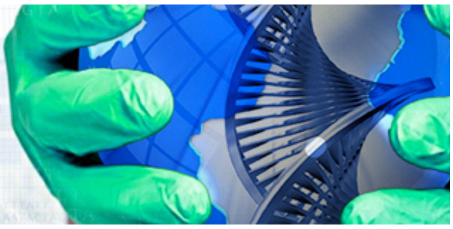
FACT SHEET
14 January 2015

# The environmental impacts of nanomaterials



## What are nanomaterials?

Nanomaterials are objects with one or more dimensions, or surface structures, on the nano-scale. The nano-scale ranges from approximately 1-100 nanometres - with one nanometre being one billionth of a metre.

## Unknown risks

Scientists are only just beginning to understand the potential risks associated with releasing nanomaterials into the environment. The European Environment Agency argues "there are still critical gaps in our knowledge that need to be addressed in EHS [Environment, Health and Safety] research programmes."[1] A recent report by the US National Research Council observed that "environmental, health, and safety (EHS) research efforts are not keeping pace with the increasing and evolving applications of nanotechnology, and uncertainty persists about the potential effects of these materials on the health of consumers, workers, and on ecosystems."[2]

## The use of nanotechnology is expanding rapidly

Despite growing evidence of potential harm, hundreds of thousands of tonnes of nanomaterials are already being released into our soils, water and atmosphere. It was estimated that in 2010, 260,000–309,000 tonnes of global nanomaterial production ended up in landfills (63–91%), soils (8–28 %), water bodies (0.4–7 %), and the atmosphere (0.1–1.5 %). More accurate estimates of nanomaterial emissions were hampered by the lack of available data on use. [3]

The French Government's nano-register revealed the use of over 500,000 tons of nanomaterials and 3400 different nanomaterial based products in France alone in 2012.[4] The register's 2013 report identified the use of significant quantities of nanomaterials in agricultural chemicals. This will invariably lead to their accumulation in soil, plants and water. [5]

## Negative impacts on plants

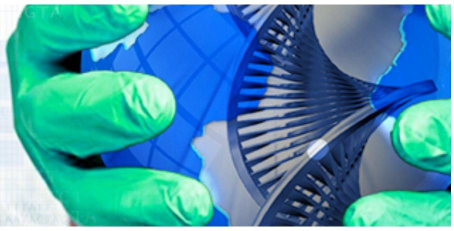
The negative effects of exposure of plants to nanomaterials include growth inhibition, oxidative stress, altered photosynthesis, genetic damage and compromised agronomic and yield characteristics.[6]

## Adverse effects of nanomaterials in soil

Emissions of nanomaterials to soils represent up to about 25 per cent of the material flows, mostly from the disposal of biosolids onto agricultural land.[7] This is concerning, since studies have shown that nanomaterials can potentially harm beneficial soil microorganisms, plants, nematodes and earthworms and prevent nitrogen fixation.[8] In Australia, we produce approximately 300,000 dry tonnes of biosolids annually. Approximately 55 per cent of this is applied to agricultural land. The quantities of nanomaterials used in agricultural chemicals in Australia are unknown as they are unregulated.

A 2013 study found adverse impacts on plants and microorganisms in a long-term field experiment following the application of sewage biosolids containing a low dose of nano-silver.[9] The nano-silver treatment also led to an increase in nitrous oxide ($N_2O$) fluxes. This is significant since $N_2O$ is a notorious greenhouse gas, with 296 times the global warming potential of $CO_2$. It is also the dominant ozone depleting substance.

A European study suggests that, like other metal nanoparticles, the low mobility of nano-silver in soil and repeated applications of sewage sludge containing nano-silver can cause it to accumulate in soil.[10]



## Impacts on aquatic organisms

The fact that as much as 7 per cent of nanomaterial emissions end up in water bodies is also of concern given their potential toxicity to aquatic organisms. A 2013 review found that silver, copper oxide and zinc oxide nanoparticles are toxic to fish, algae and crustaceans.[11]

## Human health concerns

The release of nanomaterials into the environment may also have implications for human health. A recent US study concluded that the use of nanoparticles in consumer products is resulting in nanoparticles in drinking water sources and that treatment may not remove them.[12]

While the uptake of nanomaterials in the edible tissues of a variety of food plants has been shown in a number of studies, a recent review concluded that research is so limited that the "the risk posed to humans consuming these food products is completely unknown."[13]

## Urgent regulatory action is needed

In 2004 the United Kingdom's Royal Society recommended that given the evidence of serious nanotoxicity risks, nanomaterials should be treated as new chemicals and subject to new safety assessments before being allowed in consumer products. It also recommended that releases of nanomaterials to the environment should be avoided as far as possible until it could be demonstrated that the benefits outweighed the risks.[14]

In Australia the overwhelming majority of nanomaterials remain effectively unregulated.[15] Seven different federal agencies have responsibility for various aspects of nanotechnology: FSANZ, NICNAS,TGA, APVMA, ACCC, Department of the Environment and Safe Work Australia. States have legal responsibility for nanomaterials in waste streams, but have thus far not taken any steps to assess or regulate those environmental impacts. To date there is not even an agreed legal nanomaterial definition between agencies.

---

## What needs to happen?

Friends of the Earth is calling for:

1. A nano-register to allow the tracking of nanomaterials through the supply chain and risk assessments to be conducted;
2. A moratorium on the commercial release of products containing nanomaterials until testing has determined that they are safe;
3. The labelling of all products containing nanomaterials to allow consumer choice.

---

[1] Hanson, S.F. *et al.* (2013) Nanotechnology – early lessons from early warnings, from *Late lessons from early warnings: science, precaution, innovation,* EEA Report No 1/2013.
[2] NRC (2013) Research Progress on Environmental, Health, and Safety Aspects of Engineered Nanomaterials, http://dels.nas.edu/report/research-progress-environmental-health/18475
[3] Keller, A.A. *et al.* (2013) Global life cycle releases of engineered nanomaterials, *J Nanopart Res,* 15:1692.
[4] Publication d'un premier bilan du dispositif national de déclaration des substances à l'état nanoparticulaire, http://www.developpement-durable.gouv.fr/spip.php?page=article&id_article=35990
[5] Rapport d'étude (2013). Éléments issus des déclarations des substances à l'état nanoparticulaire
[6] Deng, y. *et al.* (2014) Interactions between engineered nanomaterials and agricultural crops: Implications for food safety. *J. Zhejiang Univ-Sci A (Appl Phys & Eng)* **15**(8):522-572, p560
[7] Keller, A.A. *et al.* (2013)
[8] Ruitenberg, R. (2013) Earthworm Health Hurt by Nanoparticles in Soil in Alterra Study, *Bloomberg*, www.bloomberg.com/news/2013-01-29/earthworm-health-hurt-by-nanoparticles-in-soil-in-alterra-study.html; Unrine, J.M. *et al.* (2013) Trophic transfer of Au nanoparticles from soil along a simulated terrestrial food chain, *Environ Sci Technol.*, **46(17):**9753-9760; Priester, J.H. (2012) Soybean susceptibility to manufactured nanomaterials with evidence for food quality and soil fertility interruption, *PNAS*, 109(37): 14734-14735.
[9] Colman, B.P. *et al.* (2013) Low Concentrations of Silver Nanoparticles in Biosolids Cause Adverse Ecosystem Responses under Realistic Field Scenario, *PLOS ONE,* 8(2):1-10.
[10] Schlich, K. et al. (2013) Hazard assessment of a silver nanoparticle in soil applied via sewage sludge, *Environmental Sciences Europe*, **25**:17
[11] Bondarenko, O. *et al* (2013) Toxicity of Ag, CuO and ZnO nanoparticles to selected environmentally relevant test organisms and mammalian cells *in vitro*: a critical review, *Arch Toxicol,* 87:1181–1200.
[12] Abbott Chalew T.E. *et al.* (2013) Evaluating Nanoparticle Breakthrough during Drinking Water Treatment, *Environmental Health Perspectives*, **121(10)**:1161-1166.
[13] Deng, y. *et al.* (2014) Interactions between engineered nanomaterials and agricultural crops: Implications for food safety. *J. Zhejiang Univ-Sci A (Appl Phys & Eng)* **15**(8):522-572, pp. 553, 559 564
[14] UK Royal Society/Royal Academy of Engineers (2004) *Nanoscience and nanotechnologies: opportunities and uncertainties*, London.
[15] Friends of the Earth (2014). Nanotechnology regulation in Australia. http://emergingtech.foe.org.au/wp-content/uploads/2014/10/Nanotechnology-Regulation-Fact-Sheet.pdf