**Global Biodiversity Sub-Committee (GBSC)**

Meeting papers

# Nanotechnology and biodiversity: an initial consideration of whether research on the implications of nanotechnology is adequate for meeting aspirations for global biodiversity conservation

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**Discussion paper for the Global Biodiversity Sub-committee of the Global Environmental Change Committee**

From the Organisation for Economic Co-operations and Development (OECD) website:

Nanotechnology is the set of technologies that enables the manipulation, study or exploitation of very small (typically less than 100 nanometres) structures and systems. Nanotechnology contributes to novel materials, devices and products that have qualitatively different properties. Its advances have the potential to affect virtually every area of economic activity and aspect of daily life.

Nanotechnologies are likely to offer a wide range of benefits, including in helping address a range of societal and environmental challenges, e.g. in providing renewable energy and clean water, and in improving health and longevity, as well as the environment. However, unlocking this potential will require a responsible and co-coordinated approach to ensure that potential challenges are being addressed at the same time as the technology is developing.

## A summary of some[1] current activities that focus on understanding the possible benefits and impacts on biodiversity of nanotechnology

1. *International coordination and collaboration:*

### a. Consideration of nanotechnology by CBD

To date, there has been minimal explicit consideration within CBD of the possible impacts on biodiversity from nanotechnology development, and hence no clear recommendations emerging on evidence requirements or possible international policy responses.

### b. Organisation for Economic Co-operations and Development (OECD)

The OECD Working Party on Nanotechnology (WPN) was established in March 2007 to advise upon emerging policy issues of science, technology and innovation related to the responsible development of nanotechnology. It is a subsidiary group of, and receives its mandate from, the Committee for Scientific and Technological Policy (CSTP).

Relevant OECD initiatives include:

[1] Please note that this briefing is not a comprehensive review of this area and other relevant activities may be underway that are not included.

- OECD Conference on Potential Environmental Benefits of Nanotechnology: Fostering Safe Innovation-Led Growth, Paris, 15-17 July 2009. This conference will cover both the opportunities and the challenges of the use of nanotechnologies for potential environmental benefit. The aim is to learn from international expertise and to identify ways in which to improve, in a timely manner, policies with the potential to enhance both short- and long-term economic growth.

- Risk governance for nanotechnology: a policy roundtable on risk governance is proposed for September or October 2009 in conjunction with the Austrian NanoTrust project annual meeting.

- Funding research on the human health and environmental safety aspects of 14 highest priority manmade nanomaterials.

#### c. DIVERSITAS

DIVERSITAS was established in 1991, with the goal of developing an international, non-governmental umbrella programme that would address the complex scientific questions posed by the loss of and change in global biodiversity. Its founding sponsors were the United Nations Educational, Scientific and Cultural Organization (UNESCO), the Scientific Committee on Problems of the Environment (SCOPE) and the International Union of Biological Science (IUBS). The science plans of the core programmes of DIVERSITAS appear to provide limited opportunity to consider risks to biodiversity from pollution, and there appears to have been no explicit consideration of nanotechnology within projects to date.

*2. EU coordination and collaboration:*

#### a. EU Framework Programme 7

One of the explicit themes identified within the cooperation activity of PF7 is nanotechnology (P7-NMP; December 2006). The environment (including climate change) theme is another of the 10 themes specified for action in the programme, all underpinned by an overarching aim to contribute to sustainable development. ERA-Nets (see below) are one of the supporting activities funded through FP7.

The nanotechnology theme has an overarching objective of improving the competitiveness of European industry and generating knowledge to ensure its transformation from a resource-intensive to a knowledge-intensive industry. Within its listed activities is impact on human safety, health and the environment, including the environmental compatibility of materials. However, the focus of the first call on this activity has been on continued development of technology, building on previous FPs. The focus of projects on impacts appears to be predominantly around human health.

Within the environment theme, activities aiming to improve knowledge, and its exchange, on pressures on the environment and climate cover possible impacts on the environment from

nanotechnology. The theme also includes an activity around assessment of environmental technologies.

**b. ERA-Nets**

There are several ERA-Nets currently involved in aspects of environmental protection, some of which include activities relating to nanotechnology.

NanoSci-ERA aims to facilitate collaboration on all aspects of nanotechnology research and includes as a specific objective the consideration of societal impacts, which encompasses *inter alia* environmental benefits and impacts (see Appendix 1 for a longer summary). The Engineering and Physical Sciences Research Council is the UK member of NanoSci-ERA.

SKEP ERA-NET (Scientific Knowledge for Environmental Protection) aims to improve coordination in research on environmental protection and deals with nanotechnology in its emerging issues work package (Appendix 1). The Environment Agency is the UK member of SKEP.

BiodivERsA (an FP6 project) has yet to focus any activity or support projects on the impacts of pollution, including nanotechnology, on biodiversity. BiodivERsA hosts a database of biodiversity research, which currently features a small number of nanotechnology related projects; including some of the UK Environmental Nanoscience Initiative (ENI) funded projects (see below under UK for more detail on ENI).

**c. Other cooperation activities under FP7**

Alongside ERA-Nets, there are a number of other knowledge exchange initiatives funded through FP7 – some examples are summarised below. These build on a number of completed cooperation activities funded under FP6, including IMPART, NANOSAFE2, NANOTOX and NANOINTERACT.

Nano health-environment commented database (NHECD): How nanoparticle toxicity (i.e. nanotoxicology) affects the health and environment of Europeans is a concern that many researchers are currently investigating. Rising to the challenge is the NHECD ('Nano health-environment commented database') project, funded under the EU's Seventh Framework Programme (FP7) to the tune of EUR 1.45 million. The ultimate objective of NHECD is to develop an open access, robust and sustainable system that can meet the challenge of automatically maintaining a rich and up-to-date scientific research repository. This repository would enable a comprehensive analysis of published data on health and environment effects following exposure to nanoparticles. The project started in December 2008.

ICPCNANONET is a web-based repository of nanoscience and nanotechnology publications, database of researchers and online forum, to inform and facilitate networking between EU and international cooperation partner country (ICPC) RTD. UK involvement is through project leadership by Stirling University.

**d. European Platform for Biodiversity Research Strategy (supported by Biostrat)**

The EPBRS includes a general section on evidence requirements for assessing the impacts of pollution in its informal discussion paper 'Biodiversity research issues of priority for Europe at the start of the 21st Century' (section 2.8; 2005), but no specific mention of developing technologies, like nanotechnology, is included. None of the EPBRS thematic meetings has covered the issue of risks to biodiversity from pollution.

*3. UK research coordination and activities:*

**a. Towards a UK Strategy**

The Royal Commission on Environmental Pollution (RCEP) undertook a review of properties of manmade nanomaterials, and possible pathways into the environment and resulting threats (Novel materials in the environment: the case of nanotechnology[2], 2008). The review looked at government coordination on nanotechnology, environmental protection, evidence, regulations and benefits. A major recommendation of the report was that a more coordinated and concerted effort is required by the Research Councils on research to assess the properties of nanomaterials and their possible environmental impacts. Another recommendation was that environmental monitoring should be the responsibility of the environment agencies in each country.

UK government responded to the RCEP report in June 2009 (Cm 7620[3]) setting out existing and planned governance and coordination activities (some of the advisory bodies involved are discussed below). The primary response to research needs is via the ENI (see below). The response also lists the 14 nanomaterials identified by OECD as of highest global priority for research on environmental and human health impacts. The UK has lead on two of these and through the PROSPEcT project is undertaking research on characterisation and likely ecological impact. Government has made a clear commitment through its response to RCEP to develop a 'UK Strategy for nanotechnologies' and will inform this by undertaking an evidence gathering exercise with stakeholders in 2009.

**b. Nanotechnology Research Coordination Group (NRCG)**

In response to a 2004 report on nanotechnology by the Royal Society and Royal Academy of Engineering, the Nanotechnology Research Coordination Group (NRCG) was set up to coordinate publicly funded research into the potential risks presented by the products and applications of nanotechnologies. Defra chairs the NRCG and the membership includes Government Departments, Regulatory Agencies and the Research Councils. BBSRC, NERC and EA are members of the NRCG, but there is no representation from the statutory conservation agencies. The group has established an Environmental Hazard and Risk Assessment Task Force, and as an early step undertaken a systematic review of research on health and environmental risks of nanotechnology (EMERGNANO[4]).

**c. Advisory Committee on Hazardous Substances (ACHS)**

[2] http://www.rcep.org.uk/reports/27-novel%20materials/27-novelmaterials.htm
[3] http://www.official-documents.gov.uk/document/cm76/7620/7620.asp
[4] http://www.safenano.org/Uploads/EMERGNANO_CB0409_Full.pdf

The Advisory Committee on Hazardous Substances (ACHS) provides expert advice on the science behind hazardous chemicals. It is made up of scientists drawn from both private-sector industries and public-sector non-governmental organisations and a lay member. The respective fields of Committee members include medicine, chemistry, ecotoxicology and other fields of science that provide a valuable contribution to the successful risk management of chemicals. The remit of ACHS was widened at the end of 2005 to cover advising on the hazard and risk posed by nanomaterials.

**d. Environmental Nanoscience Initiative (ENI)**

In recognition of the need for understanding the environmental pathways of nanomaterials and potential areas for accumulation in ecosystems, the UK has embarked on a research programme to significantly increase our knowledge base, in particular through the Environmental Nanoscience Initiative (ENI).

ENI was set up by the Natural Environment Research Council (NERC), Defra and the Environment Agency to begin to answer questions about the fate, behaviour, ecotoxicology and ecological effects of engineered nanoparticles.

In Phase 1, launched in 2006 and ending earlier this year, 17 small-scale research projects were funded covering multiple areas including ecotoxicology in freshwater and marine model systems. These projects highlighted the need for existing test guidelines to be reviewed and this is now being taken forward with the OECD. The second phase of ENI (ENI-2) is a substantial joint programme of research with the USA to produce and validate models that predict transport, fate and bioavailability of manmade nanomaterials and their interaction with biological and ecological systems.

**e. Environment Research Funders' Forum (ERFF)**

The potential risks to the environment from manmade nanomaterials have been highlighted in ERFF's horizon scanning activities (2007 report). ERFF identified a lack of leadership in this area and a significant gap in knowledge about tools to assess impacts and evidence. The Living With Environmental Change (LWEC) programme was initiated by ERFF in 2008 to undertake significant research projects on key environmental issues. One of the LWEC projects is the Collaborative Centre of Excellence in Understanding and Managing Natural and Environmental Risks - The Risk Centre – based at Cranfield University; this is likely to be the most relevant project for gathering evidence for nanotechnology risk assessment, but the current focus of research on nanotechnogy is properties and materials development.

**Conclusions**

International coordination activity appears limited, although recent initiatives by OECD should help to build better international awareness and knowledge exchange. The development of the Inter-governmental Platform on Biodiversity and Ecosystem Services (IPBES) could provide an opportunity to consider nanotechnology issues as part an overall international response to pollution pressures. It's probable that there is currently inadequate

knowledge exchange on nanotechnology impacts on biodiversity at the international level; again, an IPBES could help improve this, and there are a number of European initiatives that could contribute.

At the European level, there appears to be significant funding of nanoscience, but relatively little on research into environmental impacts; the primary focus of impact work seems to be human health. The division of environmental management issues between the nanotechnology theme (NMP) and environment theme may be hindering collaboration on research into benefits and impacts of nanotechnology on biodiversity, also leading to an overall lack of research activity. Opportunities for knowledge exchange exist through several initiatives, including ERA-Nets and other cooperation projects (building on initiatives developed under previous FPs).

Within the UK, there is now a body of research activity on impacts of nanotechnology on biodiversity, and the opportunity for new projects to be funded through currently active calls. UK government has also committed itself to develop a strategy on nanomaterials and environmental protection.

**Challenges for the UK**

At a national level, is the biodiversity conservation community appropriately engaged with activities relating to nanotechnology? [A question for UK BRAG/ Defra/ NERC/ EA?]

Is the UK a leader in research on the environmental benefits and impacts of nanotechnology, and if so is the knowledge and skills generated by this activity being adequately shared within the EU and globally?

Are we sufficiently well coordinated to understand the scope of research taking place globally that might benefit interpretation of impacts on biodiversity?

Do we have sufficient understanding of and clarity in what the highest priority evidence needs are for understanding impacts of nanotechnology on biodiversity, at the UK and EU levels?

Is there an adequate level of research on the possible benefits and impacts of manmade nanomaterials on biodiversity being funded at the EU level?

**GBSC considerations**

Is there sufficient activity ongoing to ensure that the UK is making an adequate contribution to research on the impacts of nanotechnology on biodiversity, including influencing EU spend on research, and is the knowledge generated from this activity being exchanged via appropriate international mechanisms?

Would the GBSC like to request a more comprehensive briefing from an expert engaged directly in research on environmental impacts of nanotechnology in the UK (e.g. from the ENI or from EA)?

Does the GBSC perceive a role for either itself or UK BRAG in helping UK government develop its strategy on nanomaterials and environmental protection?

*Helen Baker, JNCC*
*July 2009*

**Appendix 1: ERA-Nets relating to nanotechnology and the environment**

1. NanoSci-ERA

The main objective of NanoSci-ERA is to promote the collaboration and integration of the national research communities in nanoscience throughout the ERA (European Research Area), and thus overcome the fragmentation of nanoscience research along national or regional lines.

This focus is seen as fundamental for long-term research, for developing nanoscience as a knowledge-generating activity without topical restrictions, for allowing the emergence of strong bottom-up (community driven) thematic programmes. The interdisciplinary character of nanoscience, including physics, chemistry, materials science, biology, gives an additional dimension and challenge to NanoSci-ERA, in bringing these communities together on a European scale.

This prime objective is complemented and served by three operational objectives:

- an effective and durable coordination of the Partner and Associate organizations;
- the development of a coherent scientific policy on the multidisciplinary;
- development of nanoscience throughout the ERA a concerted outreach to the societal players.

The fifth line of action to deliver objectives: deal with issues on nanoscience in relation to society at large, its interface with the educational system, its industrial and economic impact, its relation to human health and to the environment, and the questions its uses raise regarding ethics or the protection of privacy.

UK Consortium member is EPSRC - Engineering and Physical Sciences Research Council.

2. SKEP ERA-NET

The SKEP ERA-NET (Scientific Knowledge for Environmental Protection) aims to facilitate the improvement of science into policy processes, and to support evidence-led modern regulation.

The objectives include: delivering better value for money for our research; encouraging innovation through more efficient use of research funding; and the improvement of environmental protection capability by setting down foundations for co-ordinating research programmes. The aims will be delivered through 6 work packages in the lifetime of the project, from June 2005 to May 2009.

Work package 6: Investigate emerging issues for future research planning -
A workshop on Nanotechnology, Biotechnology, Information technology and Cognitive sciences: environmental opportunities and risks of converging technologies took place on 28-29 February 2008.

UK Member is Environment Agency.