Circular Economy Lab & Observatory

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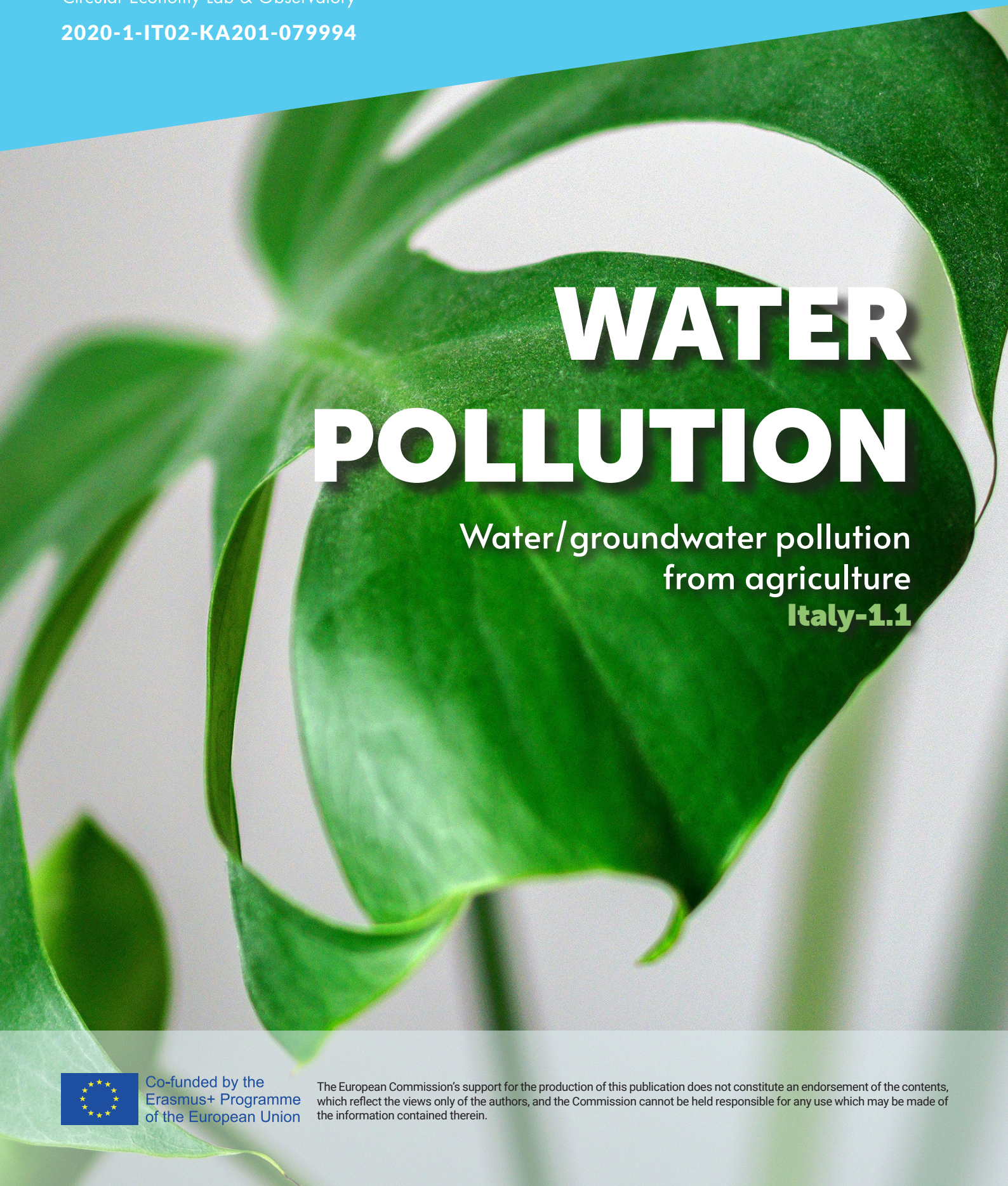

WATER POLLUTION

Water/groundwater pollution from agriculture

Italy-1.1

Co-funded by the Erasmus+ Programme of the European Union

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Introduction

Water is the base of life on Earth and covers over 71% of its surface. About 97% of it is salt water consisting mainly of seas and oceans; the remaining 3% is fresh water. Only a small amount of freshwater is directly available for humans in the form of surface water (rivers, lakes, wetlands), because most of freshwater is in the "solid" form (icecaps and glaciers, 66.7%), and about 30% is existing below the surface as groundwater. [1-2]
Water is usually classified into fresh and salt water, but it can also be classified according to its chemical physical and biological characteristics.

Fertiliser dissolved in water, used in a greenhouse - Photo by Karolina Grabowska, https://www.pexels.com/it-it/cerca/inquinamento%20dell\'acqua%20per%20agricoltura/

Although water is abundant on the planet Earth, fresh water is a limited resource, especially in some regions.

Fresh and clean water is even more rare.

Strictly speaking, there is no pure water in nature, that is, a molecule formed by two atoms of hydrogen and one atom of oxygen.

"Due to the unique water properties, which make it an universal solvent, water in nature always contains some quantities of dissolved gases, minerals and microorganisms. Water containing low levels of suspended or dissolved solids, low levels of dissolved adverse gases, as well as low biological content, is considered to be clean, or water of high quality." [1]

Water is clean or not relatively clean according to its use. For example a source of water could be of good quality for irrigation, but could not be good for human consumption. Water pollution is one of the most significant problems of modern times. The problem of water pollution didn't always exist, but with the growth of population, urbanisation and the growth of industrial activities waste started to build up (especially in big cities and urban areas in general) and most of it ended up near water bodies.

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We can identify three types of water pollution:

- civil pollution: when wastewaters from our homes end up into rivers or into the sea without or with inappropriate treatment;
- industrial pollution: when harmful substances used in industrial processes are discharged into water bodies;
- agricultural pollution: mainly linked to an excessive or improper use of pesticides and fertilisers that pollute surface water and that can reach underground water. [3]

Agriculture needs a lot of clean water - Photo by Greta Hoffman, https://www.pexels.com/it-it/cerca/inquinamento%20dell\'acqua%20per%20agricoltura/

Agriculture is often responsible for damaging the environment, but can also be affected by civil and industrial pollution, as water used for irrigation can be polluted as well. Currently, it is estimated that some 2 250 km^3/year of effluent is discharged into the environment, 330 km^3/year as urban wastewater, 660 km^3/year as industrial wastewater (including cooling water) and 1 260 km^3/year as agricultural drainage. [10]

Problem's description

How land and water are linked

Precipitation that falls on land completes the cycle of fresh water and results in either runoff or groundwater. Phosphorus fate is different, since it travels bound to soil particles, that can travel big distance before being deposited in fresh water sediments. [5]

Agriculture accounts for 70% of total water consumption worldwide and is the single-largest contributor of nonpoint- source pollution to surface water and groundwater. Pollution caused by agriculture can contaminate water, food, fodder, farms, the natural environment and the atmosphere. Pesticides and fertilizers used in agriculture can contaminate both groundwater and surface water, as can organic livestock wastes, antibiotics, silage effluents, and processing wastes from plantation crops.

Agriculture as a user of marginal quality water With increasing demand for agricultural commodities, farmers are increasingly looking to non-conventional water sources of marginal quality, including wastewater. The unsafe use of non-conventional water sources – especially wastewater – in agriculture can lead to the accumulation of microbiological and chemical pollutants in crops, livestock products and soil and water resources, and ultimately to serious health impacts for exposed food consumers and agricultural workers; it may also exacerbate antimicrobial resistance.

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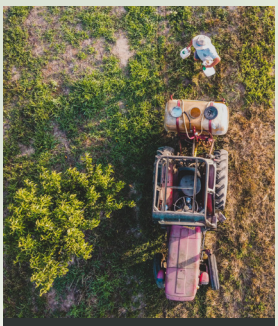

Fertiliser used in a field - Photo by Czapp Árpád, https://www.pexels.com/it-it/cerca/pesticidi/

The main causes are:
Pesticides and Fertilizers
The main source of pollution are fertilisers and pesticides, once these chemicals have been sprayed some of them mix with water while the rest gets absorbed by the plants. As a result the crops that are supplied with this water get contaminated, but also the water that runs off from the fields.
Contaminated Water
Part of the clean and pure water we use is polluted with organic compounds and heavy metals, these substances tend to dissolve in the crops and contaminate them.

Livestock
Cattle, sheep, pigs, chickens and other animals, if they are kept in large numbers and in relative small spaces (intensive farming) contribute to wastewater. wastewater are not limited to manure, but come from other processes as: milking wash water, egg washing and processing, slaughterhouse wastewaters.

Heavy Metals
Heavy metals are a big problem in water pollution and in agriculture, because not only they accumulate in the soil and poison livestock but they also leach into groundwater sources or get absorbed by the plants and get consumed by animals and humans.

Organic Contaminants
Manure and Biosolids often contain nutrients, including nitrogen, carbon and phosphorus. In addition, because they are industrially processed, they may also contain contaminants such as personal care products and pharmaceuticals.

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Pestisides sprayed by man - Photo by Gilmer Diaz Estela, https://www.pexels.com/it-it/cerca/pesticidi/

Land Management

Deep land management is crucial to keep agricultural pollution to a minimum. Therefore, farmers need to be aware of how their actions can impact the environment.

Excess Nutrients

Excess nutrients can have serious consequences for water quality and the survival of aquatic life. The result is the species composition of the respective ecosystems. The most common consequence is eutrophication, which depletes the amount of dissolved oxygen in the water, and as a result can kill fish and other aquatic life. [6]

Possible solution

On-farm practices in crop production, livestock and aquaculture are crucial for preventing pollution. In crop production, management measures for reducing the risk of water pollution due to organic and inorganic fertilizers and pesticides include limiting and optimizing the type, amount and timing of applications to crops. [7] Establishing protection zones along surface watercourses, within farms and in buffer zones around farms, have been shown to be effective in reducing pollution migration to water bodies. Also, efficient irrigation schemes will reduce water return flows and therefore can greatly reduce the migration of fertilizers and pesticides to water bodies.

The best way of mitigating pressures on aquatic ecosystems is to avoid or limit the export of pollutants. Simple offfarm techniques, such as riparian buffer strips or constructed wetlands, can cost-effectively reduce loads entering surface water bodies. Buffer strips are a well-established technology.

Vegetated filter strips at the margins of farms and along rivers are effective in decreasing concentrations of pollutants entering waterways. Integrated systems in which crops, vegetables, livestock, trees and fish are managed collectively can increase production stability, resource use efficiency and environmental sustainability.

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Integrated farming ensures that waste from one enterprise becomes inputs to another, thereby helping to optimize the use of resources and reduce pollution. Before any action, to design cost-effective measures for preventing pollution and mitigating risks, managers, planners and lawmakers need to know the state of aquatic ecosystems, the nature and dynamics of the drivers and pressures that lead to water-quality degradation, and the impacts of such degradation on human health and the environment.

Buffer strips among different crops - Photo by Anil Sharma - https://www.pexels.com/it-it/cerca/fasce%20tampone%20ripariali%20%20agricoltura/

Farmers often unknowingly cause harm to the environmental system. They should be taught that the excessive use of fertilizer and pesticides has a huge adverse impact on the whole ecosystem.
Thus, by increasing the farmers' knowledge and awareness, agricultural pollution can be mitigated to a certain degree.
They must know:
Applying the right quantity of pesticides and fertilizers that are necessary to get a reasonable crop yield. Using cover crops to prevent bare ground when the actual harvest is over, thus preventing soil erosion and loss of waterways.

Planting grasses, trees and fences along the edges of a field that lies on the borders of water bodies. They could act as buffers, and nutrient losses can be avoided by filtering out nutrients before reaching the groundwater. Reduction in tillage of the fields in order to reduce runoffs, soil compaction and erosion.

Animal or cattle waste is a big cause of agricultural pollution. The management of these pollutants is crucial. Several manure treatment processes need to be put in place, in order to reduce the adverse impact of manure on the environmental system. [6]

A farmer in his greenhouse - Photo by João Jesus https://www.pexels.com/it-it/cerca/agricoltori%20/

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Conclusions

As we know water is very important , because without it we would not survive. With the increase of agriculture water gets more and more polluted. Agriculture contributes both to the pollution of surface water and groundwater.

While wastewater from our houses and industries can be easily collected via sewers, the pollutant that are used in agriculture, mainly pesticides and fertilisers, are carried out from the fields directly in rivers, lakes, and eventually in the oceans, but they also find a way to infiltrate through the soil to reach the groundwater. Some contaminants are not easily removed from the water even if water is treated properly in a wastewater treatment plant, for instance, antibiotics. More advanced techniques for the removal of these contaminants are required, and many traditional (and old) plants are not equipped with this technology.

Farmers are working near a river - Photo by Soumik Mohanty https://www.pexels.com/it-it/cerca/agricoltori%20/

Considering the intensive use of antibiotics for the livestock in intensive farming, large amounts of these contaminants are to be found in the manure.

Farmer is collecting new crops - Photo by Anna Tarazevich https://www.pexels.com/it-it/cerca/agricoltori%20%20con%20pesticidi/

If not removed, they will end up into water bodies. But is it not simpler to just reduce or eliminate the need for antibiotics in the first place? This is another reason to prefer food from farms where animals grow up with enough space so as to avoid the possibility of spreading diseases and so the need for lots of antibiotics and other drugs.

In comparison to groundwater, surface water can be more easily polluted because it is in closer contact to contaminants.

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So the best option is to prevent the flow of these substances in the water instead of trying to treat contaminated water. Using less, or nothing at all, of pesticides and fertiliser could be the optimal solution. Organic farming and in general sustainable agriculture avoid the use of pesticides and other non-natural substances, using other strategies to optimise the crop yields.

Protection of water bodies can be also achieved by creating buffer zones or constructed wetlands around the fields where significant amounts of harmful substances are being used. There are many techniques for water remediation, both for groundwater and surface water, but these techniques are usually expensive and they are used primarily for the remediation of waters contaminated by industrial activities.

Constructed wetlands (CWs) and ecological floating beds (EFBs) are methods that can be used to degrade some organic pollutants from surface water, EFBs combine phytoremediation and microbiological bioremediation. To treat groundwater, things usually get more complicated and more expensive.

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GROUP

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