STUDY REGARDING THE IDENTIFICATION OF THE WATER POLLUTION SOURCES AND FACTORS ON THE SIRET RIVER IN THE BACAU-MARASESTI SPAN

MĂDĂLIN-IONUȚ ROTARU1*, VALENTIN NEDEFF1, ALEXANDRA-DANA CHIȚIMUȘ1, EMILIAN FLORIN MOȘNEGUȚU1, NARCIS BĂRSAN1

1“Vasile Alecsandri” University of Bacau, Calea Marasesti 157, Bacau, 600115, Romania

Abstract: The main pollution sources of the Siret river and its tributaries in the Bacau-Marasesti span are submitted in the present study. The Siret River, through the watershed it forms, is one of the largest tributaries of the Danube. Thereby Siret river through its water volume outlet for the Danube River, which crosses our country, is considered a major pollution agent for the surrounding areas of the river from a social, economical and agricultural point of view.

Keywords: pollution sources, Siret River, accidental pollution, industrial activities

1. INTRODUCTION

Water pollution represents the modifying actions, directly or indirectly, of the natural composition of the water in such a manner that it can not be used for its intended purpose (Figure 1) [1-6].

The indirect water pollution happens when the pollutants are inputted in the environment through anthropic changes [5]. An example of this type of water pollution is when the fertilizer from the fields is transferred in a water body by precipitations damaging the aquatic ecosystem [7]. Many causes of water pollution, including sewage leaks and fertilizers, contain nutrients such as nitrates and phosphates [8]. When these pollutants exist in high levels the growth of algae and water plants is overstimulated, and the overgrowth of this type of organisms

* Corresponding author, email: dana.chitimus@ub.ro
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lead to the silting of the water courses, consume oxygen while they decompose and block the access of the light in the depth of the water body [8]. Water pollution is also caused by the sludge and suspended solids, such as soil, destruction of agricultural areas, construction works and sawmills, urban areas, and shore erosion when it rains.

The direct water pollution occurs when harmful substances are emitted directly into water [5].

It is considered that pollutants are formed by solid, liquids or gaseous substances that when they are in water can produce negative effects on plants, domestic animals or materials. Pollutant impurified waters are also called wastewaters [1, 2]. Most important sources of water pollution are presented in Figure 2 [9].

![Fig. 2. Main sources of water pollution [9].](image)

Major pollution problems from the cities are often created through the refuse storage in the water or near water bodies [5]. An obvious alternative method of water pollution control to modify the discharge flow path of the wastewaters to the fields. Such methods of nonaqueous wastewaters storage could eliminate many problems regarding water pollution and in certain cases could create secondary benefits such as groundwater restoration and an increase of crops [5]. While experiencing these methods, there have been noticed secondary benefits such as improved tree growth, field productivity and the improving of the general state of the environment. The reuse of the wastewaters is one of the key methods of optimal natural water resource use [9].

Water pollution sources can be classified into two categories [2] and these is:

- by the action of the pollutants in time, pollution sources can be classified in:
  1. Permanent pollution sources (continuous, e.g. city and industry sewage);
  2. Discontinuous pollution sources, temporary (e.g. colonies, isolated buildings);
  3. Accidental pollution sources (e.g. reservoir or installations damages).

- by the origin of the pollutants (Figure 3), pollution sources are classified in:
  1. Organized pollution sources, which are represented by wastewaters originating from different activities such as:
     - domestic wastewaters that originate from the use of water in living spaces, public institutions, public baths, washrooms, schools, commercial units and public alimentation. It is considered that the daily requirement of fresh water for a person is about 100 L. These waters are polluted by organic substances (detergents, pesticides, oil products), mineral substances (chlorides, ammonia), pathogens and parasites.
     - industrial wastewaters that originate from different manufacturing processes and from the worst type of water pollution. The most important feature of these wastewaters is the large variety of pollutants and their high harmful. Main industrial sources of water pollution are:
       a. Mining industry (preparation of the metallic and nonmetallic ores, extraction and preparation of coal, of the radioactive ores). These wastewaters contain a high level of heavy
metals, particles in suspension, organic products used in the flotation stage, radioactive substances;

b. Metallurgy, which produces wastewaters polluted with insoluble suspensions, heavy metals, phenols, cyanides and sulfates (45 m³ per ton of cast iron);

c. Chemical industry, which produces wastewaters that contain suspensions, acids, hydroxides, salts, phenols, dyes, detergents, pesticides;

d. Pulp and paper industry, the wastewaters originated contain organic substances, sulfur compounds, dyes with lignin;

e. Food industry, discharges in the water organic substances, nitrogen compounds, fats, pathogens (150 m³ for ton of sugar or 10 m³ for the preparation of a ton of meat).

- agrozootechnical wastewaters originated from:

  a. agriculture, which contain fertilizers, suspensions, pesticides, herbicides, fungicides and pest repellents;

  b. zootehnics, which contain organic substances, pathogens, hormones or growth inhibitors, dewormers.

2. Unorganized water pollution sources which produce a diffuse pollution, hard to find and control and are represented by rainfall and snowfall, which through the washing of the atmosphere and the contaminated soil may contain organic or mineral substances, pathogens, parasites, toxic substances, radioactive substances.

The pollution of rivers and lakes is usually invisible because the pollutants are dissolved in the water [1]. There are exceptions such as detergents that produce spume, oil products that float on the surface or a series of dyes that color the waters. All the pollutants can be detected in laboratories through biochemical standardized tests. From these tests, we can know the pollution level and the relative purity of the water [1].

![Fig. 3. Water pollution sources classification by the origin of the pollutants](image)

Very few natural pollutants exist [1]. The soil contains some fertilizers such as nitrates that during the agricultural works or winters can migrate to the surface. In the soil, we can also find phosphates, aluminum, magnesium that can cause difficulties to the aquatic life [1]. These natural or semi-natural pollutant leaks are insignificant in comparison to those made by humans.

Farmers input in the environment a large variety of chemicals among such as: herbicides, insecticides, acaricides, fungicides, pest repellents, growth hormones and animal dewormers which, taken together, which contain more than 450 chemicals called biocides [10]. The spread phosphates, nitrates and complex fertilizers on fields in order to stimulate the plant growth and they lead to toxic liquid leaks from silos and animal farms.

The industry and transport cause some other pollutants among which the most important are : heavy metals such as cadmium, lead and zinc, exhaust gases resulted in the burning of the fossil fuels or from the engines of the
mean of transportation, dust, and powders [11]. Once they reach the water, the heavy metals penetrate the meat of the fish, which are eaten by humans and are made very sick.

Also the aquatic birds that consume vegetation, fish, and contaminated water also have high levels of heavy metals, fact that causes death or the intoxication of humans that consume their meat [11].

Water pollution can also be identified in the form of the organic materials that are inputted in the water through different leaks, leaves, and other vegetal refuse. When bacteria and protozoa from the water decompose this organic material, they start to use the oxygen from the water [9]. Many species of fish and abyssal creatures can not survive when the level of oxygen falls under 5 part per million (ppm). When this decrease happened at the same time, a decrease in the number of aquatic organisms could be noticed which leads to the breakage of the trophic chain. There are three more types of water pollution, and these are oil action, radioactive substances and the influence of heat [5].

Increase of domestic wastewater volume is usually linked to a higher demand for water, in a drought season, and it strongly affects the water resource and can lead to a water shortage [5]. It is a paradox because the communities that have water shortages will in the same time discharge a high quantity, millions of liters of water in the water flows for rapid flows and evacuation. The waste from the commercial agents are collected and stored on the ground, this leading to the pollution of water through leaks and leachate. In order to control these events, it is necessary to have settling tanks, biological treatment limited in anaerobic and aerobic lagoons, and a diversity of other methods [5].

The industrial wastewater features can contain differences both intra and interindustrial. The industrial discharge impact depends not just on collective features, such as biochemical oxygen consumption and the quantity of suspended solids, but also on the specific quantity of organic and inorganic substances. The agriculture and animal breeding field (chicken, pigs, cattle, sheep), is the source of numerous organic and inorganic pollutants that affect the surface and underground waters [5]. These contaminants include both sediment that originate from the erosion of the crop fields and compounds of phosphorus ant nitrogen that originate from the commercial fertilizers and animal manure. The refuse and animal manure contains materials that have a high demand for oxygen, nitrogen and phosphorus for their decomposition and they often contain pathogens [8].

The more polluted the water source the higher the risk of the evaporation of the pollutants in the atmosphere together with the water, leading to the increase of air pollution and to acid rains. Additionally, pollutants from the water can easily migrate in water creatures, which are consumed by land animals and somewhere in the food chain it reach the people [5].

2. FACTORS AND SOURCES FOR SIRET RIVER POLLUTION IN THE BACAU-MARASESTI SPAN

2.1. Characterization of the Siret River watershed

Siret River springs from the Woody Carpathian Mountains situated in the region North Bucovina (today known as the Cernauti region of Ukraine), at an altitude of 1238 m, travels 706 km (of which 596 km on the territory of Romania and 110 km on the territory of Ukraine) and overflow in the Danube (Figure 4), near the city of Galati, at an altitude of 5 m. It is considered the most important tributary of the Danube, with a multiannual flow, in the merging point with the Danube, of about 250 m³/s and represents the largest watershed on the territory of Romania. The Siret watershed is neighboring to the west with the Somes-Tisa, Mures, and Olt watersheds, in the south with the Ialomita-Buzau watersheds, and in the east with the Prut watershed [12].

Economic and social development is linked to the current state of development of the existing economical branches: industry and agriculture. In the region of large cities and towns the industrial branches are developed according to the specific natural resources: wood industry, paper, and cellulose industry, chemical industry, petrochemical industry and electric and thermal energy industry. Animal breeding is developed mostly in the northern regions, and the arable lands, of about 906.300 ha, are cultivated mostly with corn, wheat, potatoes, etc. [12].
2.2. Main pollutants of the Siret river in the Bacau-Marasesti span
Main possible pollutants of the Siret basin in the Bacau-Marasesti span are (with the activity domains, Figure 5) [12]:
- CRAB Bacău – water treatment;
- AMURCO Bacău – fertilizers production;
- Nicolae Bălcescu City Hall – services (wastewater);
- Agricola International Nicolae Bălcescu – animal breeding;
- RAFO Onesti – oil industry;
- CHIMCOMPLEX Borzesti – petrochemical industry;
- SGCL Sascut – water treatment;
- Water Canal Onesti – water treatment;
- CAROM Onesti – petrochemical industry;
- SNP Petrom Moinesti – oil industry;
- SC Conpet SA Ploiești divizia Moinesti – oil industry;
- Dărmănești City hall – services (wastewater);
- Târgu Ocna City Hall – services (wastewater);
- Oituz City Hall – services (wastewater);
- Dofteana City Hall – services (wastewater);
- VRANCART Adjud – paper industry;
- ILGO Mărășesti – services (wastewater).

2.3. Main pollution factors of Siret basin in the Bacau-Marasesti span
Looking on the list shown above, the pollutants, we can notice that the following industrial domains can be found among the Siret river pollutants:
- Oil industry;
- Chemical and petrochemical industry;
- Wastewater treatment plants;
- Paper industry;
- Zootechnics.

These industrial activities input in the environment, and especially in the water, the following pollutants:
- Oil industry – refined and raw oil products, hydrocarbons;
- Chemical and petrochemical industry – oil products, hydrocarbons;
- Wastewater treatment plants – wastewaters with a low content (but different from the natural level) of detergents, different level of CCO-Cr, CCO-Mn, organic materials suspensions, pH, coliforms etc.;
- Paper industry – wastewaters with a low content (but different from the natural level) of detergents, different level of CCO-Cr, CCO-Mn, organic materials suspensions, pH, coliforms etc.;
- Zootechnics – wastewaters with a low content (but different from the natural level) of detergents, different level of CCO-Cr, CCO-Mn, organic materials suspensions, pH, coliforms and animal manure.

So, the pollutants listed above can damage the environment as following [13-16]:
- Oil products, hydrocarbons – can pollute water and soils. Waters are polluted at the surface, due to the fact that oil products do not mix with water, for a depth that varies from a few millimeters, in some areas, to a few meters. Also, the underground waters can be polluted from soil infiltration and leading to rendering the water undrinkable.
- Soil is directly polluted through the deposition of raw or refined products, solid or semisolid and indirectly by the vapour emissions, originating from the preparation of the raw oil products, which reach back the soil by rainfall ant the action of environment factors (wind, gravitational force);
- Detergents – may pollute waters and through infiltration soils. Detergents pollute water sources from the discharged wastewaters and cause the following effects: cause a lower sedimentation rate of substances in suspension, increase the decantation speed of particles larger the 25 μm, benefit the suspension of finely divided substances, increase soil permeability and favour other pollutants infiltration. Detergents have both toxicological (on humans and other living creatures), and ecotoxicological effects (on the environment) because of surfactants and conditioning agents. The lethal dose for an adult is 1-10 g/kg of body. Detergents exist in the water sources, in quantities that reach 100mg/L from wastewaters originating from washrooms, 10 mg/L in municipal wastewaters, 5 mg/L in surface waters and 2.5 mg/L in some underground water sources.
- CCO-Cr, CCO-Mn, Organic material suspensions - All these pollutants led to a low water oxygenation and increased algae and water plants growth thus leading to riverbeds silting.
- Animal manure – pollute water both through the pathogens they contain and also because they have a high content of phosphorus and nitrogen, two elements that require a high level of oxygen consumption for assimilation.

Fig. 5. Main possible pollutants of the Siret basin [12].
3. ACCIDENTAL POLLUTIONS IN THE SIRET RIVER BASIN

According to existing information regarding accidental pollution (Figure 6), from Siret river basin, in the period 2002-2013 have been identified the following cases of pollution [17-27]:
- In 2002, 18 cases of accidental pollutions have affected the surface waters that came from Siret river tributaries (p. Tazlau, p. Trotus);
- In 2003, five accidental pollution situations were recorded in Moinesti within the Petrom oil platform;
- In 2004, a single case of accidental pollution with a significant impact on the Moinesti oil platform;
- In 2006, two cases of accidental pollution have been recorded in Doftana and Albotesti areas that originated from broken/cracked pipes that belong to SNP Petrom Moinesti;
- In 2007, a single case of accidental pollution noticed on the Tazlau river;
- In 2008 four cases of pollution were found, of which three from SNP Petrom Moinesti and one from SC Conpet SA Moinesti;
- In 2009, there have been eight cases of accidental pollution of the Siret River tributaries within the divisions/departments of SN Petrom (Doftana, Moinesti, Comanesti, Lucacesti, Zemes, Urmenis river);
- In 2010 seven accidental pollution cases were identified, all with insignificant impact, caused by the oil industry (SN Petrom, RAFO Onesti, SC OMV Petrom SA);
- In 2011 three situations of accidental pollution were recorded for OMV Petrom SA, but they had a insignificant feature and have originated from the old age of oil product transport networks;
- In 2012 three cases of pollution (soil, water) were recorded and they originated from the oil industry companies SC Conpet SA and SC OMV Petrom SA;
- In 2013, a single case of accidental pollution has been recorded, and it originated from SC OMV Petrom SA.

4. CONCLUSIONS

Water pollution within the Siret river basin, and especially in the Bacau-Marasesti span, can have a significant impact mostly in accidental cases.

Water pollution can be avoided through:
- Prevention of accidental oil products and hydrocarbons leaks from tanks by building reservoirs with multiple layers of protection;
- In case of accidental leaks to proceed in notifying the specialized state agencies as well as preliminary intervention using absorbent materials and by removing the affected soil for treatment and further elimination with the help of a specialized and authorized economical agent;
- Granting the building/location permit for the oil and petrochemical domain only in areas with low risk of contamination (e.g. areas with deep underground waters, hard soils with low permeability, at a sufficient distances from water courses)
- Wastewater treatment at the highest levels and standards, using only treatment plants that are approved for outputting the water quality features required for input in natural sources;
- Close supervision of discharged wastewaters in natural sources by regularly taking water samples and analyzing them weekly, two times a week or monthly according to the activity domain;
- Avoiding the discharge of treated wastewaters directly in the natural water source by building intermediary tanks that can collect treated waters, and discharged only after specific laboratory test are made;
- If an authorized economical agent collects the wastewaters, it is necessary to supervise the final destination of these waters in order to prevent unauthorized discharges;
- Animal manure shall be eliminated through a authorized agent that can store them and use in the energy/recycling method.

REFERENCES

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