Scientific Committee on Health, Environmental and Emerging Risks

SCHEER

Statement on emerging health and environmental issues (2018)

The SCHEER adopted this statement by written procedure on 20 December 2018.

ABSTRACT

The purpose of this SCHEER statement is to draw the EU Commission Services' attention to emerging issues in the non-food area that SCHEER members have identified as having the potential to impact human health and /or on the environment in the future. The Secretariat will use this list when discussing potential new mandates with relevant Commission services.

Keywords: SCHEER, emerging issues, emerging risks, newly identified health risks, health, environment, impacts

Opinion to be cited as:

SCHEER (Scientific Committee on Health, Environmental and Emerging Risks) Statement on emerging health and environmental issues (2018), 20 December 2018.

ACKNOWLEDGMENTS

Members of the Working Group are acknowledged for their valuable contribution to this Opinion. The members of the Working Group are:

The SCHEER members:

Roberto Bertollini
Teresa Borges
Wim de Jong
Pim de Voogt
Raquel Duarte-Davidson
Peter Hoet
Rodica Mariana Ion
Renate Krätke
Demosthenes Panagiotakos
Ana Proykova
Theodoros Samaras
Marian Scott (Rapporteur)
Remy Slama
Emanuela Testai
Theo Vermeire (Chair)
Marco Vighi
Sergey Zacharov

All declarations by Working Group members are available at the following webpage: https://ec.europa.eu/health/scientific_committees/experts/declarations/scheer_en

About the Scientific Committees (2016-2021)

Two independent non-food Scientific Committees provide the Commission with the scientific advice it needs when preparing policy and proposals relating to consumer safety, public health and the environment. The Committees also draw the Commission's attention to the new or emerging problems which may pose an actual or potential threat.

The Scientific Committee on Consumer Safety (SCCS) and the Scientific Committee on Health, Environmental and Emerging Risks (SCHEER) review and evaluate relevant scientific data and assess potential risks. Each committee includes top independent scientists from all over the world who are committed to working in the public interest.

In the formulation of its policies and proposals, the Commission also relies on other Union bodies, such as the European Food Safety Authority (EFSA), the European Medicines Agency (EMA), the European Centre for Disease prevention and Control (ECDC) and the European Chemicals Agency (ECHA).

SCHEER

This Committee, on request of Commission services, provides Opinions on questions concerning health, environmental and emerging risks. The Committee addresses questions on:

- health and environmental risks related to pollutants in the environmental media and other biological and physical factors in relation to air quality, water, waste and soils.

- complex or multidisciplinary issues requiring a comprehensive assessment of risks to consumer safety or public health, for example antimicrobial resistance, nanotechnologies, medical devices and physical hazards such as noise and electromagnetic fields.

SCHEER members

Roberto Bertollini, Teresa Borges, Wim de Jong, Pim de Voogt, Raquel Duarte-Davidson, Peter Hoet, Rodica Mariana Ion, Renate Kraetke, Demosthenes Panagiotakos, Ana Proykova, Theo Samaras, Marian Scott , Remy Slama, Emanuela Testai, Theo Vermeire, Marco Vighi, Sergey Zacharov

Contact:
European Commission
DG Health and Food Safety
Directorate C: Public Health, Country Knowledge, Crisis management
Unit C2 – Country Knowledge and Scientific Committees
Office: HTC 03/073 L-2920 Luxembourg
SANTE-C2-SCHEER@ec.europa.eu

ISSN 2467-4559 ISBN 978-92-76-00231-4
doi:10.2875/840266 EW-CA-19-003-EN-N

The Opinions of the Scientific Committees present the views of the independent scientists who are members of the committees. They do not necessarily reflect the views of the European Commission. The Opinions are published by the European Commission in their original language only.

http://ec.europa.eu/health/scientific_committees/policy/index_en.htm

TABLE OF CONTENTS

1. INTRODUCTION

The primary purpose of this position statement is to draw the attention of the EU Commission Services to emerging issues in the non-food area that have been identified by the SCHEER members as having the potential to significantly impact human health and /or on the environment in the future.

Identifying emerging issues early on may greatly help for ensure a high level of public safety and environmental protection. However, the data available to correctly identify emerging issues and their impacts is inevitably likely to be very limited. It is therefore important that each issue that is identified is regularly reviewed. The SCHEER aims, therefore, to regularly review any relevant new developments and to produce an updated position statement twice during the Scientific Committee term (this term is from 2016-2021). The Committee can also submit an urgent issue to the Commission at any time. In considering emerging issues, the SCHEER would like to work closely with other EU scientific advisory committees whose mandates also include looking at emerging issues.

The SCHEER recognised the need to establish a very flexible framework to aid the correct identification of emerging issues and their potential impacts (see document 'Emerging Issues and the Role of the SCHEER, Position Paper').

SCHEER members have been asked during plenary meetings, in dedicated 'brainstorming sessions', to identify emerging/relevant issues that they think should be flagged for the Commssion Services.

The criteria used to identify an emerging issue were as follows:

- Novelty of the stressor or process
- Scale of possible impacts on man and /or the environment
- Severity of impacts for particular organisms (priority for life threatening)
- Urgency i.e. the temporal nature of the likely changes (priority for rapid increases)
- Not investigated in depth recently by a reputable scientific body
- Anticipated to be increasingly important over time

To aid this, a standardised format has been used and issues have been placed in particular categories. It is acknowledged that further consideration of some of the issues that have been identified should be led by other scientific committees.

2. FORMAT FOR DESCRIBING AN EMERGING ISSUE

A common format was proposed to describe emerging issues. This was in the format of a table in which the committee members have been asked to fill in the following:

- The topic proposed
- The author (name of SCHEER submitter)

- Sources (one or more selected items from the ones mentioned under point 1 between 1-12)
- Causative factors (one or more selected items from the ones mentioned under point 2 between a and h)
- Preliminary ranking of the hazard ((*,1, 2 or 3 where *=uncertain and 3 is high for uniqueness, soundness, severity, spatial scale, urgency, and interactions, respectively)
- Preliminary estimation of importance (*,1, 2 or 3 where *=uncertain and 3 is high)
- Description / background

1) Sources

Risks associated with:

1) Buildings and infrastructure

2) Energy and electronic communications

3) Disease evolution e.g. due to pathogen changes

4) Industrial and related activities

5) Waste processing and utilisation

6) Use of natural resources

7) Transport and storage

8) Human behaviour (socio-economic, lifestyle, perception)

9) Medical developments (technology, pharmaceuticals)

10) Environmental change

11) Product use/misuse

12) Agriculture and food

13) New materials

2) Causes / Contributing factors:

a) Technical advances opening up the prospect of new products and/or processes and/or raising concerns about waste treatment safety

b) A consequence of changes in the natural environment

c) Changes resulting from alterations in price, supply of materials and commodities

d) Changes due to alterations in legislation or public welfare measures

e) Other socio-cultural or demographic elements

f) Outcomes of research

g) Large scale illegal activities

h) Public/political concern

3. NEXT STEPS

The list will be used by the Secretariat when discussing potential new mandates with relevant Commission services.

4. ISSUES

4.1. Personal communication and listening devices

Topic	**Personal communication and listening devices**
Initiator(s)	Theodoros Samaras
Sources **Causative factors** **(see section 2 of this document)**	8, 11 a, c, e
Hazard (Rank features as 1,2,3 or *) **-uniqueness** **-soundness** **-severity** **-scale** **-urgency** **-interactions**	 1 1 * 3 1 2
Parallels with past emerging issues. Potential interactions with other stressors)	It has already been established that driving while using a portable device presents a quantifiable risk for traffic accidents. In addition, texting has been linked in the past to orthopaedic problems of hand and arm joints, as well as to more serious musculoskeletal injuries. More information: Fares *et al.* (2017). The use of personal digital devices adds to the exposure to screen light (this has been dealt with in previous Opinions about artificial light and LED exposure). Moreover, it exacerbates the problems resulting from environmental noise (also assessed in the past), especially by using high volume levels on earphones.
Preliminary Estimation of importance (*,1,2 or 3 where *=uncertain and 3 is high)	1
Background including reliability of data, a key reference if possible any other reasons for concern.	There are mainly two issues associated with personal communication and listening devices, which mostly concern young people since they constitute the main users of such devices and start to use them at an ever earlier age. The first one has to do with pedestrian safety. Distraction due to texting, listening to music or using multimedia apps can compromise cognitive and audiovisual awareness and may pose a risk for the safety of

	pedestrians (e.g. at street crossings). The second issue has to do with nearsightedness (myopia). The increased use of personal digital devices has been mentioned as a risk factor for this trend (especially in the under-40 age group). For more information: **References** 1. Schwebel D.C. *et al.* (2012). 2. Schabrun S.M. *et al.* (2014). 3. Holden B.A. *et al.* (2016).

4.2 Virtual reality

Topic	**Virtual reality**
Initiator(s)	Ana Proykova
Sources **Causative factors (see section 2 of this document)**	8, 11 a,e,f Virtual reality (VR) and augmented reality (AR) are gaining momentum as promising new technologies. They can potentially expand the field of human knowledge by changing how people learn, work, play and entertain themselves. High-tech VR and AR headsets are popping up everywhere – from the expensive ones from Samsung, Google and Facebook, to the generic cardboard headsets for the lower-end market.
Hazard **(Rank features as 1,2,3 or *)** **- uniqueness** **- soundness** **- severity** **- scale** **- urgency** **- interactions**	Health risks: anxiety, nausea, eye strain, radiation exposure. VR can have neurological effects because of its eerily realistic simulated motion. Virtual Reality (VR) sickness can cause intense discomfort, shorten the duration of a VR experience, and create an aversion to further use of VR. 3 * * 3 3 *
Parallels with past emerging issues. Potential interactions with other stressors)	Parallel with Army Aviation - Simulator sickness Environmental Social Stress
Preliminary Estimation of importance (*, 1, 2 or 3 where *=uncertain and 3 is high)	3 Considering the broad usage of Virtual Reality (from games to hospital treatment of anxiety) The hazard and risks are under investigation.
Background including reliability of data, a key reference if possible any other reasons for concern.	**References** 1. Fernandes A.S., Feiner S.K. (2016). 2. Pallavicini F. *et al.* (2013). 3. Veling W. *et al*.. (2016). 4. Jáuregui-Renaud K. (2015). 5. Cobb S.V.G., Nichols S.C., Wilson, J.R. (1995).

4.3 E-cigarette and chronic diseases

Topic	E-cigarettes and chronic diseases
Initiator(s)	Demosthenes Panagiotakos
Sources **Causative factors** **(see section 2 of this document)**	9 E-cigarettes, in their modern form, were introduced in the early 2000s as a means for smoking cessation. The e-cigarette liquid contains several chemicals, like nicotine, propylene glycol, glycerin, flavourings and others. Current research suggests that the e-cigarette aerosol contains substances that could be considered as harmful, including flavouring chemicals, metals (like lead), and other cancer-causing chemicals. There is no consistent evidence regarding the effectiveness of e-cigarettes in helping people to quit smoking. Moreover, there is a tendency in people to start vaping (e-cigarettes), instead of smoking. Compared with "regular" cigarettes, e-cigarettes may be less harmful in terms of smoking-related chronic diseases, but regarding their use compared to no smoking, the health effects are not well understood or appreciated. Moreover, taking into account that e-cigarette use is increasingly prevalent and fashionable, especially among adolescents and younger people, it can be regarded as an emerging public health issue.
Hazard **(Rank features as 1,2,3 or *)** **- uniqueness** **- soundness** **- severity** **- scale** **- urgency** **- interactions**	 2 1 * 3 3 (due to the increasing frequency of use) 3 (due to the interactions with other lifestyle determinants and psychological stressors)
Parallels with past emerging issues. Potential interactions with other stressors.	The e-cigarette has been described as a possible form of harm reduction. To date, there has been no consistent evidence that e-cigarette can significantly reduce smoking in the population, and there have not been enough studies done on the effect of (active or passive) e-cigarette exposure compared to non-smoking on human health. Moreover, cigarette smoking, in general, is known to interact with a variety of unfavourable lifestyle behaviours, like unhealthy dietary habits and physical inactivity, as well as the presence of chronic stress, leading to increased risk for cardiovascular disease, COPD and types of cancer. Taking into account that the aforementioned synergistic factors are now increasing at alarming rates and the fact that data about the effects of e-cigarette on human health are not well understood yet, the study of e-cigarette on human health is considered more important as ever before, in terms of public health prevention.
Preliminary Estimation of	3

importance (*,1,2 or 3 where *=uncertain and 3 is high)	
Background including reliability of data, a key reference if possible any other reasons for concern.	E-cigarettes have been patented since the 1960s, however, they have been available as a product from the early 2000s. The use of e-cigarettes has risen exponentially over the past 10 years; however, it is difficult to estimate its use at population level. E-cigarettes are now available in Europe and in the majority of countries in the Western world, but with significant differences in use between countries. It is notable that the use of the e-cigarette tends to be a habit by a considerable proportion of young adults and adolescents in many European countries. The health risks of e-cigarettes are uncertain. There are studies suggesting that e-cigarettes may cause, similar to tobacco cigarettes, harm to the cardiovascular and lung system. Although some of the identified harmful components in e-cigarettes were measured in lower quantities than those in cigarettes, recent studies unveiled that the toxic effects of e-cigarettes should not be understated. There is an overlap between tobacco laws and medical drug policies and e-cigarette legislation in many countries. A European Directive of 2016 set standards for liquids, vaporizers, ingredients and child-proof liquid containers while the US FDA extended its regulatory power to include e-cigarettes. In some countries, new legislations are underway to regulate e-cigarette use. **References** 1. Filippidis F.T., Laverty A.A., Vardavas C.I. (2016). 2. Ioakeimidis N., Vlachopoulos C., Tousoulis D. (2016). 3. Makadia L.D., Roper P.J., Andrews J.O., Tingen M.S. (2017). 4. Cai H., Wang C. (2017). 5. Chun L.F., Moazed F., Calfee C.S., Matthay M.A., Gotts J.E. (2017). 6. Benowitz N.L., Burbank A.D. (2016). 7. Rahman M.A., Hann N., Wilson A., Mnatzaganian G., Worrall-Carter L. (2015). 8. European Commission (2014). MEMO, 26 February 2014.

4.4 Potential effects on wildlife of increases in electromagnetic radiation

Topic	Potential effects on wildlife of increases in electromagnetic radiation
Initiator(s)	Marian Scott
Sources **Causative factors** **(see section 2section 2 of this document)**	2 e "On the horizon, a new generation of even shorter high frequency 5G wavelengths is being proposed to power the Internet of Things (IoT). The IoT promises us convenient and easy lifestyles with a massive 5G interconnected telecommunications network. However, the expansion of broadband with shorter wavelength radiofrequency radiation highlights the concern that health and safety issues remain unknown. Controversy continues with regard to harm from current 2G, 3G and 4G wireless technologies. 5G technologies are far less studied for human or environmental effects" (Russell, 2018).
Hazard **(Rank features as 1,2,3 or *)** **- uniqueness** **- soundness** **- severity** **- scale** **- urgency** **- interactions**	 2 1 * 3 3 3 (due to the interactions with other ecosystems and species)
Parallels with past emerging issues. Potential interactions with other stressors.	This concern is more related to the change to 5G rather than a completely new concern. The effects of electromagnetic radiation have been generally well studied, however low frequency electromagnetic radiation is less well studied, hence the justification for introducing this an emerging issue.
Preliminary Estimation of importance (*,1,2 or 3 where *=uncertain and 3 is high)	3
Background including reliability of data, a key reference if possible any other reasons for concern.	5G networks will soon be rolled out for mobile phone and smart device users. How exposure to electromagnetic fields could affect humans remains a controversial area, and studies have not yielded clear evidence of the impact on mammals, birds or insects. The lack of clear evidence to inform the development of exposure guidelines to 5G technology leaves open the possibility of unintended biological consequences.

	References 1. https://www.rsm.govt.nz/projects-auctions/current-projects/preparing-for-5g-in-new-zealand/folder-potential-health-effects-of-5g-technology/submissions-relating-to-health-concerns.pdf 2. Aertsa S., Wiart J., Martens L., Joseph W. (2017). 3. Pall M.L. (2018). 4. Di Ciaula A. (2018). 5. Russell C.L. (2018).

4.5 Chemicals in recycled materials, an issue in a circular economy

Topic	Chemicals in recycled materials, an issue in a circular economy
Initiator(s)	Theo Vermeire
Sources **Causative factors** **(see section 2 of this document)**	Many potential sources a, c, g, h
Hazard (Rank features as 1,2,3 or *) **- uniqueness** **- soundness** **- severity** **- scale** **- urgency** **- interactions**	 1 3 * 3 3 3
Parallels with past emerging issues. Potential interactions with other stressors)	In view of EU-wide strategies toward a circular economy, the issue of hazardous substances in recycled products is getting more and more attention. Risks can arise for the environment, consumers, workers. Over the last decade interest in the circular economy and therefore in recycling has increased considerably. One of the problems of recycling is that the materials may contain substances that pose a risk to man and the environment. So the possible advantages of recycling, such as more energy-efficient and CO_2-efficient production, should be weighed against the potential effects of these substances. Examples of hazardous substances incorporated into potentially recyclable material: the flame retardant hexabromocyclododecane (HBCDD) in extruded polystyrene, the plasticiser DEHP, cadmium and lead in polyvinyl chloride (PVC), heavy metals and PAHs in rubber crump from tyres.
Preliminary Estimation of importance (*,1,2 or 3 where *=uncertain and 3 is high)	3
Background including reliability of data, a key reference if possible any other reasons for	Examples are: Lead, phthalates, cadmium, organotins, POPs, BDEs, HBCDD, e-waste, hazardous chemicals in rubber crump and toys. **References** 1. EFSA CEF Panel (EFSA Panel on Food Contact Materials,

concern.	Flavourings and Processing Aids) (2015). 2. Grant K., Goldizen F.C., Sly P.D., Brune M.-N., Neira M., van den Berg M., Norman R.E. (2013). 3. Janssen M.P.M. *et al.* (2016). 4. KEMI (2012). 5. Verschoor A.J., Bodar C.W.M., Baumann R.A. (2018).

4.6 Pharmaceuticals (human and veterinary) and illicit drugs in wastewater and surface waters

Topic	**Pharmaceuticals (human and veterinary) and illicit drugs in wastewater and surface waters**
Initiator(s)	Pim de Voogt, Marco Vighi
Sources **Causative factors** **(see section 2 of this document)**	5 Urban waste water. Wastes from pharmaceutical industries and from illegal drugs manufacturing. Animal farm emissions. Agricultural soils treated with WWTP sludge or animal manure. Aquaculture.
Hazard **(Rank features as 1,2,3 or *)**	Pharmaceuticals and illicit drugs loads in wastewater increase as a result of increased use of legal, illicit and counterfeit drugs, aging of the population and also due to fly tipping of waste from illegal drug manufacturing sites (Emke *et al*. 2018). As a result wastewater treatment facilities may become jeopardised. Exposure of aquatic environments (receiving surface waters) because WWTPs don´t (completely) remove residuals (Wang *et al.* 2016; Bijlsma *et al.* 2012). The occurrence of pharmaceuticals in wastewater and surface waters has been object of systematic research since the 1990s (Zuccato *et al*., 2006). Therefore, it might seem as if the issue should not be considered as an emerging risk. However, knowledge on the hazards for aquatic communities is still far from being complete and, in many cases, the possible effects on the aquatic ecosystems are completely unknown. Pharmaceuticals and illicit drugs are, by definition, biologically active compounds. The type of biological effect is highly specific and, in most cases, unwanted for natural populations. At the concentrations likely to occur in surface waters, the possibility of effects that may be studied with tools capable to measure traditional endpoints (e.g. acute or chronic toxicity) or more specific effects (e.g. endocrine disrupting effects) is, in most cases, highly improbable. Nevertheless, other types of direct or indirect effects on the functioning of ecosystems determined by the specific biological activity, are possible and largely unknown. A couple of examples of the most known cases are: • Occurrence and spread of antibiotic resistance (AMR). Determined by the presence of antibiotics in surface water, this may represent a change in ecosystem functioning and a risk for human health (see, for example, Xi *et al*., 2009). • Behavioural changes due to antidepressants. Psychoactive drugs alter the behaviour of aquatic vertebrates, for example reducing the capability to escape from predators, with dramatic changes in

- uniqueness **- soundness** **- severity** **- scale** **- urgency** **- interactions**	ecosystem functioning (see, for example, Brooks, 2014). Other possible effects are fully unknown and difficult to predict. 1 * * 3 3 *
Parallels with past emerging issues. Potential interactions with other stressors)	Interactions among different pharmaceuticals with possibilities of synergisms or antagonisms.
Preliminary Estimation of importance (*,1,2 or 3 where *=uncertain and 3 is high)	3
Background including reliability of data, a key reference if possible any other reasons for concern.	**References** 1. Bijlsma L., Emke E., Hernández F., de Voogt P. (2012) 2. Brooks B. (2014). 3. Emke E., Vughs D., Kolkman A., de Voogt P (2018). 4. Wang J., Wang S. (2016). 5. Xi C., Zhang Y., Marrs C.F., Ye W., Simon C., Foxman B., Nriagu J. (2009). 6. Zuccato E., Castiglioni S., Fanelli R., Reitano G., Bagnati R., Chiabrando C., Pomati F., Rossetti C., Calamari D. (2006). 7. http://score-cost.eu/emcdda-wastewater-analysis-and-drugs/

4.7 Substance Mobility: a new criterion in chemicals regulation

Topic	**Substance Mobility: a new criterion in chemicals regulation**
Initiator(s)	Pim de Voogt
Sources **Causative factors** **(see section 2 of this document)**	5, 8, 9, 11 d,e Changes in public welfare measures / demographic changes Our society is using increasingly more chemical substances, and among the new emerging pollutants we are finding an increasing number of polar organic compounds. Although the concentration level of total organic contaminants decreases by about 2 orders of magnitude going from WWTP effluents to groundwater used for drinking water production to tapwater. The most polar contaminants in the WWTP effluents remain in the water throughout its passage to groundwater and also withstand traditional drinking water treatment processes. As a result, persistent mobile organic chemicals (PMOCs) may reach drinking water. Examples include trifluoromethanesulfonic acid and its halogenated homologues; 1-naphthalenesulfonic acid; 1,3-di-o-tolylguanidine and GenX (2,3,3,3-Tetrafluoro-2-(heptafluoro-propoxy)propanoic acid; aka FRD-903 or HFPO-DA).
Hazard (Rank features as 1,2,3 or *) **- uniqueness** **- soundness** **- severity** **- scale** **- urgency** **-interactions**	PMOC may be of an equivalent level of concern as PBT substances. If emissions of PMOC or very persistent very mobile substances are ongoing and removal during water treatment is incomplete, their environmental concentrations will increase over time as these substances circulate and enrich in the water cycle. 3 3 3 3 3 2
Parallels with past emerging issues. Potential interactions with other stressors)	European legislation on chemical substances (REACH) primarily focuses on substances that do not easily break down and are therefore Persistent (P), accumulate in organisms (Bioaccumulation, B) and have an effect on organisms (Toxicity, T). This PBT legislation pays insufficient attention to the drinking water function of our surface waters and groundwater. After all, there are substances that do not accumulate very much but that are very difficult to remove from water. Due to their great affinity for water such substances are Mobile (M). If substances have PMT properties then they can present an exposure risk for humans via drinking water.

	Potential Interactions: Exposure to (mixtures of) chemicals
Preliminary Estimation of importance (*, 1, 2 or 3 where *=uncertain and 3 is high)	3 -Topic is highly relevant for REACH legislation -German UBA has issued a revised proposal for implementing criteria and an assessment procedure to identify Persistent, Mobile and Toxic (PMT) and very Persistent, very Mobile (vPvM) substances registered under REACH.
Background including reliability of data, a key reference if possible any other reasons for concern.	Whether an organic compound does or does not possess an affinity for water is mainly determined by the polarity of that substance. Polar substances and those that have a permanent charge (ions, such as salts) have an extremely high affinity for water. That high affinity means that polar and charged substances dissolve easily in water and are poorly retained in soils through which the water passes, in riverbanks or by sorptive water treatment processes. Such substances are difficult to remove from water during purification. In other words, the substances move easily with the (moving) water, are transported along with it and can easily reach drinking water: the substance is Mobile (M). Drinking water companies are certainly increasingly confronted with new expenditures necessary to cope with polar substances. **References** 1. Reemtsma T., Berger U., Arp H.P.H., Gallard H., Knepper T.P., Neumann M., Quintana J.B., de Voogt P. (2016). 2. Sjerps R.M.A., Vughs D. van Leerdam J.A., ter Laak T.L., van Wezel A.P. (2016). 3. http://www.ufz.de/promote/ 4. https://www.umweltbundesamt.de/en/publikationen/protecting-the-sources-of-our-drinking-water-from 5. Zahn D., Frömel T., Knepper T.P. (2016). 6. Montes R., Aguire J., Vidal X., Rodil R., Cela R., Quintana J.B. (2017). 7. Versteegh J.F.M., de Voogt P. (2017).

4.8 Drinking water treatment interactions with compounds and potential health effects

Topic	**Drinking water treatment interactions with compounds and potential health effects**
Initiator(s)	Marian Scott
Sources **Causative factors** **(see section 2 of this document)**	5,6,10 a,b New and modified drinking water treatments are being used to deal with removal of chemical (natural and anthropogenic) contaminants in the source waters. It is anticipated that in the light of climate change, there may be further interactions between such natural contaminants, leading to new (or increased) concentrations of by-products with potential for human health concerns.
Hazard (Rank features as 1,2,3 or *) **- uniqueness** **- soundness** **- severity** **- scale** **- urgency** **- interactions**	 2 1 2 3 1 *
Parallels with past emerging issues. Potential interactions with other stressors.	Many disinfection methods are being used in the production of drinking water. Among these, the advanced oxidation processes serve the dual purposes of disinfection and removal of chemical contaminants present in source water. Studies have shown that water containing natural organic matter, when treated with UV for disinfection, generated multiple disinfection byproducts (DBPs). [Bond *et al*. Water Res 45 (2011) 4341-54; Richardson *et al*. Mutat. Res. 636 (2007) 178-242; Ceretti *et al*. J Public Health Res. 2016 Dec 9; 5(3), 769], including Nitrogen-containing mutagenic DBPs [Vughs *et al.* Environ Sci Pollut Res 25 (2018) 3951-64]. Climate change is expected to increase surface run off in river catchments, leading to increased amounts and loads, as well as possible changes in characteristics, of natural organic matter in the source waters [Soh *et al.*, The Environmentalist 28 (2007) 158-165]. used for producing drinking water. This means that there is an increased probability that DBPs are being formed in the treatment processes required for disinfection and purification. Climate change effects may result in the need to modify water treatment processes resulting in potentially new interactions, and lead to the development of new treatment methods which could result in the

	formation of novel disinfection products with health effects including mutagenicity.
Preliminary Estimation of importance (*, 1, 2 or 3 where *=uncertain and 3 is high)	2
Background including reliability of data, a key reference if possible any other reasons for concern.	There are a variety of papers and studies being published concerning interactions between water treatment chemicals, organic material and residues in drinking water, exacerbated by climate change and with potential health effects (including neurological disorders). Aluminium has been implicated in the past, but the treatment interactions with chemical contaminants and the possible effects of climate change mean that this topic is gaining renewed interest. Examples of some of the studies are given below. **References** 1. Lalas S., Athanasiadis V., Dourtoglou V.G. (2018). 2. Glassmeyer S.T., Furlong E.T., Kolpin D.W., Batt A.L., Benson R., Boone J.S., Conerly O., Donohue M.J., King D.N., Kostich M.S., Mash H.E., Pfaller S.L., Schenck K.M., Simmons J.E., Varughese E.A., Vesper S.J., Villegas E.N., Wilson V.S. (2017). 3. Benson R., Conerly, O.D. Sander W., Batt A.L., Boone J.S., Furlong E.T., Glassmeyer S.T., Kolping D.W. Mash H.E., Schenck K.M., Simmonsi J.E. (2017). 4. Kessing, L.V., Gerds T. A. Nygård Knudsen N., *et al.* (2017). 5. Post G.B., Gleason J.A., Cooper K.R. (2017). 6. Bond T., Huang J., Templeton M.R., Graham N. (2011). 7. Richardson S.D., Plewa M.J., Wagner E.D., Schoeny R., Demarini D.M. (2007). 8. Ceretti E., Moretti M., Zerbini I., Villarini M., Zani C., Monarca S., Feretti D. (2016). 9. Vughs D., Baken K.A., Kolkman A., Martijn A.J., de Voogt P. (2018). 10. Soh Y., Roddick F., Van Leeuwen J. (2007).

4.9 Per- and polyfluorinated organic substances

Topic	**Per- and polyfluorinated alkyl substances (PFAS)**
Initiator(s)	Pim de Voogt
Sources **Causative factors** **see section 2**	4, 11, 13 c, d, h
Hazard (Rank features as 1,2,3 or *) **- uniqueness** **- soundness** **- severity** **- scale** **- urgency** **- interactions**	Because of the persistence of PFAS, these compounds constitute potential risks for humans and the environment. 3 3 3 3 3 *
Parallels with past emerging issues. Potential interactions with other stressors)	Parallels: POPs Very few PFAS have been regulated (PFOS Stockholm convention; PFOS in products (EC); TDIs for PFOS and PFOA (EFSA). A new Opinion on PFOS and PFOA in food, by the EFSA Contam panel, has been finalised in Mar 2018. A Scientific Opinion by EFSA on the risk to human health related to the presence of Perfluoroalkylated substances in food, other than Perfluorooctane sulfonate and Perfluorooctanoic acid, is in the process of completion. PFOA is under review by the Stockholm POP convention. Possible interactions: dietary exposure to (mixtures of) chemicals.
Preliminary Estimation of prioritisation (*, 1, 2 or 3 where *=uncertain and 3 is high)	2-3 As a result of new information becoming available on the toxicity of PFAS, the revision of current guideline values (e.g. TDIs, drinking water guidelines) is urgent and for some members of the PFAS group it is underway. For others essential data are still missing. Hence the prioritisation is high.
Background including reliability of data, a key reference if possible any other reasons for concern.	For several members of the PFAS group PBT properties have been demonstrated. Others appear to be persistent and mobile (PM) and cross natural or technological barriers, thus posing risks to public health because of human exposure. Replacements by industry for the major part appear to rely on fluorine chemistry (e.g. GenX) which inherently leads to similarities in persistence. Many more emerging PFAS have been recently found to occur in surface waters (see e.g. Gebbink *et al*., 2017).

	References 1. Scientific Panel on Contaminants in the Food Chain, Minutes of the 85th Plenary meeting held on 4-6 July 2017, Parma (Italy). https://www.efsa.europa.eu/sites/default/files/event/170704-m.pdf; http://registerofquestions.efsa.europa.eu/roqFrontend/questionLoader?question=EFSA-Q-2015-00526; http://registerofquestions.efsa.europa.eu/roqFrontend/questionDocumentsLoader?question=EFSA-Q-2017-00549 2. Gebbink W.A., van Asseldonk L., van Leeuwen S.P.J. (2017).. 3. Blum A., Balan S.A., Scheringer M., Trier X., Goldenman G., Cousins I., Diamond M., Fletcher T., Higgins C., Lindeman A.E., Peaslee G., de Voogt P., Wang Z., Weber R. (2015). 4. Ritscher A. *et al.* (2018).

4.10 New RNA pesticides and gene editing to reduce/eradicate pest populations

Topic	**New RNA pesticides and gene editing to reduce/eradicate pest populations**
Initiator(s)	Marian Scott
Sources **Causative factors** **(see section 2 of this document)**	6,8,10,12 a,f,h With increasing concerns about the negative impact of the use of chemical pesticides (see recent debates concerning glyphosates and neonicotinoids), on both the environment and humans, there are new developments in the use of gene technology (in the broadest sense) to manage pest populations).
Hazard **(Rank features as 1, 2, 3 or *)** **- uniqueness** **- soundness** **- severity** **- scale** **- urgency** **- interactions**	 2 1 2 3 3 3
Parallels with past emerging issues. Potential interactions with other stressors)	Effects of various pesticides including examples such as neonicotinoids and glyphosate have been much contested, and any form of gene editing is likely to be met with concerns particularly given the social and political debates concerning GMO.
Preliminary Estimation of importance (*,1,2 or 3 where *=uncertain and 3 is high)	3
Background including reliability of data, a key reference if possible any other reasons for concern.	Laboratory tests have shown that topical application of RNA could be a new way of controlling plant pests, including viruses and insects, by silencing genes that affect survival and reproduction. It is thought this method could be more publicly acceptable than other forms of genetic modification because its effects will not be passed on to offspring. However, the impact of widespread use of the method as a pesticide on non-target species is not yet known. New gene editing technologies could also be used to control animal populations, including invasive species, within the coming decade. For instance, applications of CRISPR-enabled gene drive technology are

	foreseen for several applications, such as the elimination or suppression of insect vectors and transmitting (plant) diseases. At a cost of more than £3 million a year, New Zealand aims to rid itself of rats, possums and stoats by 2050. These methods raise both ethical and ecological questions, from repercussions on wider ecosystems to the potential for gene traits to spread and wipe-out species in unintended areas. **References** 1. Lundgren J.G., Duan J.J. (2013). 2. Albright *et al*. (2017). 3. Medina R.F. (2018). 4. Royal Society Te Apārangi Gene Editing Panel. (2017). https://royalsociety.org.nz/assets/Uploads/Gene-editing-in-pest-control-technical-paper.pdf

4.11 Do-it-Yourself Synthetic Biology, biohacking

Topic	**Do-it-Yourself Synthetic Biology, biohacking**
Initiator(s)	Theo Vermeire
Sources **Causative factors** **see section 2**	3, 9, 11 a, c, g
Hazard (Rank features as 1,2,3 or *) **- uniqueness** **- soundness** **- severity** **- scale** **- urgency** **- interactions**	 2 2 3 3 2 1
Parallels with past emerging issues. Potential interactions with other stressors)	As SynBio advances, its methods, equipment and technologies will be cheaper, simpler and easier to use. The number and complexity of products, new pathways to risk-assessment endpoints, large range of types of products, new actors, including DIY bioengineers (also known as biohackers) and complex alignment of potential future products with agency authorities are likely to change rapidly as biotechnology advances. SynBio will likely foster citizen science, i.e. attracting DIY biologists into a field traditionally reserved for highly trained professionals. The nature of the citizen science community raises concerns that its practitioners will not abide by risk assessment and biosafety practices required by law of the professional SynBio community. The issue is not whether SynBio can be safely practiced; it is a question of whether DIY biologists will practice it safely. Accidental use or misuse of SynBio kits by consumers was identified as a cause of concern in the SCENIHR Opinion on SynBio. There is evidence that this may lead to actual risks, e.g. when a kit is contaminated by pathogenic species or malware is incorporated in DNA-samples.
Preliminary Estimation of importance (*,1,2 or 3 where *=uncertain and 3 is high)	3
Background	**References**

including reliability of data, a key reference if possible any other reasons for concern.	1. SCHER (Scientific Committee on Health and Environmental Risks), SCENIHR (Scientific Committee on Emerging and Newly Identified Health Risks), SCCS (Scientific Committee on Consumer Safety), Synthetic Biology II - Risk assessment methodologies and safety aspects, Opinion, December, 2014. 2. Epstein M., Vermeire T. (2016). 3. National Academies of Sciences, Engineering, and Medicine (2017). 4. Schmidt M. (2008). 5. http://www.dw.com/en/biohacking-genetic-engineering-from-your-garage/a-42030559?maca=en-rss-en-all-1573-rdf 6. https://groups.google.com/forum/#!topic/diybio/PXeoidiWPYA 7. https://www.wired.com/story/malware-dna-hack/ 8. https://www.youtube.com/watch?v=F9HScPlBFhM 9. https://www.lgl.bayern.de/presse/detailansicht.htm?tid=680089 10. https://www.scientificamerican.com/article/mail-order-crispr-kits-allow-absolutely-anyone-to-hack-dna/?sf188033786=1

4.12 Micro and nano-plastic in the environment

Topic	**Micro and nano-plastic in the environment**
Initiator(s)	Marco Vighi, Qasim Chaudhry (SCCS)
Sources **Causative factors (see section 2 of this document)**	5 Urban and industrial waste water. Agricultural soils treated with WWTP sludge. Macroplastic debris. Tyre debris. a
Hazard (Rank features as 1,2,3 or *)	The increasing environmental pollution by plastic materials has recently come to the attention of authorities around the world. For example, WHO has recently launched a health review after microplastics were found in 90% of bottled water (www.bbc.co.uk/news/science-environment-43389031). The UK has banned the use of plastic microbeads in cosmetic products (https://chemicalwatch.com/62944/uk-microbeads-ban-enters-into-force). The production, use and disposal of plastic materials is now ubiquitous. The largest area of plastic use is for packaging materials and a wide range of other objects. Plastic polymers have not been considered substances of health concern because they are generally inert in nature, and are unlikely to be absorbed in the body due to large molecular sizes. They are nevertheless highly persistent in the environment where they may end up via a variety of disposal/emission routes. Gradual degradation of plastic materials over time is known to result in microplastics - which in theory could also further degrade to nano-plastics. Some forms of microplastics are also used in cosmetic products which makes their direct emission into the aquatic environment possible. The effects of MPs on living organisms may be direct, mainly physical (damages to respiratory systems or digestive tracts) or behavioural (changes in food intake), or indirect, determined by the uptake of chemicals adsorbed on the plastic. The actual relevance of these effects is dependent on the realistic exposure in soil and water environments, which is still largely unknown.
- uniqueness **- soundness** **- severity** **- scale** **- urgency** **- interactions**	3 * * 3 3 *
Parallels with past emerging issues.	This is a relatively new topic and after decades of ignorance has recently come under the focus of attention of researchers, authorities and the

Potential interactions with other stressors)	general public. Possible interactions between MPs and potentially toxic chemicals.
Preliminary Estimation of importance (*, 1, 2 or 3 where *=uncertain and 3 is high)	* Considering the amount of the emissions, the issue could be of high importance. However the available information on actual exposure in the different environmental compartments as well as on the effects on living organisms is still highly controversial. The sampling methods for microplastic as well the analytical methods are not standardised and different procedures, providing different results, are used in monitoring studies. Therefore, measured data in the aquatic environment reported in the literature are often difficult to compare. As for the effect assessment, microplastic (arbitrarily defined as bigger than 1 μm) should not cross cell membranes and, if ingested, should remain in the digestive system, producing only physical effects. On the contrary, nanoplastics can probably enter the cells and, possibly, interact with cell metabolism. However, to date, these are just hypotheses. There is some evidence in the literature of the cellular uptake of nanoplastic but the threshold below which this may occur is unknown, as well as the type of biological effects. These uncertainties point to the need for a better assessment of hazard and risk. It is opinion of the SCHEER that the standardisation of methods for assessing exposure, as well as the development of methods for assessing the different behaviour in living organisms of micro and nano plastics, represent urgent priorities.
Background including reliability of data, a key reference if possible any other reasons for concern.	The occurrence of micro and macro plastic in the environment is recognised as one of the most serious environmental problems at the global level. In particular, microplastics (MPs) in the marine environment have been extensively studied for a long time (GESAMP, 2015), while, in freshwater, the problem is much less known (Breuninger *et al*., 2017). **References** 1. GESAMP (2015). Joint Group of Experts on the Scientific Aspects of Marine Environmental Protection). 2. Breuninger E., Bänsch-Baltruschat B., Brennholt N., Hatzky S., Kochleus C., Reifferscheid G., Koschorreck J. (2017). 3. Wright S.L., Kelly F.J. (2017). 4. Andrady A.L. (2017). 5. Galloway T.S., Cole M., Lewis C. (2017). 6. www.efsa.europa.eu/en/press/news/160623 7. www.independent.co.uk/environment/microplastics-microbeads-health-risks-investigations-uk-government-ban-possibility-a7416271.html

4.13 Nanoparticles released from Building Materials and construction waste to the Environment

Topic	**Nanoparticles released from Building Materials and construction waste to the Environment**
Initiator(s)	Rodica-Mariana Ion
Sources **Causative factors** **(see section 2 of this document)**	1,4,5 a, **Sources:** Nanomaterials are found in construction products, primarily in surface coatings, concrete, window glass, insulation and steel. Not all of them contain nanoparticles. However, some nanomaterials may be hazardous due to the presence of very small particles and the similarities observed between some nanomaterials and asbestos fibres. The involved materials have potential impact on both human health and on the environment. The most used are: TiO_2, SiO_2, ZnO, Ag, CuO, and $CaCO_3$. Also, there are some nanomaterials in cement such as: SiO_2, Al_2O_3, Fe_2O_3, ZrO_2, carbon nanotubes (CNTs) and carbon nanofibers (CNFs). Titanium dioxide particles or antimicrobial silver nanoparticles or even carbon nanotubes (CNTs) provide concrete with self-cleaning properties, or antimicrobials or give it with improved strength and potentially electrical conductivity. **Causative factors:** various nanomaterials used in the building industry and their potential release from paint waste, during the renovation and demolition processes, during recycling, landfilling and incineration technologies. The release of NPs may occur when the coatings are not adequately fixed to the stone or when they are not sufficiently effective to prevent stone degradation and crumbling. Those NPs that end up in the water systems can adversely affect aquatic and marine life and in the soil, essential microbial interactions may be interfered with, affecting functional diversity.
Hazard (Rank features as 1,2,3 or *) **-uniqueness** **- soundness** **- severity** **- scale** **- urgency** **- interactions**	 3 * * 3 3 *
Parallels with past emerging issues. Potential interactions with other stressors	Several building materials exist from the older building technologies still exist and are used because of their proximity, availability and geographical location. Such material includes mud bricks (adobe), stones, cobs and wood to mention a few. These the traditional building materials are stereotypically binary: earth related material and wood related. There is currently lack of regulations requiring labeling or other listings of

	these materials containing nanomaterials The possible release of nanomaterials into the environment by this route must therefore be taken into consideration, as follows: [i] identify the sources and the flows of released nanomaterials in construction waste, [ii] identify the potential exposure pathways of released nanomaterials for humans and other organisms, [iii] identify the release of released nanomaterials to technical compartments and the environment and [iv] identify the hazard they represent for organisms. After gathering all these elements, a characterisation of risk is plausible.
Preliminary Estimation of importance (*,1,2 or 3 where *=uncertain and 3 is high)	3
Background including reliability of data, a key reference if possible any other reasons for concern.	**References** 1. Christine G., Benjamín O.O.M. (2018). 2. Shandilya N., *et al*. (2015). 3. Hincapié I., Caballero-Guzmán A., Nowack B. (2015)., 4. Mitrano D.M., Mehrabi K., Dasilva Y.A.R. Nowack B. (2017). 5. Dulger M., Sakallioglu T., Temizel I., Demirel B., Copty N.K.,. Onay T.T., Uyguner-Demirel C.S., Karanfil T. (2016). 6. Sakallioglu T., Bakirdoven M., Temizel I., Demirel B., Copty N.K., Onay T.T., Uyguner Demirel C.S., Karanfil T. (2016). 7. van Broekhuizen P., van Broekhuizen F., Cornelissen R., Reijnders L. (2011).. 8. Hanus M.J., Harris A.T. (2013).

4.14 Environmental factors and the Human Microbiome

Topic	Environmental factors and the Human Microbiome
Initiator(s)	Teresa Borges
Sources **Causative factors** **(see Section 2 of this document)**	 b and f *Microbiome* refers to "the entire habitat, including the microorganisms (bacteria, archaea, lower and higher eukaryotes and viruses), their genome (i.e., genes), and surrounding environmental conditions" (Marchesi and Ravel 2015). A key aspect of the human microbiome is the variation in its composition and function observed among populations, over the human life span, and between body sites such as the gut, skin, or respiratory microbiome. Research is showing that the human microbiome has a modulating role between environmental factors and the health status (Fallani 2016; Gibson *et al*. 2016; Yassour *et al.* 2016; Chu *et al*. 2017). On the other hand, microbial changes in the human microbiome are being linked to an array of neurological, gastrointestinal, metabolic, oncologic, hepatic, respiratory and auto immune disorders (Lynch and Pedersen 2016). In this sense, it seems sensible to have a better understanding on the relation between human exposure to environmental stressors, changes occurring in the human microbiome and onset of certain health conditions. Additionally, there is sufficient scientific knowledge on toxicity and risk assessment of a great number of environmental chemicals, generated during the last decades under several regulatory frameworks (WHO, IPCS, EPA, EFSA, ECHA) that can contribute substantially to gaining a better understanding of the underlying critical factors.
Hazard (Rank features as 1,2,3 or *) **- uniqueness** **- soundness** **- severity** **- scale** **- urgency** **- interactions**	 2 2 * 2 2 3
Parallels with past emerging issues. Potential interactions with other stressors	The structure and function of the human microbiome in both disease and healthy states have been benefiting from improvements in high-throughput and accuracy of DNA sequencing of the genomes of microbial communities that are associated with human samples, complemented by OMICS analysis (transcriptomes, proteomes, metabolomes and immunomes) and by mechanistic experiments in model systems. Also, as a result of international projects dedicated to the Human Microbioma, gut microbioma has been subjected to intensive research and quality criteria and standardisations have been developed i.e. reference microbiota strains, in housing protocols, human sampling protocols. Presently, gut

	microbes can be transplanted effectively and under experimental controlled conditions into germ-free mice to recapitulate their associated phenotypes (Blanton *et al*., 2016). Also, Schwarzer *et al.* (2016) showed in mice that strains of *Lactobacillus plantarum* in the gut microbiota sustained growth hormone activity via signalling pathways in the liver, thus overcoming growth hormone resistance. This evidence strengthens the correlation between the changes in children's gut microbiota composition and children's growth factors, therefore showing that beneficial gut microbes can potentially be exploited to resolve undernutrition syndromes in children. It is expected that in the near future, metrics and biomarkers will be identified to set more effective measures and health therapies (Dietert and Silbergeld 2015).
Preliminary Estimation of importance (*,1,2 or 3 where *=uncertain and 3 is high)	2
Background including reliability of data, a key reference if possible any other reasons for concern.	**References** 1. Gilbert J.A., Blaser M.J., Caporaso J.G., Jansson J.K., Lynch S.V., Knight R. (2018). 2. Schwarzer M., *et al* (2016). 3. Blanton L.V*. et al.* (2016). 4. Collado M.C. *et al.* (2016) 5. Fallani 2016; Gibson *et al.* 2016; Yassour *et al*. 2016; Chu et al. 2017. 6. Lynch S.V., Pederson O. (2016) 7. Dietert R.R. and Silbergeld E.K. (2015).

5. CONCLUSIONS

The SCHEER identified 14 emerging issues to bring to the attention of the Commission services. The overall prioritisation scores (*, 1,2,3 where *=uncertain and 3 is high) are as follows:

4.1	Personal communication and listening devices	1
4.2	Virtual reality	3
4.3	E-cigarette and chronic diseases	3
4.4	Potential effects on wildlife of increases in electromagnetic radiation	3
4.5	Chemicals in recycled materials, an issue in a circular economy	3
4.6	Pharmaceuticals (human and veterinary) and illicit drugs in wastewater and surface waters	3
4.7	Substance Mobility: a new criterion in chemicals regulation	3
4.8	Drinking water treatment interactions with compounds and potential health effects	2
4.9	Per- and polyfluorinated organic substances	2-3
4.10	New RNA pesticides and gene editing to reduce/eradicate pest populations	3
4.11	Do-it-Yourself Synthetic Biology, biohacking	3
4.12	Micro and nano-plastic in the environment	*
4.13	Nanoparticles released from Building Materials and construction waste to the Environment	3
4.14	Environmental factors and the Human Microbiome	2

6. REFERENCES

Aertsa S., Wiart J., Martens L., Joseph W. (2017). Assessment of long-term spatio-temporal radiofrequency electromagnetic field exposure. Environmental Research 161, 136-143. Doi: https://doi.org/10.1016/j.envres.2017.11.003.

Albright V.C. III, Wong C.R., Hellmich R.L., Coats J.R. (2017). Dissipation of double-stranded RNA in aquatic microcosms. Environmental Toxicology and Chemistry 36 (5), 1249–53. Doi: https://doi.org/10.1002/etc.3648.

Andrady A.L. (2017). The plastic in microplastics: A review, Marine Pollution Bulletin, 119(1), 12-22.

Benowitz N.L., Burbank A.D. (2016). Cardiovascular toxicity of nicotine: Implications for electronic cigarette use. Trends Cardiovasc Med. 26(6), 515-23. doi: 10.1016/j.tcm.2016.03.001.

Benson R., Conerly, O.D., Sander W., Batt A.L., Boone J.S., Furlong E.T., Glassmeyer S.T., Kolping D.W. Mash H.E., Schenck K.M., Simmonsi J.E. (2017). Human health screening and public health significance of contaminants of emerging concern detected in public water supplies. Science of the Total Environment 579, 1643-8. Doi: http://dx.doi.org/10.1016/j.scitotenv.2016.03.146.

Bijlsma L., Emke E., Hernández F., de Voogt P. (2012). Investigation of drugs of abuse and relevant metabolites in Dutch sewage water by liquid chromatography coupled to high resolution mass spectrometry. Chemosphere 89, 1399-406.

Blanton L.V. Charbonneau M.R., Salih T., Barratt M.J., Venkatesh S., Ilkaveya O., Subramanian S., Manary M.J., Trehan I., Jorgensen J.M., Fan Y.M., Henrissat B., Leyn S.A., Rodionov D.A., Osterman A.L., Maleta K.M., Newgard C.B., Ashorn P., Dewey K.G., Gordon J.I.. (2016). Gut bacteria that prevent growth impairments transmitted by microbiota from malnourished children. Science 351 (6275), aad3311.

Blum A., Balan S.A., Scheringer M., Trier X., Goldenman G., Cousins I., Diamond M., Fletcher T., Higgins C., Lindeman A.E., Peaslee G., de Voogt P., Wang Z., Weber R. (2015). The Madrid Statement on Poly- and Perfluoroalkyl Substances. Environ. Health Perspect. 123, A107-A111. http://dx.doi.org/ 10.1289/ehp.1509934.

Bond T., Huang J., Templeton M.R., Graham N. (2011). Occurrence and control of nitrogenous disinfection by-products in drinking water--a review. Water Res 45(15), 4341-54. doi: 10.1016/j.watres.2011.05.034.

Breuninger E., Bänsch-Baltruschat B., Brennholt N., Hatzky S., Kochleus C., Reifferscheid G., Koschorreck J. (2017). Plastics in Freshwater Environments. Environmental Research of the Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety. Project No. (FKZ) 3715 22 2020 Report No. (UBA-FB) 002480/ENG.

Brooks B. (2014). Fish on Prozac: ten years later. Aquatic Toxicology. 151, 61-7.

Cai H., Wang C. (2017). Graphical review: The redox dark side of e-cigarettes; exposure to oxidants and public health concerns. Redox Biol. 13, 402-06. doi:

10.1016/j.redox.2017.05.013. Review. PubMed PMID: 28667909; PubMed Central PMCID: PMC5493817.

Ceretti E., Moretti M., Zerbini I., Villarini M., Zani C., Monarca S., Feretti D. (2016). Occurrence and Control of Genotoxins in Drinking Water: A Monitoring Proposal. J Public Health Res. 5(3), 769. doi: 10.4081/jphr.2016.769.

Christine G., Benjamín O.O.M. (2018). Nanoparticles and the Building Industry-A Short Review. Arch Nano Op Acc J 1(1) ANOAJ.

Chun L.F., Moazed F., Calfee C.S., Matthay M.A., Gotts J.E. (2017). Pulmonary toxicity of e-cigarettes. Am J Physiol Lung Cell Mol Physiol. 313(2), L193-L206. doi: 10.1152/ajplung. 00071.2017. Review. PubMed PMID: 28522559; PubMed Central PMCID: PMC5582932.

Cobb S.V.G., Nichols S.C., Wilson, J.R. (1995). Health and Safety Implications of Virtual Reality: In Search of an Experimental Methodology. Proceedings of FIVE '95 Conference. London, Dec. 1995.

Collado M.C., Rautava S., Askko J., Isolauri E., Salminen S. (2016). Human gut colonisation may be initiated *in utero* by distinct microbial communities in the placenta and amniotic fluid. Scientific Reports 6, Article number: 23129.

Di Ciaula A. (2018). Towards 5G communication systems: Are there health implications? International Journal of Hygiene and Environmental Health 221 (3), 367-75. Doi: 10.1016/j.ijheh.2018.01.011.

Dietert R.R., Silbergeld E.K. (2015). Biomarkers for the 21st century: listening to the microbiome. Toxicol Sci. 144(2), 208-16. doi: 10.1093/toxsci/kfv013.

Dulger M., Sakallioglu T., Temizel I., Demirel B., Copty N.K.,. Onay T.T., Uyguner-Demirel C.S., Karanfil T. (2016). Leaching potential of nano-scale titanium dioxide in fresh municipal solid waste, Chemosphere 144, 1567–72.

EFSA CEF Panel (EFSA Panel on Food Contact Materials, Flavourings and Processing Aids) (2015). Scientific Opinion on the safety assessment of the processes 'Biffa Polymers' and 'CLRrHDPE' used to recycle high-density polyethylene bottles for use as food contact material. EFSA Journal 2015 13(2), 4016, 25 pp. doi:10.2903/j.efsa.2015.4016.

EMCDDA (2018). Wastewater analysis and drugs — a European multi-city study. http://score-cost.eu/emcdda-wastewater-analysis-and-drugs/

Emke E., Vughs D., Kolkman A., de Voogt P. (2018). Wastewater-based epidemiology generated forensic information: amphetamine synthesis waste and the impact on a small sewage treatment plant. Forens. Sci. Internl. doi: 10.1016/j.forsciint.2018.03.019.

Epstein M., Vermeire T. (2016). Scientific Opinion on risk assessment of synthetic biology. Trends in Biotechnology 34, 601-3.

European Commission (2014). Questions & Answers: New rules for tobacco products. MEMO, 26 February 2014. (http://europa.eu/rapid/press-release_MEMO-14-134_en.htm).

Fallani 2016; Gibson *et al.* 2016; Yassour *et al.* 2016; Chu *et al.* 2017. Environmental Chemicals, the Human Microbiome, and Health Risk: A Research Strategy. National Academies of Sciences, Engineering, and Medicine. (2018). doi: https://doi.org/10.17226/24960.

Fernandes A.S., Feiner S.K. (2016). Combating VR sickness through subtle dynamic field-of-view modification. 2016 IEEE Symposium on 3D User Interfaces (3DUI) . Electronic ISBN: 978-1-5090-0842-1, DOI: 10.1109/3DUI.2016.7460053.

Filippidis F.T., Laverty A.A., Vardavas C.I. (2016). Experimentation with e-cigarettes as a smoking cessation aid: a cross-sectional study in 28 European Union member states. BMJ Open.6(10), e012084. doi: 10.1136/bmjopen-2016-012084. PubMed PMID: 27855092; PubMed Central PMCID: PMC5073471.

Galloway T.S., Cole M., Lewis C. (2017). Interactions of microplastic debris throughout the marine ecosystem, Nature Ecology & Evolution volume 1, Article number: 0116, doi:10.1038/s41559-017-0116.

Gebbink W.A., van Asseldonk L., van Leeuwen S.P.J. (2017). Presence of Emerging Per- and Polyfluoroalkyl Substances (PFASs) in River and Drinking Water near a Fluorochemical Production Plant in the Netherlands. Environmental Science and Technology 51, 11057 - 65. http://dx.doi.org/10.1021/acs.est.7b02488.

Gilbert J.A., Blaser M.J., Caporaso J.G., Jansson J.K., Lynch S.V., Knight R. (2018). Current understanding of the human microbiome. Nature Medicine . 24, 392–400.

Glassmeyer S.T., Furlong E.T., Kolpin D.W., Batt A.L., Benson R., Boone J.S., Conerly O., Donohue M.J., King D.N., Kostich M.S., Mash H.E., Pfaller S.L., Schenck K.M., Simmons J.E., Varughese E.A., Vesper S.J., Villegas E.N., Wilson V.S. (2017). Nationwide reconnaissance of contaminants of emerging concern in source and treated drinking waters of the United States. Science of the Total Environment 581-582, 909–22. https://doi.org/10.1016/j.scitotenv.2016.12.004.

Grant K., Goldizen F.C., Sly P.D., Brune M.-N., Neira M., van den Berg M., Norman R.E. (2013). Health consequences of exposure to e-waste: a systematic review, Lancet Glob Health 1, e350–61.

Hanus M.J., Harris A.T. (2013). Nanotechnology innovations for the construction industry, Progress in Materials Science 58(7), 1056-1102.

Hincapié I., Caballero-Guzmán A., Nowack B. (2015). Nanomaterials in Landfills Module 3: Nanomaterials in Construction Waste. EMPA, Swiss Federal Laboratories for Materials Science and Technology.

Holden B.A., Fricke T.R., Wilson D.A, Jong M., Naidoo K.S., Sankaridurg P., Wong T.Y., Naduvilath T.J., Resnikoff S. (2016). Global Prevalence of Myopia and High Myopia and Temporal Trends from 2000 through 2050. Ophthalmology 123, 1036-42 https://www.aaojournal.org/article/S0161-6420(16)00025-7/pdf.

http://www.efsa.europa.eu/en/press/news/160623

http://www.independent.co.uk/environment/microplastics-microbeads-health-risks-investigations-uk-government-ban-possibility-a7416271.html

https://groups.google.com/forum/#!topic/diybio/PXeoidiWPYA

https://www.efsa.europa.eu/sites/default/files/event/170704-m.pdf

https://www.lgl.bayern.de/presse/detailansicht.htm?tid=680089

https://www.rsm.govt.nz/projects-auctions/current-projects/preparing-for-5g-in-new-zealand/folder-potential-health-effects-of-5g-technology/submissions-relating-to-health-concerns.pdf
https://www.scientificamerican.com/article/mail-order-crispr-kits-allow-absolutely-anyone-to-hack-dna/?sf188033786=1

https://www.umweltbundesamt.de/en/publikationen/protecting-the-sources-of-our-drinking-water-from

https://www.wired.com/story/malware-dna-hack/

https://www.youtube.com/watch?v=F9HScPlBFhM

Ioakeimidis N., Vlachopoulos C., Tousoulis D. (2016). Efficacy and Safety of Electronic Cigarettes for Smoking Cessation: A Critical Approach. Hellenic J Cardiol.57(1), 1-6. Review. PubMed PMID: 26856194.

Janssen M.P.M. *et al*. (2016). Plastics that contain hazardous substances: recycle or incinerate? RIVM Letter report 2016-0025.

Jáuregui-Renaud K. (2015). Vestibular Function and Depersonalization/ Derealization Symptoms, Multisensory research 28(5-6), 637-51. DOI: 10.1163/22134808-00002480.

KEMI (2012). Material recycling without hazardous substances – Experiences and future outlook of ten manufacturers of consumer products. Swedish Chemicals Agency, Report PM14/12.

Kessing, L.V., Gerds T. A. Nygård Knudsen N., *et al.* (2017). Association of Lithium in Drinking Water With the Incidence of Dementia. JAMA Psychiatry, 74(10), 1005-10. doi:10.1001/jamapsychiatry.2017.2362.

Lalas S., Athanasiadis V., Dourtoglou V.G. (2018). Humic and Fulvic Acids as Potentially Toxic Metal Reducing Agents in Water. Clean Soil Air Water 46 (2), 1700608. https://onlinelibrary.wiley.com/doi/pdf/10.1002/clen.201700608

Lundgren J.G., Duan J.J. (2013). RNAi-Based Insecticidal Crops: Potential Effects on Nontarget Species BioScience 63, 657–65. https://doi.org/10.1525/bio.2013.63.8.8.

Lynch S.V., Pederson O. (2016). The Human Intestinal Microbiome in Health and Disease, N. Eng. J. Med 375(24), 2369-79.

Makadia L.D., Roper P.J., Andrews J.O., Tingen M.S. (2017). Tobacco Use and Smoke Exposure in Children: New Trends, Harm, and Strategies to Improve Health Outcomes. Curr Allergy Asthma Rep. 17(8), 55. doi: 10.1007/s11882-017-0723-0. Review. PubMed PMID: 28741144.

Medina R.F. (2018). Gene drives and the management of agricultural pests, Journal of Responsible Innovation, 5 (1), S255-S262, DOI: 10.1080/23299460.2017.1407913.

Mitrano D.M., Mehrabi K., Dasilva Y.A.R. Nowack B. (2017). Mobility of metallic (nano)particles in leachates from landfills containing waste incineration residues, Environ. Sci.: Nano ,4, 480–92.

Montes R., Aguire J., Vidal X., Rodil R., Cela R., Quintana J.B. (2017). Screening for Polar Chemicals in Water by Trifunctional Mixed-Mode Liquid Chromatography–High Resolution Mass Spectrometry. Environ Sci Technol 51, 6250-59.

National Academies of Sciences, Engineering, and Medicine (2017). Preparing for Future Products of Biotechnology. Washington, DC: The National Academies Press. doi:10.17226/24605.

Pall M.L. (2018). Wi-Fi is an important threat to human health. Environmental Research 164, 405-16. doi: https://doi.org/10.1016/j.envres.2018.01.035

Pallavicini F., Cipresso P., Raspelli S., Grassi A., Serino S., Vigna C., Triberti S., Villamira M., Gaggioli A., Riva G. (2013). Is virtual reality always an effective stressors for exposure treatments? some insights from a controlled trial. BMC Psychiatry 13, 52. doi: 10.1186/1471-244X-13-52.

Post G.B., Gleason J.A., Cooper K.R. (2017). Key scientific issues in developing drinking water guidelines for perfluoroalkyl acids: Contaminants of emerging concern PLoS Biol 15(12), e2002855. https://doi.org/10.1371/journal.pbio.2002855.

Protecting Water Resources from Mobile Trace Chemicals - PROMOTE a Water JPI project: http://www.ufz.de/promote/

Rahman M.A., Hann N., Wilson A., Mnatzaganian G., Worrall-Carter L. (2015). E-cigarettes and smoking cessation: evidence from a systematic review and meta-analysis. PLoS One. 2015 Mar 30; 10(3)., e0122544. doi: 10.1371/journal.pone.0122544.

Reemtsma T., Berger U., Arp H.P.H., Gallard H., Knepper T.P., Neumann M., Quintana J.B., de Voogt P. (2016). Mind the Gap: Persistent and Mobile Organic Compounds—Water Contaminants That Slip Through. Environ. Sci. Technol. 50, 10308-15.

Richardson S.D., Plewa M.J., Wagner E.D., Schoeny R., Demarini D.M. (2007). Occurrence, genotoxicity, and carcinogenicity of regulated and emerging disinfection by-products in drinking water: a review and roadmap for research. Mutat. Res. 636 (1-3), 178-242.

Ritscher A., Wang Z., Scheringer M., Boucher J.M., Ahrens L., Berger U., Bintein S., Bopp S.K., Borg D., Buser A.M., Cousins I., DeWitt J., Fletcher T., Green C., Herzke D., Higgins C., Huang J., Hung H., Knepper T., Lau C.S., Leinala E., Lindstrom A.B., Liu J., Miller M., Ohno K., Perkola N., Shi Y., Småstuen Haug L., Trier X., Valsecchi S., van der Jagt K., Vierke L. (2018). Zürich Statement on Future Actions on Per-and Polyfluoroalkyl Substances (PFASs). Environ. Health Perspect. 126(8), 84502. DOI: 10.1289/EHP4158.

Royal Society Te Apārangi Gene Editing Panel. (2017). The use of gene editing to create gene drives for pest control in New Zealand. December 2017. https://royalsociety.org.nz/assets/Uploads/Gene-editing-in-pest-control-technical-paper.pdf.

Russell C.L. (2018). 5G wireless telecommunications expansion: Public health and environmental implications. Environmental Research 165, 484-95. DOI: 10.1016/j.envres.2018.01.016.

Sakallioglu T., Bakirdoven M., Temizel I., Demirel B., Copty N.K., Onay T.T., Uyguner Demirel C.S., Karanfil T. (2016). Leaching of nano-ZnO in municipal solid waste. J. Hazard. Mater. 317, 319–26.

Schabrun S.M., van den Hoorn W., Moorcroft A., Greenland C., Hodges P.W. (2014). Texting and Walking: Strategies for Postural Control and Implications for Safety. PLOS ONE 9(2), e91489. https://doi.org/10.1371/journal.pone.0084312.

Schauenberg T. (2018). Biohacking - genetic engineering from your garage http://www.dw.com/en/biohacking-genetic-engineering-from-your-garage/a-42030559?maca=en-rss-en-all-1573-rdf.

SCHER (Scientific Committee on Health and Environmental Risks), SCENIHR (Scientific Committee on Emerging and Newly Identified Health Risks), SCCS (Scientific Committee on Consumer Safety), Synthetic Biology II - Risk assessment methodologies and safety aspects, Opinion, December, 2014.

Schmidt M. (2008). Diffusion of synthetic biology: a challenge to biosafety. Systems Synth. Biol. 2, 1–6.

Schwarzer M., Makki K., Storelli G., Machuca-Gayet I., Srutkova D., Hermanova P., Martino M.E., Balmand S., Hudcovic T., Heddi A., *et al*. (2016). Lactobacillus plantarum strain maintains growth of infant mice during chronic undernutrition. Science, 351, 854-7.

Schwebel D.C., Stavrinos D., Byington K.W., Davis T., O'Neal E.E., de Jong D. (2012). Distraction and pedestrian safety: How talking on the phone, texting, and listening to music impact crossing the street. Accident Analysis & Prevention, 45, 266-71. https://doi.org/10.1016/j.aap.2011.07.011

Scientific Panel on Contaminants in the Food Chain, Minutes of the 85th Plenary meeting held on 4-6 July 2017, Parma (Italy). https://www.efsa.europa.eu/sites/default/files/event/170704-m.pdf; http://registerofquestions.efsa.europa.eu/roqFrontend/questionLoader?question=EFSA-Q-2015-00526; http://registerofquestions.efsa.europa.eu/roqFrontend/questionDocumentsLoader?question=EFSA-Q-2017-00549.

Shandilya N. *et al*. (2015). Emission of titanium dioxide na-noparticles from building materials to the environment by wear and weather. Environ Sci Technol 49(4), 2163-70.

Sjerps R.M.A.; Vughs D. van Leerdam J.A., ter Laak T.L., van Wezel A.P. (2016). Data-driven prioritization of chemicals for various water types using suspect screening LC-HRMS. Water Res. 93, 254−64.

Soh Y., Roddick F., Van Leeuwen J. (2007). The future of water in Australia: the potential effects of climate change and ozone depletion on Australian water quality, quantity and treatability. The Environmentalist 28, 158-65.

van Broekhuizen P., van Broekhuizen F., Cornelissen R., Reijnders L. (2011). Use of nanomaterials in the European construction industry and some occupational health aspects thereof. Journal of Nanoparticle Research 13(2), 447-62.

Veling W., Pot-Kolder R., Counotte J., van Os J.,van der Gaag M. (2016). Environmental Social Stress, Paranoia and Psychosis Liability: A Virtual Reality Study; Schizophr Bull. 42(6), 1363–71. doi: 10.1093/schbul/sbw031.

Verschoor A.J., Bodar C.W.M., Baumann R.A. (2018). The environmental impact of rubber infill near synthetic turf fields. National Institute for Public Health and the Environment (RIVM), Bilthoven, The Netherlands, DOI 10.21945/RIVM-2018-0072.

Versteegh J.F.M., de Voogt P. (2017). Risicoduiding en v66rkomen van FRD-903 in drinkwater en drinkwaterbronnen bij een selectie van drinkwater¬winningen in Nederland. RIVM Report 2017-0175, Bilthoven, p.1-22.

Vughs D., Baken K.A., Kolkman A., Martijn A.J., de Voogt P. (2018). Application of effect-directed analysis to identify mutagenic nitrogenous disinfection by-products of advanced oxidation drinking water treatment. Environ Sci Pollut Res Int. 25(5), 3951-64. doi: 10.1007/s11356-016-7252-6.

Wang J., Wang S. (2016). Removal of pharmaceuticals and personal care products (PPCPs) from wastewater: A review. J Environ Manage. 182, 620-40. doi: 10.1016/j.jenvman.2016.07.049.

Wright S.L., Kelly F.J. (2017). Critical Review: Plastic and Human Health: A Micro Issue? Environ. Sci. Technol., 51(12) 6634–47.

Xi C., Zhang Y., Marrs C.F., Ye W., Simon C., Foxman B., Nriagu J. (2009). Prevalence of Antibiotic Resistance in Drinking Water Treatment and Distribution Systems. Appl. Environ. Microbiol. 75, 5714-18.

Zahn D., Frömel T., Knepper T.P. (2016). Halogenated methanesulfonic acids: A new class of organic micropollutants in the water cycle Water Res. 101, 292– 9.

Zuccato E., Castiglioni S., Fanelli R., Reitano G., Bagnati R., Chiabrando C., Pomati F., Rossetti C., Calamari D. (2006). Pharmaceuticals in the Environment in Italy: Causes, Occurrence, Effects and Control. Environ Sci & Pollut Res 13 (1), 15-21.