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HYDROECOLOGICAL PROBLEMS OF THE CHICAGO RIVER

The Chicago River is a navigable river (Fig. 1), which originally flowed into Lake Michigan after being formed by north and south branches about 1 mile (1.6 km) west of the lake, in Chicago, northeastern Illinois, United States. Chicago's river system includes 156 miles (251 km) from Park City (in the north) to Lockport (in the south); about 45 bridges span the river [6].

Fig. 1. **Chicago River**

The Chicago River is a significant feature in Chicago's urban landscape, not only because of its physical presence, which runs through the heart of the city, including the Chicago Loop, but also because of its historical and geographical significance [9]. Despite its relatively modest length of 251 kilometres, the river has played a key role in establishing Chicago's geographical importance. This is mainly due to the Port of Chicago, which serves as a crucial link between the

Great Lakes and the Mississippi River basin, and by extension the Gulf of Mexico. This connection has historically facilitated transportation, trade and economic growth, making the river not just a waterway but a cornerstone in Chicago's development into a major urban centre and a key player in regional, national and international networks.

Lake Michigan is the source of the Chicago River's main flow. Water enters the river through locks at the Chicago River Locks, with a small additional flow provided for boat passage between the river and Lake Michigan through the Chicago Harbour Lock. The river surface elevation is maintained at 0.5 to 2 feet (0.15 to 0.61 m) below Chicago City Datum (579.48 feet (176.63 m) above sea level), except when there is excessive stormwater runoff into the river or when the lake level is more than 2 feet below Chicago City Datum. Acoustic velocity meters at the Columbus Drive Bridge and the T. J. O'Brien Lock on the Calumet River monitor the redistribution of water from Lake Michigan to the Mississippi River Basin, which is limited to an average of 3,200 cubic feet (91 m^3) per second per year over the 40-year period from 1980 to 2020 [6].

The main environmental problems of the Chicago River are: loss of biodiversity; water pollution, including excess nutrients; significant flow regulation; and bank erosion. Let's take a closer look at each of these problems.

Loss of biodiversity and habitats. Like many ecosystems, the Chicago River and its watershed were once home to a great diversity of aquatic organisms. Some of these organisms are no longer found in the area at all, while others are present in minimal numbers. For example, black bears once frolicked by the river, and a variety of orchids inhabited the prairies and forests. This is no longer the case. The decline in biodiversity is mainly due to habitat loss and the fragmentation of large wilderness areas into small plots of land. Habitat loss and fragmentation are the result of human population growth, agriculture and urbanisation. Additional causes of biodiversity loss include invasive species (species, usually from other countries, that invade ecosystems and displace native species) and

overharvesting by humans. Solutions to this problem include the conservation of natural areas and the restoration of natural areas, which in turn involves the removal of invasive species and the planting of native species [4].

Water pollution and excess nutrients in the river. The Chicago River suffered greatly from industrial discharge prior to the passage of the Clean Water Act of 1972. Although this law dramatically reduced pollution from specific sources, many toxins (including heavy metals) remain in the river, especially in sediment. Toxic substances continue to enter the river through pollution from diffuse sources (pollution that does not originate from a specific source but from the entire catchment area; such as leaching of chemical fertilisers, pesticides, oil, etc.). Many toxins can accumulate (build up in the tissues of organisms) and biomagnify in the food chain (organisms higher up the food chain receive higher doses of toxins by eating many organisms containing lower doses). Ways to address this problem include cleaning up sediments, reducing pollution from dispersed sources, and banning the consumption of fish from the river [1].

Excess nitrogen and phosphorus can have a negative impact on a water body. When these nutrients enter the water, they cause an explosion in the algae population. Algae block light from entering the water, which leads to the death of aquatic plants. When a large number of algae die, they sink to the bottom and join the dead plants. The decomposing bacteria begin to consume the large amount of dead organic material at a high rate. During the decomposition process, the bacteria use large amounts of oxygen through cellular respiration and release carbon dioxide and other gases. This reduces the amount of oxygen in the water. Fish and other aquatic animals begin to die, providing more material for the bacteria to decompose. In extreme cases, the water body can become almost oxygen-free and thus lifeless.

Over time, water bodies naturally tend to become eutrophic due to the movement of sediment and organic material. This natural eutrophication does not lead to rapid ecosystem collapse. However, cultural eutrophication refers to the rapid eutrophication of a water

body due to the addition of nutrients from human activities. For example, chemical fertilisers from farms, lawns and golf courses, livestock and pet waste can be washed or dumped into water bodies, thus causing cultural eutrophication. Solutions to this problem include: limiting the use of chemical fertilisers and proper waste disposal.

Excessive faecal coliform bacteria. Fecal coliform bacteria are an indicator species that warn of the presence of faecal matter in water. These bacteria are not pathogenic, but are almost guaranteed to indicate the presence of pathogenic bacteria in faeces. Fecal coliform bacteria in water can be naturally occurring, originating from faeces of animals living in the river, or introduced into water bodies through the presence of untreated sewage that is not disinfected.

South of Dempster, Chicago has «mixed sewers», which means that all the water that runs off homes, buildings, factories, and plants is mixed with rainwater and goes into one pipe underground. The mixed sewer pipes carry the water to a treatment plant so it can be cleaned before being returned to the river. When it rains heavily in the Chicago area, huge amounts of water are poured into the combined sewers. Because there are few places for water to infiltrate the ground, most of it ends up in road runoff. When the mixed sewers and sewage treatment plants are overloaded, the excess water is diverted to huge tunnels and reservoirs underground. These tunnels are known as «Deep Tunnel» or TARP (Tunnel and Reservoir Project) [10]. When these tunnels and tanks fill up, untreated water is released directly into the Chicago River without any treatment. This is known as a mixed sewer overflow. This is one of the main reasons why beaches on Lake Michigan are often closed. Ways to address this problem include restoring natural areas, installing rainwater barrels, and creating rooftop gardens. Reducing water use at home during storm events can also help [7].

Erosion of the river banks. The banks around the Chicago River are heavily eroded in many places. Wooded areas of the river have trees that almost fall into the water. In addition, when sediment is eroded, it is washed into the river, reducing visibility for aquatic life, clogging

aquatic gills and burying bottom-dwelling aquatic life. Erosion is a direct result of runoff. Rainwater that falls on our catchment can either run off over the ground, reaching the river quickly, or it can infiltrate the soil and move through it, slowly reaching the river. Water that moves over land can erode the land it flows over. As the land in a catchment becomes anthropogenised - as forests, prairies and wetlands are converted into roads, houses, offices, shopping centres and car parks-less and less water can infiltrate the ground. Consequently, more water runs off the land. In natural areas, 10% of rainfall runs off on the ground compared to 55% in urban areas. 50% of rainwater infiltrates the ground in natural areas, compared to 15% in urban areas.

With more rainwater running off quickly on the ground, huge amounts of water reach the river very quickly. For example, a major rain storm on 13 October 2011 caused the Chicago River at Touhy Avenue to rise from 3.5 feet to just over 9 feet in a matter of hours. This large volume of water has the power to severely erode the banks of the river. Solutions to this problem include: reducing runoff and planting native vegetation to stabilise the river banks [3].

Regulation of the Chicago River flows. Dams are a major environmental problem around the world. On a large scale, dams can cause flooding upstream and lower water levels downstream. There are several dams on the Chicago River [6]. Although they do not usually cause flooding and drying up, they do block fish migration along the river. This is very detrimental to biodiversity recovery, especially when fish can return due to improved water conditions. Ways to address this include: removing dams where possible and installing fish ladders and waterfalls to allow for favourable migration around dams [3].

There are many places on the Chicago River that people do not have access to because of fences, walls, or dense rows of non-native shrubs. In order for people to feel connected to and care about the river, they need to be able to interact with it. People need to see beavers and herons in the river or take a canoe trip past Chicago's magnificent architecture to truly appreciate the river as a natural resource [5]. Ways to address this problem include: supporting the ongoing development

of a continuous walking path along the river, encouraging the city municipality to improve access to the river, and organising public tours of the river.

The Chicago River has experienced a lot of negative publicity throughout its history. There are many people who still remember its smelly black water and the large amounts of garbage floating down the river. Many people do not realise the significant improvement in the river's cleanliness, the restoration of its banks and the return of a wide variety of organisms to its waters. Although the situation has improved, the river still needs a lot of help. People cannot offer help if they do not know what to do or how to act [8]. Ways to address this issue include: informing the public about the «new face» of the Chicago River, encouraging participation in river and watershed restoration activities, helping people understand how their daily actions harm the river, writing letters to state and local governments to increase funding for river cleanup efforts [6].

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ПРОБЛЕМИ ПРИРОДОКОРИСТУВАННЯ БОРСУКІВСЬКОЇ ТЕРИТОРІАЛЬНОЇ ГРОМАДИ ТА ШЛЯХИ ЇХ ВИРІШЕННЯ: ГЕОЕКОЛОГІЧНИЙ ВИМІР

Актуальність дослідження. Сучасні процеси розвитку територіальних громад потребують аналізу тих базових геоекологічних проблем, які виступають гальмом їх узгодженого розвитку. Серед них проблема оптимального землекористування та емісії парникових газів, збору та утилізації твердих побутових відходів та відведення стічних вод, сприятливості природних умов проживання населення та охорони природи тощо. Наявність