Committee: Environment Sub-Commission 1

Issue: Eradicating Nanopollution

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INTRODUCTION

Nanopollution is a pollutant deriving from nanotechnology – which is the study of extremely small dimensions and particles (1-100 nanometers in size) and may be used in all scientific fields. Nanotechnology is seen as a breakthrough in science as it already has allowed us to achieve something as simple as sunscreen being able to reflect harmful ultraviolent radiation and even ranging to medical application. Scientists are also hoping, in the near future, to develop nanomaterials that will change the taste of food, batteries that will last for decades and even a lightweight space aircraft that could potentially lower the cost and time needed to go to space.

This relatively new form of nanotechnology has been conducted for about 30 years now and has bought about great benefits to our everyday life; however, there still are unknown issues about this topic, with its unclear long-term effects being the primary one. Nanotechnology has also brought about nanopollution, which involves all the waste products created during the manufacture of nanoscopic particles. For example, “fullerene”, which is a molecular sphere of carbon, is used in the manufacture of sports equipment and many other devices. This carbon molecule is non-biodegradable and can therefore end up in an ecosystem and have an unclear long-term effect on both us humans and the surrounding environment. In addition to this, nanoparticles are extremely hard to isolate, due to their microscopic size, which makes it hard to measure their concentration in the environment. The social repercussions of nanotechnology stem from its reduced workforce requirements: If this form of technology becomes more popular in the future, it will certainly lead to higher unemployment rates. In addition, it is expensive to research into it and even more expensive to buy nanotech machines, leaving Less Economically Developed Countries (LEDCs) out of this new science. Finally, nanotechnology has allowed easy accessibility to the creation of atomic weapons, making them more powerful and more destructive.

DEFINITION OF KEY TERMS

Nanoparticle [7]

"A nanoscale particle" which is approximately 1-100 nanometers in size. More specifically, "in nanotechnology, a particle is defined as a small object that behaves as a whole unit with respect to its transport and properties." Three types of nanoparticles have been found, namely a natural nanoparticle produced naturally particularly in volcanic eruptions, incidental ones such as emissions from engine combustion and engineered ones, which are created artificially.

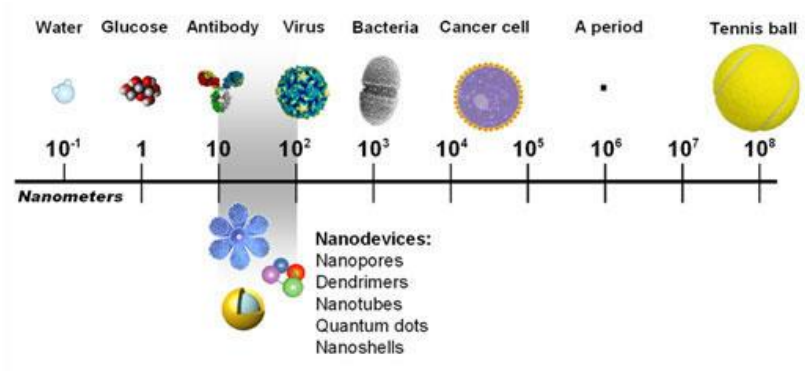

Figure 1: Diagram illustrating the size of a nanoparticle

Nanotechnology[8]

Nanotechnology has been directly defined by the Oxford Dictionary as "the branch of technology that deals with dimensions and tolerance of less than 100 nanometres, especially the manipulation of individual atoms and molecules." Examples of uses of nanotechnology may include: "additives to composite material" such as baseball bats and tennis rackets making them stronger and lighter, "nanoscale thin films" on computer/phone screens making them waterproof, antimicrobial and scratch resistant and nanoscale additives on the surface of fabrics aiding to help them resist wrinkling, staining and bacterial growth, all of which are just few examples of the many uses of nanotechnology.

Pollution[9]

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[7] Definition taken from: Article Title: Nanoparticles: Properties, Classification, Characterization, and Fabrication
https://www.novapublishers.com/catalog/product_info.php?products_id=18755

[8] Definition taken from Oxford dictionary,
examples of nanotechnology taken from
http://www.nano.gov/you/nanotechnology-benefits

[9] Definition taken from Oxford dictionary

Pollution is generally defined as the "environmental contamination of man-made waste." This contamination may be responsible for causing unfavourable change towards the environment and therefore impacting our everyday lives. The most common forms of pollution may include noise, air and water pollution.

Nanopollution[10]

The resulting product after the manufacturing of nanodevices, which may not be decomposed and is viewed as a threat to the environment.

Non-biodegradable [11]

This has been officially defined as: "Not being capable of being decomposed by bacteria or other living organisms." This means that nanoparticles, such as fullerenes, cannot be naturally decomposed and therefore become a source of nanopollution.[12]

BACKGROUND INFORMATION

Environmental Implications

Concerning nanotechnology, there is little that can be said about its impact on the environment, as it is a relatively new scientific field. Nanoparticles have higher surface areas than other materials and therefore cause more damage to the environment and the human body as it makes them more destructive. There are a few said risks of how nanoparticles may end up in the environment and as this industry expands the environmental exposure to nanoparticles also vastly increases. A few examples may include, discharge of waste streams coming from industrial plants into streams and rivers and nanoparticle discharge from the use of sunscreens and cosmetics. Seeing as nanoparticles have been circulating in nature, it is commonly hypothesized that only a toxic nanoparticle, such as fullerenes, will have a harmful effect on the environment. A prime example would be if a nanoparticle enters a river and the microorganisms find it extremely toxic: then, this would lead to a disruption in the food chain possibly causing the deaths of many species.

[10] Definition from http://www.azonano.com/article.aspx?ArticleID=3138
[11] Definition taken from Oxford Dictionary
[12]

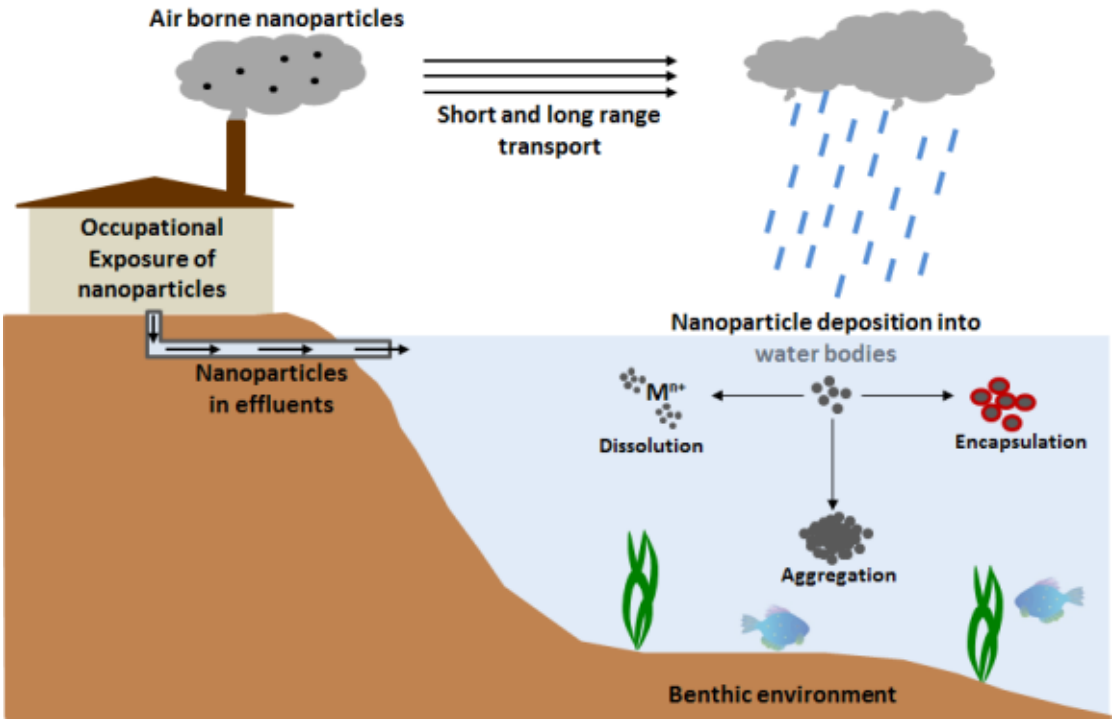

Figure 2: Diagram showing different ways in which nanoparticles may enter a stream or river.

It has also been noted that even if a nanoparticle itself is not toxic, it may still cause abrupt changes in the environment. For example, a simple nanoparticle entering a stream may change its pH. An issue such as "altering the pH of a stream can lead to metals that are not normally soluble dissolving[13]"; a prime example is aluminium, which has been known to be noxious to organisms, as it can affect their entire physiology.

It must also be taken into consideration that researchers have argued that the main environmental problem of using nanotechnology is that there is no completely reliable way of detecting the nanoparticle upon its release into the environment. This is a vital issue as it may result in unknown consequences and create complications within the scientific community.

Harmful effects on humans

Nanopollution may be just as harmful to us humans as it is to the environment. This is because smaller particles have a larger surface area to volume ratio causing them to be more reactive and once again there is no valid scientific research on how nanoparticles

[13] Environmental issue taken from: http://www.nanocap.eu/Flex/Site/Pagefdba.html?PageID=20815

interact with our biological system. Due to nanotechnologies, recent advances we are buying products containing nanoparticles everyday which thereby increases our exposure to them. Some of these products may include, sunscreens, clothing and foods/beverages containing Nano ingredients.

The easiest way for nanopollution to affect us is by inhaling a nanoparticle and end up deposited in the lungs. Their miniature size allows them to easily diffuse across any cell membrane, reach the blood and therefore end up in any organ. This may also result in lung inflammation and cardiovascular if transported to other organs. In support of this, Doctor Kevin L. Dreher observed on a mouse that after inhaling a simple carbon block particle it affected its epithelial cells causing its lungs to become less dense. If a nanoparticle enters the human body via absorption it may cause "the production of reactive molecules that could lead to cell damage". The main danger of this is that it is largely unexplored as it is unknown whether nanoparticles can enter the skin from cosmetics or from sunscreen to those who have damaged skin. Scientists are also fearing that the uptake of some nanoparticles may bring about mutations and changes in DNA/RNA strands which may have devastating and certainly unknown side effects on future generations.

It also needs to be added that all the effects nanoparticles have on the environment will also have catastrophic effects on humans, for example, if an ecosystem is ruined then we can no longer use its resources, leading to water and food shortages and make the environment more vulnerable to pollution.

Potential Benefits

Although nanotechnology may have some rather harmful effects on the environment and us humans, it has also bought about great benefits to our society, therefore it must be taken into consideration whether the risks of nanotechnology outweigh the benefits. Nanotechnology has created hundreds of real life applications making this form of technology to even be considered as "revolutionary." It also has shown potential to be able to meet some of the most strenuous challenges that face us in the world today, these including providing inexpensive solar powers and other forms of alternative energy. This may prevent us from using up fossil fuels which are costly and air/water pollutants and contribute to global warming. It may also assist the UN and NGOs into helping to provide clean drinking water to LEDCs in need, as nanotechnology offers "inexpensive water

purification, due to rapid, low cost impurity detection". They may also aid in cleaning up brownfields such as oil spills and some nanoparticles have antimicrobial properties. In addition, they help in reducing other forms of pollution as they have already provided "lighter cars and machinery that requires less fuel."[14]

Aside from all these benefits, there have also been increased social and medical benefits, as nanotechnology has allowed for more medical applications of nanoparticles, which have changed the lives of thousands of people. For example, a way to spur the growth of damaged nerve cells is already been tested on hamsters and gold nanoparticles are being used to detect early Alzheimer's disease, all of which are illnesses that before were considered incurable. In addition to this, nanoparticles may also be used in drugs to make them more effective and with less side effects, there will also be improved MRIs to help optical detection up to 1,000 times better which will therefore, help us see specific kinds of cells. However, it needs to be noted that these medical advancements with nanotechnology are only available to More Economically Developed Countries (MEDCs).

MAJOR COUNTRIES AND ORGANIZATIONS INVOLVED

This form of science has no international law for the regulation of Nano products and in addition to this there are also no "agreed protocols for the toxicity testing of nanoparticles" and "no standardized protocols for evaluating the environmental impacts of Nano particles"

United States of America

The USA spends almost $300,000,000 annually on nanotechnology, surpassing China by almost triple the amount of money. The USA is the world's leader in this field of science, and has contributed greatly on the funding of nanotechnology, including the creation of the National Nanotechnology Initiate (NNI). The US is not only interested in nanotechnology due to the technological advancements it provides but also because it can provide them with new ways to improve their military warfare.

[14] Examples taken from http://www.nano.gov/you/nanotechnology-benefits

South Korea

Currently in South Korea many universities are opening and allowing scientists to explore with nanotechnology in the hope of releasing new medicines and electric cars. South Korea adopted the Nanotechnology Development Plan in 2001, which aimed to build necessary equipment to allow South Korea to place in the world's top in advances of nanotechnology. South Korea has a Ministry of Environment which is aiming to explore all the risks and implications of nanotechnology as well as to find ways to completely eradicate nanopollution. An example of this is their "Nanomaterial Safety Supervision Plan" where approximately 14billion Euros were invested into the creation of a "supervision system" to ensure the limitation of risks deriving from nanotechnology.

European Union

The European Union (EU) has been increasingly concerned with the fact that there are unknown side effects and implications of nanotechnology, which could potentially result in very harmful effects towards humans and the environment. The "Scientific Committee on Emerging and Newly Identified Health Risks" The EU has also increased the level of its funding and has "now become the largest single funding agency in the world"

Germany

Germany has been researching and funding nanotechnology for over 30 years, since nanotechnology became more frequent in the early 2000s, the German government initiated the "Nan Initiative-Action Plan 2010" whereby its aims where to, develop new industries, recognize the risks of nanotechnology, find methods of handling nanoparticles responsibly, and raise awareness of the issue to the public.

National Nanotechnology Initiate (NNI)

The NNI is world's biggest NGO when coming to involvement with nanotechnology. As stated above, it was introduced by the US and gets a vast fund of 1.64 billion USD annually. The NNI is currently in co-operation with 25 federal agencies, including the National Science Foundation, the National Institutes of Health and the National Institute of Standard and Technology. The NNI has established the Nanotechnology Environmental and Health Implications (NEHI) whereby its aims are to "protect public health and the environment." An important action taken to reach the stated aims is the cooperation with governments and other NGOs to exchange information and develop ways to research on the environmental

and health implications of nanotechnology. So far, the NNI has produced significant accomplishments when coming to its aims as it has helped scientists progress their research with nanotechnology and has released updated strategies to ensure the safe use of nanotechnology.

TIMELINE OF EVENTS

Date	Description of Event
1981	The "scanning tunneling microscope" is invented allowing scientists for the first time to see and study individual atoms
1999	Huge advancement in nanotechnology as Cornell University scientists publish the "secrets of chemical bonding by assembling a molecule"
1999-2003	Nanotechnology products started appearing in the market causing a high demand and more products in need for manufacturing
2000	US President launches the "National Nanotechnology Initiative (NNI)" which would support responsible and sustainable development of nanotechnology and worldwide nanotechnology research.
2003	Nanotechnology Congress funded the NNI and thereby, enacted the "21st Century Nanotechnology Research and Development Act" providing a foundation for the NNI to start researching potential negative aspects of nanotechnology.
2004	Britain's Royal Academy publishes "Nanoscience and Nanotechnologies: Opportunities and Uncertainties" raising awareness of the vital need to keep in mind environmental, social and ethical issues when dealing with nanotechnology.
2008	The first official NNI "Strategy for Nanotechnology-Related, Environmental, Health and Safety (EHS) Research" was published.
2014	NNI releases the "Progress Review on the Coordinated Implementation of the NNI 2011 Environmental, Healthy, and Safety

	Research Strategy"[15]

UN INVOLVEMENT: RELEVANT RESOLUTIONS, TREATIES AND EVENTS

As this is a new issue, nanotechnology has not received adequate attention from the UN. Some important UN regulations regarding this topic are following:

- United Nation's Annual Report of the Global Environment 2007 / Emerging challenges - nanotechnology and the environment.
- Science and Technology for development, 2010/3
- NNI 2014 Environmental, Health, and Safety (EHS) Research Strategy

POSSIBLE SOLUTIONS

One of the most important measures that need to be taken to limit or completely combat nanopollution is to fund further research into the matter, as it is a new form of technology. However, it should be taken into consideration that this research will be expensive and is most likely to help eradicate nanopollution in the long-term. For example, scientists should research the different behavioral patterns of nanotechnology in the environment and in the laboratory. In addition to this, geographical areas, which are more in threat of nanopollution, should be identified and prioritized. A way of effective containment should also be established. This will be used to both store nanoparticles and help prevent accidents and spills. Another way to help prevent nanopollution is to carry out a life cycle assessment to analyze and evaluate the possible effects of nanopollution on an organism. Similarly, a full risk assessment (including exposure risk) on the safety of human health and the environmental impact needs to be carried out at all stages of nanotechnology to find out all the unknown risks of nanotechnology.

A more short-term possible solution would be the prevention of actions that would require large quantities of nanotechnology until scientists figure a way to prevent nanopollution and discover all its possible effects on the environment. Raising awareness of this issue will also be of some help as we would help the public more in deciding whether

[15] More information on the stated strategy: http://www.nano.gov/node/115

they are in favor or against this issue. The aim of this would be using the media and nanolabelling to target all audiences to get research funds and educate the public of the possible effects nanotechnology may have soon (as current nano-involved businesses make a lot of profit and, therefore, try to prevent the public from knowing the unknown consequences of nanoparticles). Since this is an issue with no agreed international law and produced nanotechnologies will enter international trade, it is also necessary to unify the standards of nanotechnology across borders. However, an important aspect that should be considered is whether the benefits of nanotechnology far outweigh the threats of nanotechnology and therefore it needs to be discussed whether we should keep on researching into nanotechnology or completely eradicate it. [16]

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