoning incidents, and we are therefore not able to distinguish the actual causes behind this occurrence, that is to say whether the majority of recorded human poisoning incidents were accidental, caused by improper use and storage of pesticides, or intentional, such as suicide or murder attempts. Worrying is the fact that every forth poisoning incident involves a child under the age of five which is indicative of improper storage and easy availability of pesticides, as small children usually get poisoned accidentally.

Based on the available data only two fatal outcomes were recorded in 2008 and 2020. In 2008 a school child was poisoned accidentally by an *Organophosphate* pesticide (OPP). Organophosphates are commonly used as insecticides in agriculture, such as Malathion, Parathion, Diazinon, Fenthion, Dichlorvos, Chlorpyrifos, Ethion.

In 2020 another fatal outcome from pesticide poisoning was recorded when an individual committed suicide by ingesting a *Glyphosate* herbicide. Glyphosate is used extensively as a non-selective herbicide by both professional applicators and consumers and its use is likely to increase further as it is one of the first herbicides against which crops have been genetically modified to increase their tolerance.

Apart from the pesticides mentioned above, data is available only for those pesticides which caused more serious clinical manifestations (Table 1). The most common toxic compounds behind human poisoning in Croatia are Glyphosate herbicides, followed by Organophosphate insecticides. Unfortunately, the data that we were able to obtain does not provide insight into individual poisoning incidents. Therefore, we are not able to evaluate whether the human poisoning incidents that were recorded annually are mostly cases of accidental poisoning, due to improper use, storage of pesticides, or intentional poisoning, such as suicide attempts.

Table 3. Overview of pesticides identified as sources of human poisoning in Croatia

Year	Toxic substance detected	Type	Brand
2008	Organophosphate pesticides	insecticides	-
2009	Organophosphate pesticides	insecticides	-
	Phenoxyacetic acid derivatives	herbicide, fungicide	-
	Glyphosate	herbicide	-
2010	Organophosphate pesticides	insecticides	-
	Copper salts	-	-
	Phenoxyacetic acids derivatives	herbicide, fungicide	-
	Fenarimol	fungicide	-
	Amitraz	insecticide, acaricide	-
	Glyphosate	herbicide	-
2011	Anticoagulant rodenticide	rodenticide	-
	Organophosphate pesticides	insecticides	-
	Pyrethroid insecticides	insecticides	-
	Phenoxyacetic acid derivatives	herbicide, fungicide	-
	unidentified herbicide	hebicide	-
2012	Anticoagulant rodenticide	rodenticide	-
	Organophosphate pesticides	insecticides	-
	Pesticides with copper	algicide, bactericide, fungicide	-
	Glyphosate	herbicide	-

	Diquat	herbicide	-
2013	Anticoagulant rodenticides	rodenticide	-
	Organophosphate pesticides	insecticides	
	Glyphosate	herbicide	Total
2014	Glyphosate	herbicide	-
	Chlorophacinone	rodenticide	-
2015	Glyphosate	herbicide	Total
	Deherban (2, 4-D)	herbicide	-
	Unspecified herbicide	herbicide	-
	Unspecified rodenticide	rodenticide	-
2016	Oxydemeton-methyl	insecticide	Metasystox
	Benzene hexachloride	insecticide	Lindane
	terbuthylazine, mesotrione, s-metolachlor	herbicide	Lumax
	Glyphosate	herbicide	Cidocor
	Chlorophacinone	rodenticide	Faciron
	Bromadiolone	rodenticide	-
	Unknown pesticide	-	-
2017	Glyphosate	herbicide	-
2018	Diazinon	insecticide	Gamacid
	Thiometon	insecticide, acaricide	Ekatin
	Organophosphate pesticide	Insecticide	Ekalux (Quinalphos)
	Glyphosate	herbicide	Total
	Aluminum phosphide	rodenticide, fumigant	Phostoxin
	Aluminum phosphide	rodenticide, fumigant	Unknown trade name
	Unknown pesticide	-	-
2019	Glyphosate	herbicide	-
	Organophosphate pesticides	insecticide, acaricide	Dimethoate
	Bromadiolone	rodenticide	-
	Mesotrione	herbicide	-
	S-metolachlor	herbicide	-
	Terbuthylazine	herbicide, algicide	-
	Lambda cyhalothrin	insecticide	-
2020	Nicosulfuron	herbicide	-
	Glyphosate	herbicide	-
	Unspecified rodenticide	rodenticide	-

3.4 NORTH MACEDONIA

Information about human poisoning incidents that occurred due to misuse of pesticides in North Macedonia was available from 2010 onwards. The data that we were able to obtain from the relevant healthcare institutions is not detailed enough to provide insight into the causes behind pesticide poisoning, and therefore we are not able to distinguish whether the majority of these incidents occur accidentally, as a result of improper use, storage of pesticides, or intentionally. The data about poisoning from Organophosphate pesticides is structured in a way that only the total number of poisoned individuals from different age groups is represented on an annual basis (Annex III) for the entire country. Additionally, the available data only refers to poisoning incidents that occurred from the use of Organophosphate and Carbamate pesticides, without any specific details about the actual brand of the product used, which makes it impossible to evaluate the actual scope of this issue. Therefore, it is highly likely that many of these incidents remain unrecorded by the relevant authorities.

Since 2010 a total of 230 individuals were poisoned from the misuse of Organophosphate pesticides in North Macedonia (Figure 3). This occurrence was most common among adults (78,7%), followed by children (7,4%) and adolescents (6,5%).

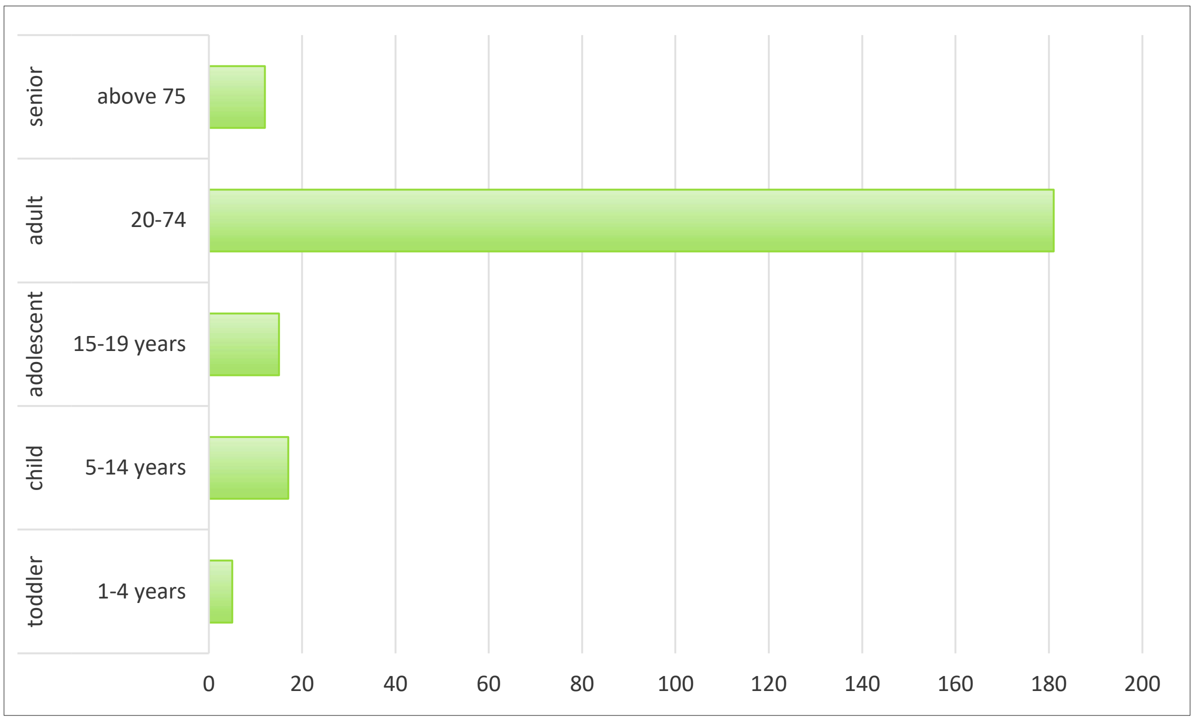

Figure 3. Distribution of poisoning incidents with Organophosphates by different age groups in North Macedonia

Apart from Organophosphates, records obtained from relevant health-care institutions indicate that a total of 62 individuals got poisoned from Carbamate pesticides during this period. Carbamates are a class of insecticides structurally and mechanistically similar to Organophosphate insecticides. While they possess a similar mechanism of action to the irreversible phosphorylation of acetylcholinesterase by organophosphates, carbamates bind to acetylcholinesterase reversibly. Subsequently, carbamates have a similar toxicological presentation to OP poisonings with a duration of toxicity that is typically less than 24 hours (Vale et al. 2015). Signs include hypersalivation, GI hypermotility, abdominal cramping, vomiting, diarrhea, sweating, dyspnea, cyanosis, miosis, muscle fasciculations (in extreme cases, tetany followed by weakness and paralysis), and convulsions. In brief, the acronym SLUD (salivation, lacrimation, urination, and diarrhea) describes the overall clinical features of carbamate poisoning. Death usually results from respiratory failure and hypoxia due to bronchoconstriction leading to tracheobronchial secretion and pulmonary edema.

3.5 SERBIA

Human poisoning due to misuse of pesticides and other toxic compounds is well documented in Serbia. The National Poison Control Centre (NPCC) operating within the Military Medical Academy of Serbia is the referent health-care institution where patients are threated to recover from poisoning. A more detailed study of the effect of poisoning with Organophosphates on human health has been conducted by Vučinić et. al. in 2018. The main aim of the study was to analyze and present data regarding the clinical management of poisoning with OP pesticides at the NPCC, that were collected during a 17-year period (from 1998-2014).

In the period 1998-2014, about 17.250 patients were hospitalized at the NPCC. There were around 14.000 patients treated for poisoning by various toxic agents, and among them 410 cases (3%) due to poisoning with OP pesticides. In this period, 92% of OP poisonings treated in the NPCC were suicidal by intention, while only 8% were due to accidental ingestion or inhalation. The most common clinical signs of poisoning in patients exposed to anticholinesterase pesticides, observed at Clinic of Toxicology of the NPCC were miosis (63.4%), bronchorrhea (51.9%), vomiting and diarrhea (44.8%), hypotension (19.5%). Acute respiratory insufficiency was registered in 81 (19.7%) and acute cardiocirculatory failure in 16 (3.9%) patients. There were about 25% of most severely poisoned patients. Besides general supportive measures (decontamination, respiratory support), specific pharmacological treatment (atropine, oxime, diazepam) was applied.

The study conducted by Vučinić concludes that acute poisoning with OP pesticides is not frequent in Serbia, however, it represents important clinical feature due to severity, possible health complications and their impact on duration and costs of hospitalization. The average population of the last 5 years reported in the study (2010-2014) were used for the non-fatal poisonings' prevalence. The non-fatal poisonings cases were reported in Vucinic et al. 2018 as: 410 cases * 8% accidental, divided by 17 years = 2 cases per year for the time period. As the rate had not changed according to authors, this was used as the number of cases per year for the Serbian general population for non-fatal poisonings prevalence. WHO Cause of Death data were available for the period 2011-2015.

Table 4. National estimates for Serbia

Population type	Population		Fatal	Non-fatal	Total cases
	Year	Size			
General	2010-2014 2011-2015	7.184.258	0.8	2	2.8
Agriculture/occupational	2011-2015			NA	0
Children	2011-2015	1.022.008	0	NA	0

The mortality data for this period did not include information on whether the poisonings were intentional. The data were from 1998-2014, and the non-fatal poisoning rate was reported as not having diminished during those years. Additionally, the study did not include data on poisonings from pesticides other than organophosphate insecticides and did not report these data by year, nor did it provide insight into the age structure of patients that were threated from pesticide poisoning.

For the purposes of creating this report and providing a more current review of scope of human poisoning due to misuse of pesticides all relevant health-care institutions were contacted, including the NPCC, several times. Unfortunately, we were not able to obtain the relevant data from the NPCC even though this data represents information of public importance and therefore must be made available. Data was only obtained from the Center for Informatics and Biostatistics in healthcare operating with the Institute of Public Health of Vojvodina. This institution is relevant for storing data about human poisoning that occurs within the territory of Vojvodina province in Serbia. Relevant data was available for a 5-year period, from 2015-2019. During this period a total of 67 poisoning incidents were reported in Vojvodina province. Three fatal outcomes were recorded, 2 in 2015 and 1 in 2019. No information was available about the type of pesticides that were the cause of poisoning, age of threated people and whether the poisoning occurred accidentally or intentionally.

4. CONCLUSIONS & RECOMMENDATIONS

Human poisoning caused by the misuse of pesticides, either by accidental exposure to these toxic compounds, or by intentional use is a well-documented occurrence in the countries of the Balkan region. Information about these incidents is recorded and stored by the relevant national health-care institutions of the countries, such as Public Health Institutes. Unfortunately, for most target countries the available data is mostly summarized to represent the total number of patients threated annually, without concrete information about the type of pesticides that caused poisoning, or the manner how poisoning occurred for each poisoning incident, whether it was accidental or intentional. Therefore, we are not able to effectively determine the scope and severity of this occurrence on the regional level, nor to precisely identify the substances mostly responsible for human poisoning. Additionally, data from most countries does not provide information about the severity of health issues and complications that the poisoned patients had, nor if the fatal outcomes recorded were consequences of suicide or accidental poisoning.

From the available data that we were able to obtain for the purpose of this report, we can conservatively conclude that a minimum of over 2.000 people got poisoned from pesticides by some manner of misuse from 2010-2020 in the Balkan countries, while there were 11 incidents with fatal outcomes. We can also estimate that the majority (over 70%) of poisoned people were adults (from 20-70 year of age), while poisoning was significantly less frequent in other age groups.

It is important to mention that, apart from Croatia, the data about human poisoning was only available for certain regions of the countries and for certain toxic compounds, usually those that caused more serious clinical features or death in rare cases. Additionally, the majority of relevant health-care institutions from the Balkan countries that were contacted for information were not responsive even though this information is of public importance and must be made available to any interested parties. Therefore, it is safe to assume that the data obtained for this report is only a fraction of the human poisoning incidents that occur annually in the Balkan region, and that the misuse of pesticides, accidental or intentional, is a very common practice. Further efforts need to be invested into obtaining this data through better engagement with the relevant authorities, submission of official complaints for non-obtaining requested information, submitted to the Commissioner for Information of Public Importance and Data Protection, or other relevant legal procedures in force in the different countries.

The most identified substances that caused poisoning in Balkan countries during this period were Organophosphate insecticides, Glyphosate herbicides, followed by Aluminum phosphide. Organophosphate poisoning occurs most commonly as a suicide attempt in farming areas of the developing world and less commonly by accident. OPPs are one of the most common causes of poisoning worldwide. There are nearly 3 million poisonings per year resulting in two hundred thousand deaths. Around 15% of people who are poisoned die as a result (Eddleston et.al. 2008). Exposure can be from drinking, breathing in the vapors, or skin exposure.

The mechanisms of toxicity of Glyphosate formulations are complicated. Not only is Glyphosate used as five different salts but commercial formulations of it contain surfactants, which vary in nature and concentration. As a result, human poisoning with this herbicide is not with the active ingredient alone but with complex and variable mixtures. Therefore, it is difficult to separate the toxicity of glyphosate from that of the formulation as a whole or to determine the contribution of surfactants to overall toxicity (Bradberry et.al. 2004).

AlP is used as both a fumigant and an oral pesticide. As a rodenticide, AlP pellets are provided as a mixture with food for consumption by the rodents. The acid in the digestive system of the rodent reacts with the phosphide to generate the toxic phosphine gas. It is used as a fumigant when other pesticide applications are impractical and when structures and installations are being treated, such as in ships, aircraft, and grain silos. All of these structures can be effectively sealed or enclosed in a gastight membrane, thereby containing and concentrating the phosphine fumes. Fumigants are also applied directly to rodent burrows.

There is very little information available about human poisoning incidents due to misuse of pesticides from online media from the respective Balkan countries and the most of this information relates to suicide attempts that had fatal outcomes. Therefore, it is evident that significant efforts need to be invested into highlighting the dangers of the misuse of pesticides in the media and also for awareness raising among farmers and other stakeholders.

REFERENCES

Aktar, M.W., Sengupta, D., Chowdhury, A., 2009. Impact of pesticides use in agriculture: their benefits and hazards. Interdiscip. Toxicol. 2 (1), 1–12.

Arrebola, J.P., Belhassen, H., Artacho-Cordón, F., Ghali, R., Ghorbel, H., Boussen, H., PerezCarrascosa, F.M., Expósito, J., Hedhili, A., Olea, N., 2015. Risk of female breast cancer and serum concentrations of organochlorine pesticides and polychlorinated biphenyls: a case-control study in Tunisia. Sci. Total Environ. 520, 106–113. http://dx.doi. org/10.1016/j.scitotenv.2015.03.045 (Epub 2015 Mar 22).

Azandjeme, C.S., Bouchard, M., Fayomi, B., Djrolo, F., Houinato, D., Delisle, H., 2013. Growing burden of diabetes in sub-saharan Africa: contribution of pesticides? Curr. Diabetes Rev. 9 (6), 437–449.

Beard, J.D., Umbach, D.M., Hoppin, J.A., et al., 2014. Pesticide exposure and depression among male private pesticide applicators in the agricultural health study. EHP 122 (9), 984–991.

Bradberry S.M., Proudfoot A.T., Vale J.A. Glyphosate poisoning. Toxicol Rev. 2004;23(3):159-67. doi: 10.2165/00139709-200423030-00003. PMID: 15862083.

Boedeker, W., Watts, M., Clausing, P. *et al.* The global distribution of acute unintentional pesticide poisoning: estimations based on a systematic review. *BMC Public Health* **20,** 1875 (2020). https://doi.org/10.1186/s12889-020-09939-0.

Eddleston M., Buckley N.A., Eyer P., Dawson A.H., (2008): Management of acute organophosphorus pesticide poisoning. *Lancet*. **371** (9612): 597–607.

Gilden, R.C., Huffling, K., Sattler, B., 2010. Pesticides and health risks. J. Obstet. Gynecol. Neonatal. Nurs. 39 (1), 103–110. http://dx.doi.org/10.1111/j.1552-6909.2009.01092.x. PMID 20409108.

Hernández, A.F., Parrón, T., Alarcón, R., 2011. Pesticides and asthma. Curr. Opin. Allergy Clin. Immunol. 11 (2), 90–96. http://dx.doi.org/10.1097/ACI.0b013e3283445939.

Matthews, G.A., 2006. Pesticides: Health, Safety and the Environment. Blackwell Publishing, Oxford, UK.

Sarwar, M., 2015. The dangers of pesticides associated with public health and preventing of the risks. Int. J. Bioinfor. Biomed. Eng. 1 (2), 130–136.

Sulaj Z, Drishti A, Çeko I, Gashi A, Vyshka G. Fatal aluminum phosphide poisonings in Tirana (Albania), 2009 - 2013. Daru. 2015 Jan 25; 23:8.

Slavica V, Dubravko B, Milan J. Acute organophosphate poisoning: 17 years of experience of the National Poison Control Center in Serbia. Toxicology. 2018 Nov 1;409:73-79. doi: 10.1016/j.tox.2018.07.010. Epub 2018 Jul 25. PMID: 30055297.

Vale A, Lotti M. Organophosphorus and carbamate insecticide poisoning. Handb Clin Neurol. 2015;131:149-68.

Ventura, C., Venturino, A., Miret, N., Randi, A., Rivera, E., Núñez, M., Cocca, C., 2015. Chlorpyrifos inhibits cell proliferation through ERK1/2 phosphorylation in breast cancer cell lines. Chemosphere 120, 343–350. http://dx.doi.org/10.1016/j.chemosphere.2014.07.088 (Epub 2014 Aug 31).

U.S. Environmental Protection Agency (USEPA), 2007. Pesticides: Health and Safety. National Assessment of the Worker Protection Workshop #3. (Available at:) http://www2.epa.gov/pesticide-worker-safety.

ANNEXES

Annex I. Overview of human poisoning incidents in Albania.

No.	Date/Period	Location *(municipality, local community)*	No. of poisoned individuals	Age of individuals poisoned	No. of individuals with fatal outcomes	Type of poisoning *(accidental, misuse/improper use of pesticides, intentional poisoning)*	Substance used
1	10.01.2018	DURRES	1	21			Phostoxin (Aluminum phosphide)
2	18.01.2018	DURRES	1	48			PESTICIDE
3	25.01.2018	DURRES	1	42			Phostoxin (Aluminum phosphide)
4	15.02.2018	DURRES	1	26			PESTICIDE
5	20.02.2018	DURRES	1	28			Phostoxin (Aluminum phosphide)
6	08.03.2018	DURRES	1	21			PESTICIDE
7	12.03.2018	DURRES	1	26			Phostoxin (Aluminum phosphide)
8	29.03.2018	DURRES	1	18			PESTICIDE
9	01.04.2018	DURRES	1	21			PESTICIDE
10	09.04.2018	DURRES	1	43			PESTICIDE
11	18.04.2018	DURRES	2	1; 3			PESTICIDE
12	07.05.2018	DURRES	1	24			PESTICIDE
13	08.05.2018	DURRES	1	15			PESTICIDE
14	24.05.2018	DURRES	1	63			Phostoxin (Aluminum phosphide)
15	29.05.2018	DURRES	1	16			PESTICIDE
16	29.05.2018	DURRES	1	34			PESTICIDE
17	03.06.2018	DURRES	1	22			PESTICIDE
18	08.06.2018	DURRES	1	17			PESTICIDE
19	10.06.2018	DURRES	3	24; 49; 52			PESTICIDE
20	20.06.2018	DURRES	1	40			Phostoxin (Aluminum phosphide)
21	21.06.2018	DURRES	1	7			PESTICIDE
22	09.07.2018	DURRES	1	18			Phostoxin (Aluminum

							phosphide)
23	13.07.2018	DURRES	1	52			PESTICIDE
24	17.07.2018	DURRES	1	28			Phostoxin (Aluminum phosphide)
25	29.07.2018	DURRES	1	19			PESTICIDE
26	05.08.2018	DURRES	1	34			PESTICIDE
27	09.08.2018	DURRES	1	24			PESTICIDE
28	10.08.2018	DURRES	1	45			Phostoxin (Aluminum phosphide)
29	13.08.2018	DURRES	1	36			PESTICIDE
30	17.08.2018	DURRES	1	68			Phostoxin (Aluminum phosphide)
31	23.08.2018	DURRES	1	47			Phostoxin (Aluminum phosphide)
32	26.08.2018	DURRES	1	25			PESTICIDE
33	27.08.2018	DURRES	1	50			PESTICIDE
34	29.08.2018	DURRES	1	21			PESTICIDE
35	29.08.2018	DURRES	1	35			PESTICIDE
36	04.09.2018	DURRES	1	23			Phostoxin (Aluminum phosphide)
37	15.09.2018	DURRES	1	31			PESTICIDE
38	19.09.2018	DURRES	1	58			Phostoxin (Aluminum phosphide)
39	19.09.2018	DURRES	1	70			Phostoxin (Aluminum phosphide)
40	22.09.2018	DURRES	1	45			PESTICIDE
41	09.10.2018	DURRES	1	30			PESTICIDE
42	03.11.2018	DURRES	1	55			PESTICIDE
43	04.11.2018	DURRES	1	1			PESTICIDE
44	11.11.2018	DURRES	1	25			PESTICIDE
45	12.11.2018	DURRES	1	18			PESTICIDE
46	27.11.2018	DURRES	1	32			Phostoxin (Aluminum phosphide)
47	27.11.2018	DURRES	1	19			Phostoxin (Aluminum phosphide)
48	07.12.2018	DURRES	1	56			PESTICIDE
49	07.12.2018	DURRES	1	57			PESTICIDE
50	16.12.2018	DURRES	1	40			Phostoxin (Aluminum phosphide)
51	01.01.2019	DURRES	1	32			Phostoxin (Aluminum phosphide)
52	06.01.2019	DURRES	1	2			PESTICIDE

53	15.01.2019	DURRES	1	46			PESTICIDE
54	24.01.2019	DURRES	1	16			PESTICIDE
55	01.02.2019	DURRES	1	53			PESTICIDE
56	09.02.2019	DURRES	1	35			Phostoxin (Aluminum phosphide)
57	11.02.2019	DURRES	1	42			Phostoxin (Aluminum phosphide)
58	13.02.2019	DURRES	1	1			PESTICIDE
59	18.02.2019	DURRES	1	19			PESTICIDE
60	21.02.2019	DURRES	1	20			Phostoxin (Aluminum phosphide)
61	10.03.2019	DURRES	1	43			PESTICIDE
62	13.03.2019	DURRES	1	27			PESTICIDE
63	26.03.2019	DURRES	1	29			Phostoxin (Aluminum phosphide)
64	26.03.2019	DURRES	1	50			Phostoxin (Aluminum phosphide)
65	05.04.2019	DURRES	1	31			PESTICIDE
66	15.04.2019	DURRES	1	54			Phostoxin (Aluminum phosphide)
67	16.04.2019	DURRES	1	64			PESTICIDE
68	28.04.2019	DURRES	1	54			PESTICIDE
69	29.04.2019	DURRES	1	24			PESTICIDE
70	02.05.2019	DURRES	1	25			PESTICIDE
71	07.05.2019	DURRES	1	25			PESTICIDE
72	10.05.2019	DURRES	1	43			PESTICIDE
73	10.05.2019	DURRES	1	20			PESTICIDE
74	12.05.2019	DURRES	1	67			PESTICIDE
75	15.05.2019	DURRES	1	53			Phostoxin (Aluminum phosphide)
76	15.05.2019	DURRES	1	57			PESTICIDE
77	17.05.2019	DURRES	1	49			PESTICIDE
78	18.05.2019	DURRES	1	60			PESTICIDE
79	22.05.2019	DURRES	1	55			PESTICIDE
80	23.05.2019	DURRES	1	21			Phostoxin (Aluminum phosphide)
81	25.05.2019	DURRES	2	16; 1			PESTICIDE
82	01.06.2019	DURRES	1	14			Phostoxin (Aluminum phosphide)
83	06.06.2019	DURRES	1	86			PESTICIDE
84	10.06.2019	DURRES	1	43			Phostoxin (Aluminum phosphide)

85	05.07.2019	DURRES	1	43			PESTICIDE
86	11.07.2019	DURRES	1	36			Phostoxin (Aluminum phosphide)
87	30.07.2019	DURRES	2	5; 7			PESTICIDE
88	04.08.2019	DURRES	1	47			PESTICIDE
89	13.08.2019	DURRES	1	42			PESTICIDE
90	20.08.2019	DURRES	1	25			PESTICIDE
91	25.08.2019	DURRES	1	31			Phostoxin (Aluminum phosphide)
92	13.09.2019	DURRES	1	34			PESTICIDE
93	15.09.2019	DURRES	1	24			Phostoxin (Aluminum phosphide)
94	19.09.2019	DURRES	1	67			PESTICIDE
95	09.10.2019	DURRES	1	??			PESTICIDE
96	26.10.2019	DURRES	1	25			PESTICIDE
97	01.11.2019	DURRES	1	40			PESTICIDE
98	15.12.2019	DURRES	1	1			PESTICIDE
99	21.12.2019	DURRES	1	1			PESTICIDE
100	05.01.2020	DURRES	1	18			PESTICIDE
101	20.01.2020	DURRES	1	76			PESTICIDE
102	27.01.2020	DURRES	1	38			PESTICIDE
103	07.03.2020	DURRES	1	18			PESTICIDE
104	17.03.2020	DURRES	1	85			PESTICIDE
105	25.04.2020	DURRES	1	49			Phostoxin (Aluminum phosphide)
106	10.05.2020	DURRES	1	2			PESTICIDE
107	24.05.2020	DURRES	1	64			PESTICIDE
108	15.06.2020	DURRES	1	20			PESTICIDE
109	27.06.2020	DURRES	1	35			PESTICIDE
110	09.07.2020	DURRES	1	37			Phostoxin (Aluminum phosphide)
111	15.07.2020	DURRES	1	52			PESTICIDE
112	24.07.2020	DURRES	1	23			PESTICIDE
113	26.07.2020	DURRES	1	38			Phostoxin (Aluminum phosphide)
114	29.07.2020	DURRES	1	29			PESTICIDE
115	04.08.2020	DURRES	1	39			PESTICIDE
116	18.08.2020	DURRES	1	28			Phostoxin (Aluminum phosphide)
117	22.08.2020	DURRES	1	46			PESTICIDE
118	30.08.2020	DURRES	1	27			Phostoxin (Aluminum phosphide)

119	09.09.2020	DURRES	1	27			PESTICIDE
120	12.09.2020	DURRES	1	18			PESTICIDE
121	15.09.2020	DURRES	1	65			PESTICIDE
122	21.09.2020	DURRES	1	51			PESTICIDE
123	06.10.2020	DURRES	1	48			Phostoxin (Aluminum phosphide)
124	30.10.2020	DURRES	1	2			PESTICIDE
125	19.11.2020	DURRES	1	76			PESTICIDE
126	22.11.2020	DURRES	1	24			PESTICIDE
127	28.11.2020	DURRES	1	47			PESTICIDE
128	24.12.2020	DURRES	1	40			PESTICIDE

Annex II. Overview of human poisoning incidents in Croatia.

Date/Period	Location *(municipality, local community)*	No. of poisoned individuals	Age of individuals poisoned	No. of individuals with fatal outcomes	Type of poisoning *(accidental, misuse/improper use of poisonous substances, intentional poisoning)*	Substance used
2006.	Croatia	14	Infants and preschool children	0		-
2006.	Croatia	3	School children and adolescents	0		
2006.	Croatia	19	Adults	0		
2007.	Croatia	28	Infants and preschool children	0		-
2007.	Croatia	8	School children and adolescents	0		
2007.	Croatia	97	Adults	0		
2008.	Croatia	23	Infants and preschool children			
2008.	Croatia	9	School children and adolescents	1		Organophosphate pesticide
2008.	Croatia	112	Adults	0		
2009.	Croatia	22	Infants and preschool children	0		organophosphate insecticides, phenoxyacetic acid derivatives, and glyphosate
2009.	Croatia	6	School children and adolescents	0		
2009.	Croatia	89	Adults	0		
2010.	Croatia	19	Infants and preschool children	0		organophosphate insecticides, copper salts, phenoxyacetic acids derivatives, fenarimol, amitraz, and glyphosate
2010.	Croatia	6	School children and adolescents	0		
2010.	Croatia	70	Adults	0		
2011.	Croatia	31	Infants and preschool children	0		anticoagulant rodenticide, organophosphate and pyrethroid insecticides, herbicide containing phenoxyacetic acid derivative
2011.	Croatia	3	School children and adolescents	0		
2011.	Croatia	75	Adults	0		

						and one unidentified herbicide
2012.	Croatia	25	Infants and preschool children	0		anticoagulant rodenticide, organophosphates, copper pesticides, glyphosate, diquat
2012.	Croatia	5	School children and adolescents	0		
2012.	Croatia	104	Adults	0		
2013.	Croatia	42	Infants and preschool children	0		anticoagulant rodenticides, organophosphates, glyphosate
2013.	Croatia	3	School children and adolescents	0		
2013.	Croatia	77	Adults	0		
2014.	Croatia	33	Infants and preschool children	0		glyphosate and chlorophacinone
2014.	Croatia	6	School children and adolescents	0		
2014.	Croatia	86	Adults	0		
2015.	Croatia	43	Infants and preschool children	0		Total (glyphosate), Deherban (2, 4-D), an unspecified herbicide, and an unspecified rodenticide
2015.	Croatia	5	School children and adolescents	0		
2015.	Croatia	87	Adults	0		
2016.	Croatia	40	Infants and preschool children	0		Metasystox (oxydemeton-methyl), Lindane, herbicides Lumax (terbuthylazine, mesotrione, s-metolachlor), Cidocor (glyphosate), Faciron (chlorophacinone), bromadiolone, and an unspecified pesticide
2016.	Croatia	12	School children and adolescents	0		
2016.	Croatia	90	Adults	0		
2017.	Croatia	36	Infants and preschool children	0		Glyphosate
2017.	Croatia	7	School children and adolescents	0		
2017.	Croatia	54	Adults	0		
2018.	Croatia	37	Infants and preschool children	0		Gamacid (diazinon), Ekatin (thiometon), Ekalux (quinalphos), Total (glyphosate), Phostoxin (aluminium phosphide), a pesticide with an unknown trade name containing
2018.	Croatia	7	School children and adolescents	0		
2018.	Croatia	81	Adults	0		

						aluminium phosphide and an unknown pesticide for fox pest control
2019.	Croatia	29	Infants and preschool children	0		glyphosate, dimethoate, bromadiolone, mesotrione, S-metolachlor, terbuthylazine, lambda cyhalothrin
2019.	Croatia	8	School children and adolescents	0		
2019.	Croatia	81	Adults	0		
2020.	Croatia	19	Infants and preschool children	0		herbicides containing nicosulfuron and glyphosate and an unspecified rodenticide
2020.	Croatia	3	School children and adolescents	0		
2020.	Croatia	59	Adults	1		

Annex III. Overview of human poisoning incidents in North Macedonia.

Date/Period	Location *(municipality, local community)*	No. of poisoned individuals	Age of individuals poisoned	No. of individuals with fatal outcomes	Type of poisoning *(accidental, misuse/improper use of poisonous substances, intentional poisoning)*	Substance used
2010	N. Macedonia	3	toddler (1-4)	-	-	Organophosphate pesticides
		11	child (5-14)	-	-	
		5	adolescent (15-19)	-	-	
		37	adult (20-74)	-	-	
		1	senior (above 75)	-	-	
		13	-	-	-	Carbamate pesticides
2011	N. Macedonia	2	child (5-14)	-	-	Organophosphate pesticides
		1	adolescent (15-19)	-	-	
		13	adult (20-74)	-	-	
		0	senior (above 75)	-	-	
		15	-	-	-	Carbamate pesticides
2012	N. Macedonia	4	child (5-14)	-	-	Organophosphate pesticides
		2	adolescent (15-19)	-	-	
		28	adult (20-74)	-	-	
		2	senior (above 75)	-	-	
		3	-	-	-	Carbamate pesticides
2013	N. Macedonia	5	adolescent (15-19)	-	-	Organophosphate pesticides
		35	adult (20-74)	-	-	
		6	senior (above 75)	-	-	
		3	-	-	-	Carbamate pesticides
2014	N. Macedonia	13	adult (20-74)	-	-	Organophosphate pesticides
		1	senior (above 75)	-	-	
		14	-	-	-	Carbamate pesticides
2015	N. Macedonia	17	adult (20-74)	-	-	Organophosphate pesticides
		2	-	-	-	Carbamate pesticides
2016	N. Macedonia	1	toddler (1-4)	-	-	Organophosphate pesticides
		1	adolescent (15-19)	-	-	
		11	adult (20-74)	-	-	
		2	-	-	-	Carbamate pesticides

2017	N. Macedonia	6	adult (20-74)	-	-	Organophosphate pesticides
		1	-	-	-	Carbamate pesticides
2018	N. Macedonia	1	adolescent (15-19)	-	-	Organophosphate pesticides
		4	adult (20-74)	-	-	
		1	senior (above 75)	-	-	
2019	N. Macedonia	1	toddler (1-4)	-	-	Organophosphate pesticides
		12	adult (20-74)	-	-	
		1	senior (above 75)	-	-	
2020	N. Macedonia	5	adult (20-74)	-	-	Organophosphate pesticides

Annex IV. Overview of human poisoning incidents in Serbia.

Date/Period	Location *(municipality, local community)*	No. of poisoned individuals	Age of individuals poisoned	No. of individuals with fatal outcomes	Type of poisoning *(accidental, misuse/improper use of poisonous substances, intentional poisoning)*	Substance used
2015	Vojvodina	20	/	2	/	/
2016	Vojvodina	10	/	0	/	/
2017	Vojvodina	12	/	0	/	/
2018	Vojvodina	15	/	0	/	/
2019	Vojvodina	10	/	1	/	/

Annex VII. Questionnaire

QUESTIONNAIRE

CONTRIBUTOR INFORMATION	
Country:	
Organisation:	
Address:	
Telephone:	
E- mail:	
Webpage:	
Name and position of person providing the information:	
E-mail of the person providing the information:	

Please specify to the best of your knowledge how many poisoning incidents of humans, which occurred due to improper or illegal use of pesticides and other plant protection substances, have occurred in your country, their location, number of people affected, and other relevant information presented in the table below.

No.	**Date/Period**	**Location** *(municipality, local community)*	**No. of poisoned individuals**	**Age of individuals poisoned**	**No. of individuals with fatal outcomes**	**Type of poisoning** *(accidental, misuse/improper use of poisonous substances, intentional poisoning)*	**Substance used**

1							
2							
3							
4							
5							

** please add new rows for more incidents if needed.*

Contributor information for relevant governmental institutions	
Country:	
Institution:	
Address:	
Telephone:	
E- mail:	
Webpage:	
Name and position of person providing the information:	
E-mail of the person providing the information:	