



Impacts of Science Popularization of Chemical Pollution on Public Environmental Protection Behaviour

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Abstract. Chemical pollution has become a global environmental challenge, threatening ecosystem stability and human health in many ways. The classification characteristics and environmental behaviours of chemical pollutants are discussed systematically in this paper. The sources, migration and transformation laws and ecological effects of gaseous, liquid and solid pollutants are analysed emphatically. Studies have shown that gaseous pollutants, liquid pollutants diffuse and accumulate in the aquatic environment through hydrological cycles, and solid pollutants remain in ecosystems for a long time due to their refractory characteristics. As an important tool of environmental governance, chemical pollution science popularization has constructed a knowledge system including pollutant characteristics, environmental behaviour, health risks and prevention measures through diversified subject cooperation and all-media channel integration. The influence of popular science communication on public environmental protection behaviour presents a multi-dimensional mechanism, including cognitive enhancement, emotional awakening, responsibility internalization and behaviour guidance, which finally promotes the transformation from environmental awareness to practical action.

Keywords: Science Popularization, Chemical Pollution, Public Environmental Protection Behaviour

1 Introduction

Chemical pollution has become a global environmental problem, and its threat to ecosystems and human health is increasingly significant. With the rapid development of industrialization and urbanization, various chemical substances are widely used in production, life and consumption. These substances not only bring convenience, but also cause serious environmental pollution. Persistent organic pollutants, heavy metals and other harmful chemicals persist in the environment for a long time and accumulate through the food chain, posing profound impacts on biodiversity and public health. The multiple consequences of chemical pollution, including disruption of the natural ecological balance, loss of biodiversity and increased risks to human health, combine to highlight the urgency of environmental governance [1].

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D. Magni et al. (eds.), *Proceedings of the 2026 3rd International Conference on Applied Economics, Management Science and Social Development (AEMSS 2026)*, Advances in Economics, Business and Management Research 389,

https://doi.org/10.2991/978-94-6239-672-2_74

Chemical pollution science popularization not only involves knowledge transmission, but also a means of social mobilization. It transforms professional environmental knowledge into publicly understandable content through multiple channels and forms, arousing environmental awareness and guiding daily behaviour choices. Such communication activities can help the public to recognize the links between individual behaviour and environmental pollution, such as the causal links between the use of chemicals in daily life and water pollution, air pollution and soil degradation [2]. In addition, popular science dissemination also strengthens public understanding and support for policies and regulations, creating social momentum for collective environmental action.

At present, chemical pollution science popularization has become an important part of environmental protection education system. The ultimate goal is to move the public from passive information reception to proactive environmental behaviour towards sustainable lifestyles. Studies have shown that effective science popularization can significantly influence public attitudes and behavioural intentions, thereby reducing overall chemical use and emissions. Therefore, exploring the influence of chemical pollution science popularization on public environmental behaviour has important theoretical significance and practical value for achieving sustainable development goals.

2 Categories of Chemical Pollution

2.1 Gaseous Chemical Pollution

Gaseous chemical pollution refers to the pollution phenomenon caused by chemical substances existing in the atmosphere in the form of gas. This kind of pollutant mainly comes from human activities such as fossil fuel combustion, industrial production and transportation. It exists in molecular state under normal pressure and has the characteristics of diffusion with airflow, uniform distribution and wide influence range. Sulfur dioxide (SO_2) and nitrogen oxides (NO_x) are typical gaseous pollutants, which not only directly harm human respiratory system, but also chemically react in the atmosphere to form secondary pollutants such as acid rain and fine particles. Ozone (O_3), as the main component of photochemical smog, will have significant negative effects on crop growth and human health when its concentration near the ground is too high [3]. Its strong oxidation can lead to respiratory tract inflammation and plant leaf damage. Ozone depleting substances such as chlorofluorocarbons (CFCs) release chloride ions through photochemical decomposition, destroying the stratospheric ozone structure and increasing the intensity of ultraviolet radiation at the surface, thus threatening ecosystem stability. The migration and transformation processes of gaseous pollutants are complex, involving regional transport and chemical reactions, and their impact ranges often cross-national boundaries, forming regional or even global environmental problems [4]. As shown in Figure 1, gaseous pollutants released by industrial emission sources are transported over long distances through atmospheric circulation, and undergo oxidation, hydrolysis and photolysis reactions under different environmental conditions, and finally return to the surface through dry and wet deposition. A strategy

combining source control with end-of-pipe treatment is needed to control gaseous pollution, including improving combustion technology, installing desulfurization devices and promoting clean energy alternatives.



Fig. 1. Typical Picture of Gaseous Chemical Pollution (figure credit: www.163.com/dy/article/K53G45GS0538190A.html?referFrom=baidu&isFromOtherWeb=true)

2.2 Liquid Chemical Pollution

Liquid chemical pollution mainly refers to the pollution caused by chemical substances dissolved or suspended in water. Industrial wastewater discharge, agricultural runoff and urban domestic sewage are the main sources of liquid pollution. These wastewaters contain a large number of organic pollutants, heavy metal ions and nutrients, which lead to changes in physical and chemical properties of water bodies and degradation of ecosystem functions. Industrial wastewater usually contains high concentrations of toxic and harmful substances, such as benzene series, phenols and cyanide, which have direct toxic effects on aquatic organisms and enter the food chain through bioconcentration effects. Pesticides and fertilizers from agricultural activities enter the water body through surface runoff, causing eutrophication and bioaccumulation effects and disrupting aquatic ecological balance [5]. Acid rain, as a special form of liquid pollution, whose pH value is lower than that of normal rainwater, can acidify soil and water, affect plant growth and aquatic life, and lead to corrosion of building materials and forest degradation. As shown in Figure 2, liquid pollutants migrate and diffuse in the water environment through hydrological cycle, and the scene of industrial pipeline discharging wastewater into natural water body visually shows the direct impact of man-made pollution sources on the water environment. These pollutants are redistributed in the

environment through adsorption, precipitation and biotransformation, and are continuously enriched in organisms through food chains, ultimately affecting the structure and function of the entire ecosystem.



Fig. 2. Typical Picture of Liquid Chemical Pollution (figure credit: https://www.sohu.com/a/759613469_114835)

2.3 Solid Chemical Pollution

Solid chemical pollution refers to environmental pollution caused by chemical substances existing in solid form. This kind of pollution mainly includes industrial solid waste, municipal solid waste and hazardous waste, which have the characteristics of long-term retention, difficult degradation and easy accumulation. Plastic waste accumulates in the environment for a long time due to its refractory characteristics, forming a white pollution problem. The microplastic particles produced by its fragmentation are more likely to be eaten by organisms, transmitted through the food chain and pose a threat to the health of the ecosystem. Heavy metal sludge contains toxic metal elements such as lead, cadmium and mercury [6]. After accumulation in soil, these elements can be absorbed into food chain through crops, which will eventually affect human health and lead to neurotoxicity and organ dysfunction. Electronic waste contains a lot of rare metals and persistent organic pollutants, which will cause serious environmental pollution if not properly disposed of. The treatment method of solid waste directly affects the degree of environmental pollution. Landfilling may lead to soil and groundwater pollution, while incineration may produce harmful gases such as dioxin, which may aggravate the air pollution problem. As shown in Figure 3, the plastic waste accumulated on the beach vividly shows the damage of solid pollution to the natural environment. To deal with solid pollution, we need to promote the concept of circular economy, strengthen waste classification and recycling, and develop efficient and safe treatment technologies to reduce environmental risks.



Fig. 3. Typical Picture of Solid Chemical Pollution (figure credit: https://www.thepaper.cn/newsDetail_forward_27118153)

3 Popular Science Dissemination of Chemical Pollution

3.1 Dissemination Subjects

The subjects of chemical pollution science popularization are diversified, including scientists, professional scientific research institutions, government environmental protection departments, educational institutions and media organizations. Scientists, as central communicators, have a unique advantage in building public trust in chemical science by accurately transmitting expertise in chemical research processes and risk assessment [7]. Scientific research institutions such as universities and research institutes transform laboratory research results into publicly understandable content by organizing science popularization activities, such as the “Future Chemists” project carried out by Beijing University of Chemical Technology, which effectively stimulates teenagers' interest in chemistry through chemical experiment shows and interactive experiences. The environmental protection department of the government undertakes the responsibility of policy interpretation and regulatory information release in the dissemination of science popularization. For example, South County Branch of Yiyang City Ecological Environment Bureau conveys the contents of Minamata Convention and knowledge of mercury pollution hazards to the public through science popularization activities for mercury pollution prevention and control. Enterprises also pay more and more attention to the dissemination of environmental protection responsibility. Some companies display the environmental protection practice and technical achievements of chemical enterprises to the public by opening environmental protection facilities and

organizing science popularization classes [8]. All kinds of communication subjects need to strengthen cooperation and establish cooperative partnership between research and practice to overcome the cognitive dilemma and lack of resources in chemical communication.

3.2 Dissemination Channels

The dissemination channels of chemical pollution science popularization can be divided into four types: traditional media, new media, offline activities and educational institutions. Traditional media include television and radio programmes, such as Australia Broadcasting Corporation's Catalyst science programme, but chemical content accounts for a relatively small proportion of traditional media. The new media channel has become an important platform for chemical communication. British chemist Dai Wei shows chemical experiments through Short Video account of "Dr. Dai Laboratory." The single video has been played more than 15 million times, effectively reaching tens of millions of audiences. Government departments also actively use new media, and the Ministry of Ecological Environment carries out science popularization propaganda of new pollutants by means of chattering Short Video and public number release. Offline activity channels include museum science popularization exhibition, enterprise open day and environmental protection facility visit experience. Educational institutions run through formal education and informal education systems. School science courses are combined with extracurricular science popularization activities. For example, the "Future Chemists" project covers millions of primary and secondary school students in more than 20 cities across the country through more than 300 experimental shows and more than 100 hands-on experiments. Different communication channels have their own advantages, so they should be integrated and utilized according to the characteristics of the audience and the communication target to improve the overall effect of chemical science popularization communication.

3.3 Dissemination Contents

The content system of scientific popularization of chemical pollution mainly covers four core dimensions: pollutant characteristics, environmental behaviour, health impact and prevention measures. Pollutant characterization includes basic properties, source classification and toxicity mechanisms of chemical substances. The environmental behaviour content mainly involves the diffusion mechanism, morphological change and ecological effect of chemical pollutants in the atmosphere, water and soil, with special emphasis on the biomagnification phenomenon of pollutants transmitted through the food chain and its long-term impact on the ecosystem structure [9]. The health effects section focuses on the dose-response relationship between chemicals and human health, including acute toxic symptoms and chronic health risks, such as the effects of endocrine disruptors on the reproductive system, the pathogenesis of carcinogens and the damaging effects of heavy metals on the nervous system. The prevention and control measures include source control, process emission reduction and terminal treatment technologies, as well as interpretation of environmental policies and regulations and

public behaviour guidance. The dissemination content also pays attention to risk communication and scientific cognitive guidance, helping the public to establish rational risk cognition and avoid excessive panic or paralysis by explaining the environmental safety threshold, exposure route and protection method of chemical substances. Content design should give consideration to both scientific and popular nature, transform professional terms into language understandable to the public, maintain the accuracy and authority of information, and ensure the effectiveness and reliability of popular science dissemination.

4 Impacts of Science Popularization of Chemical Pollution on Public Environmental Protection Behaviour

4.1 Impact Mechanisms

The influence mechanism of chemical pollution science popularization on public environmental behaviour is a multi-dimensional and multi-level process, involving the interaction of cognition, emotion, behaviour intention and social norms. Firstly, science popularization promotes the public's awareness of chemical pollution through information transmission and knowledge construction mechanism. Dissemination content translates professional knowledge of chemical pollution into publicly understandable information that helps audiences understand the sources of chemical pollutants, their transport pathways and their potential harm to ecosystems and human health. This knowledge construction not only enhances public perception of environmental risks, but also lays a rational foundation for subsequent behaviour change. Popular science communication inspires the public's environmental motivation through emotional awakening and risk perception mechanism [10]. The explanation of the serious consequences of chemical pollution in the process of communication can arouse the audience's worry, sympathy and even sense of crisis, thus strengthening its internal drive to take environmental action. This combination of emotional response and risk perception has prompted the public to shift from passive information to active attention to environmental issues and willingness to work to reduce chemical pollution. Popular science communication shapes public environmental behaviour through social norms and responsibility internalization mechanism. Communication content often emphasizes collective responsibility and social expectations for environmental protection, making the public aware of the impact of their own actions on the environment and considering environmental behaviour as a social responsibility. The transmission and internalization of such social norms can prompt the public to take voluntary environmental actions without external coercion, such as reducing the use of single-use plastics or participating in waste sorting. Popular science communication directly promotes the implementation of environmental protection behaviour through behaviour guidance and efficiency promotion mechanism.

4.2 Impact Models

The impact model of chemical pollution popularization on public environmental behaviour is mainly characterized by multi-path synergy. Information-driven mode constructs public cognitive foundation through systematic knowledge transmission. Popular science content transforms professional chemical pollution knowledge into understandable information, helps audiences understand the source, migration path and potential harm of pollutants. This knowledge construction provides necessary rational support for behaviour change. Emotional mobilization model focuses on risk perception and emotional arousal. The interpretation of serious consequences of chemical pollution in the process of communication can trigger the audience's worry and crisis sense, thus strengthening the inherent driving force to take environmental protection actions. This emotional response urges the public to shift from passive reception of information to active attention to environmental problems. Social norm model shapes behaviour orientation through responsibility internalization and group effect, emphasizes collective responsibility and social expectation of environmental protection, makes public regard environmental protection behaviour as a kind of social responsibility, and forms behaviour imitation and diffusion effect in social interaction. Behavioural guidance models directly provide practical solutions and effectiveness support. Popular science communication not only provides knowledge, but also provides specific behavioural guidance, such as how to choose environmentally friendly products or reduce chemical use. This guidance lowers the practical threshold for the public to adopt environmental behaviours and enhances self-efficacy by demonstrating the feasibility and effectiveness of behaviours. These models do not operate in isolation, but reinforce each other to form a collaborative network, jointly promoting the transformation process of the public from cognition to attitude to behaviour, and finally realizing the normalization and sustainability of environmental behaviour.

4.3 Impact Effectiveness

The effectiveness of chemical pollution popularization on public environmental behaviour is reflected in three aspects: cognitive enhancement, attitude change and behaviour change. At the cognitive level, science popularization effectively improves the public's understanding of the characteristics, environmental behaviours and health risks of chemical pollutants through systematic knowledge transmission, and helps the audience establish a scientific environmental risk cognition framework. This cognitive enhancement not only involves the understanding of the basic attributes of pollutants, but also includes the in-depth grasp of the migration and transformation laws of chemical substances in the environment and their ecological effects, laying a rational foundation for environmental protection behaviour. At the attitude level, popular science communication strengthens the public's attention and sense of responsibility to environmental problems through risk perception and emotional awakening mechanism, and urges the audience to shift from passive reception of information to active search for solutions. An explanation of the serious consequences of chemical pollution in the process of communication can stimulate public awareness of environmental protection, make

them pay more attention to the environmental impact of their own actions, and be willing to make efforts to reduce pollution. At the behavioural level, popular science communication lowers the practical threshold for the public to take environmental behaviour by providing concrete and feasible action guidelines, and promotes the transformation from awareness to action. The dissemination of practical information on how to reduce the use of chemicals and how to properly dispose of hazardous wastes directly guides the public in their daily behavioural choices, enabling them to translate environmental concepts into practical actions. Impact effectiveness also depends on the optimization of communication strategies, including differentiated content and formats for different audience groups, and enhanced coverage and penetration through multi-channel collaborative communication. The long-term effectiveness of popular science communication is reflected in the sustainability and stability of public environmental protection behaviour, and finally forms a sustainable public participation mechanism for environmental governance.

5 Conclusions

Chemical pollution control needs the coordinated promotion of scientific cognition and public participation. This paper reveals the intrinsic relationship between knowledge dissemination and behaviour change by systematically analysing the environmental behaviour characteristics of chemical pollutants and the mechanism of popular science dissemination. Transregional transport of gaseous pollutants, bioaccumulation effects of liquid pollutants and long-term environmental retention of solid pollutants highlight the complexity and urgency of chemical pollution control. As a bridge connecting professional knowledge and public cognition, popular science communication provides a new idea for improving environmental governance efficiency by its diversified subject cooperation and all-channel integration mode. In the future, science popularization of chemical pollution should pay more attention to the accessibility of communication contents, optimize the pertinence and interaction of communication strategies, and strengthen the organic combination of knowledge transmission and behaviour guidance. Through continuous and innovative science popularization practice, promote the formation of a new pattern of environmental governance, and finally realize effective prevention and control of chemical pollution risks and sustainable development of ecological environment.

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