Research Summary Sheet

Deliverable n°: 1.1 (Task 1.5)

"Key indicators and methodologies for assessing the impacts on soil, water, air quality and human safety of agro-waste management".

Indirect impact through Air

Source of harmful effect / Types of contaminants: Chemical/Ammonia

Impacts on human health

At room temperature the ammonia is colourless, pungent and flammable gas. Ammonia is a serve irritant for eye, skin respiratory track, chronic exposure induce irritation, coughing, difficult breath. 30 - 40 ppm causes irritation of mucous membranes, respiratory tract and eyes, more than 300 ppm has immediately danger to life and health (NOISH/ National Institute for Occupational Safety and Health). 1000 ppm can cause difficulty in breathing, unconsciousness. Danger of fire: 15 % - 30 %.

Threshold levels in air

DIRECTIVE 2008/50/EC which regulates ambient air quality does not contain threshold limits for ammonia.

2000/39/EC establishing the indicative occupational exposure limit values for the protection of the health and safety of workers from the risks related to chemical agents. For ammonia the 8 hours exposure limit values is 14 mg/m^3 (20 ppm), while the short term exposure is limited to 36 mg/m^3 (50 ppm).

Safety measures

The following solutions, action can reduce the risk related to ammonia: process enclosure, local exhaust ventilation, general dilution ventilation, personal protective equipment. Airborne ammonia can be determined by monitoring sulfuric acid impregnated carbon bead tubes (USA department of Health and Human services, 1992)

As a minimum it sis recommends protective gloves, splash-proof goggles, hearing protection, and steel toe shoes for employees associated with the digester system. For visitors to the facility, safety glasses and hearing protection should be available and worn while on site. In case of ammonia leak person not wearing protective equipment should be restricted from the area.

The project leading to this application has funding from European Union's Horizon 2020 research and innovation programme under grant agreement No 688338.

Bibliographic references

Anneli Petersson, Arthur Wellinger, (October 2009) IEA Bioenergy, Biogas upgrading technologies – developments and innovations

USA department of Health and Human services: Occupational safety and health guideline for ammonia (1992)

Agstar, Common safety practices for on farm anaerobic digestion, December 2011

2000/39/EC of 8 June 2000 establishing a first list of indicative occupational exposure limit values in implementation of Council Directive 98/24/EC on the protection of the health and safety of workers from the risks related to chemical agents at work

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Indirect impact through Air

Source of harmful effect / Types of contaminants: Biological/Bioaerosols

Impacts on human health

Although bioaerosols are present everywhere, in the waste management operation the level of the bioaerosols are higher due to specific feature of the process, which requires micro-organisms to support the and contains specific activities such as shredding, turning, which release the micro-organisms into the air. The can be an important indicator as aerodynamic properties allow them to be released at high numbers on site, but also potentially travel away from site, downwind. (Drew et al.) Biological agents that are transmitted as bioaerosols are of the greatest epidemiological importance. As Gróny (last accessed 2017) explains the type of interactions between the bioaerosol particles and human cells depends on the place of their deposition and is conditioned by their retention time in the respiratory tract. The health effects include but are not limited to inflammatory and allergic respiratory diseases, eye and skin irritations but it can cause infectious aspergillosis, zygomycosis. Besides, it has to be emphasized those special groups e.g.: immunocompromised individuals are more susceptible at lower concentrations of the relevant pathogens in bioaerosols.

Threshold levels in air

According to Pearson et al. (2015) there are no apparent existing guidelines for community levels in other countries, but a number of countries published occupational limit values. The following levels are acceptable but these are guidelines and not based upon dose-response relationships or health measures.

- 1000 cfu/m^3 for total bacteria.
- 300 cfu/m^3 for gram-negative bacteria.
- 500 cfu/m^3 for Aspergillus fumigatus.

The bioaerosols vary greatly depending on season, time of day, geographic location, and local weather conditions (particularly humidity and solar radiation). In the literature very different values can be found concerning the distance to which waste management (e.g: composting) bioaerosols can be detected: it ranges from 150 m to 1400 m. The UK Environmental Agency considers that concentrations can return to those of the background noise as near as 250m from the source emission but Wéry (2014) suggests extending this range to 500 m.

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Control measures

For the general public if the facility is more than 500 m from the living environment, the bioaerosol exposure can be negligible. In working environment the recommended measures include the use of:

- Vehicles with sealed cabs with air filtration and doors and windows which must be closed during operations with compost or appropriate respiratory protective equipment employed.
- Elevators, conveyors and screens should be enclosed or fitted with extraction.
- Respiratory protective equipment should be used where exposure to airborne dust is unavoidable.

Bibliographic references

Rafał L. Górny, Central Institute for Labour Protection - National Research Institute, Poland, Bioaerosols and OSH (last accessed March, 2017) URL: https://oshwiki.eu/wiki/Bioaerosols_and_OSH#Threshold_limit_values_for_occupational_bioaerosols

N. Wéry (2014), Bioaerosols from composting facilities—a review, Frontiers in CELLULAR AND INFECTION MICROBIOLOGY, 04 April 2014, doi: 10.3389/fcimb.2014.00042

Drew, G.H., Deacon, L.J., Pankhurst, L., Pollard, S.J.T. and Tyrrel, S.F., Guidance on the evaluation of bioaerosol risk assessments for composting facilities, Published by Environment Agency, Rio House, Waterside Drive, Aztec West, Almondsbury, Bristol, BS32 4UD

Pearson C, Littlewood E, Douglas P, Robertson S, Gant TW, Hansell AL. (2015) Exposures and Health Outcomes in Relation to Bioaerosol Emissions From Composting Facilities: A Systematic Review of Occupational and Community Studies. Journal of Toxicology and Environmental Health Part B, Critical Reviews. 2015;18(1):43-69. doi:10.1080/10937404.2015.1009961.

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Research Summary Sheet

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"Key indicators and methodologies for assessing the impacts on soil, water, air quality and human safety of agro-waste management".

Indirect impact through Air

Source of harmful effect / Types of contaminants: Dust, PM2.5, PM10

Impacts on human health

Employees and local residents can be exposed to dust generated in the whole value chain from the agricultural through logistic, to the process steps (e.g.: handling & transporting feedstock, carrying out different process steps such as moulding etc.) The PM can be a good indicator for benchmarking of different agricultural waste management strategies. As WHO factsheet (2016) describes the improved methods of biological waste management such as anaerobic waste digestion to produce biogas, are feasible, low cost alternatives to the open incineration of solid waste (which generates a lot of fine particles that has adverse effect on health). The inhalable particles can be divided into different groups:

- coarse particles with a diameter between 2.5 and 10 micrometres (PM10),
- fine particles with a diameter of 2.5 µm or less (PM2.5)

The dust exposure can cause respiratory and lung diseases. The particles are deposited, either in the head or in the lung; they have the potential to cause harm either locally or subsequently elsewhere in the body. The deposition of particulates in different parts of the human respiratory system depends on particle size, shape, density, and individual breathing patterns. All particles smaller than 10 microns in diameter can reach the human lungs, the retention rate is largest for the finer particle (Airborne Particulate Matter, World Bank Group 1998).

Exposure to fine particles (PM2.5) can have short or long term effect. Even the short-term exposure can have health effects like eye, nose, throat and lung irritation, coughing, sneezing, runny nose and shortness of breath. Long term exposure to fine particulate matter can be linked to increased rates of chronic bronchitis, reduced lung function and increased mortality from lung cancer and heart disease.

Threshold levels in air

Small particulate pollution have health impacts even at very low concentrations – indeed no threshold has been identified below which no damage to health is observed (WHO, 2016)

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The 2005 "WHO Air quality guidelines" offer global guidance on thresholds and limits for key air pollutants that pose health risks. In case of PM10 the annual mean is 20 µg/m^3 , and the 24-hour mean is 50 µg/m^3 . The annual mean limit for PM2.5 is 10 µg/m^3, while the 24-hour mean is 25µg/m^3.
Directive 2008/50/EC limits PM10 to 50 µg/m^3 for yearly average and 50 µg/m^3 for one day (not to be exceeded more than 35 times a calendar year, limit value entered into force in 2005).

The limit for PM2,5 entered into force in 2015. It specifies the limit value for only for yearly average, which is 25 µg/m^3. No one-day limit value is available.

ref. http://ec.europa.eu/environment/air/quality/standards.htm

Control measures

Changing processes and activities can help to o reduce dust at source, for example enclosure of the process; good general ventilation; proper handling of materials; good maintenance of plant and equipment; good housekeeping.

Control measures for occupational dust exposures: risk assessment should be carried out and protective equipment, specific design such as: using screeners, dust suppression equipment, front-end loaders needs to take into consideration. Exposition should be checked regularly.

Bibliographic references

WHO Fact sheet Ambient (outdoor) air quality and health, Updated September 2016, URL: http://www.who.int/mediacentre/factsheets/fs313/en/)

WHO/SDE/OEH/99.14, Hazard Prevention and Control in the Work Environment: Airborne Dust

Directive 2008/50/EC on on ambient air quality and cleaner air for Europe

European Commission, Air Quality Standards,
URL http://ec.europa.eu/environment/air/quality/standards.htm, (last accessed March 2017)

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Research Summary Sheet

Deliverable n°: 1.1 (Task 1.5)

"Key indicators and methodologies for assessing the impacts on soil, water, air quality and human safety of agro-waste management".

Indirect impact through Water-Air-Food

Source of harmful effect / Types of contaminants: PAH

Impacts on human health

Polycyclic aromatic hydrocarbons (PAHs) - which are genotoxic and carcinogenic agents - can contaminate foods different ways. One of the most frequent ways can be smoking processes and heating and drying processes that allow combustion products to come into direct contact with food. In Regulation (EC) No 1881/2006 it is describe that polycyclic aromatic hydrocarbons (PAH) was concluded in 2002 by the Scientific Committee on Food (SCF) as being genotoxic carcinogens (PAH) are. The effects on human health depend on the length and route of exposure, the amount or concentration of PAHs one is exposed to, and of course the innate toxicity of the PAHs . The long-term effect of PAHs may include decreased immune function, cataracts, kidney and liver damage, breathing problems, asthma-like symptoms, and lung function abnormalities.

According to the SCF, benzo(a)pyrene can be used as a marker for the occurrence and effect of carcinogenic PAH in food, including also benz(a)anthracene, benzo(b)fluoranthene, enzo(j)fluoranthene, benzo(k)fluoranthene, benzo(g,h,i)perylene, chrysene, cyclopenta(c,d)pyrene, dibenz(a,h)anthracene, dibenzo(a,e)pyrene, dibenzo(a,h)pyrene, dibenzo(a,i)pyrene, ibenzo(a,l)pyrene, indeno(1,2,3-cd)pyrene and 5-methylchrysene. (No 1881/2006)

Threshold levels in air, water and food

Water

World Health Organization (2003) summarized the concerns related to PAHs in drinking water. It describes hat apart from highly industrially polluted rivers, the concentrations of individual PAHs in surface and coastal waters are generally =50 ng/litre. PAH levels in uncontaminated groundwater are usually in the range of 0–5 ng/litre. Leaching of PAHs from soils into groundwater is negligible, as the compounds tend to adsorb strongly to the soil organic matter. Elevated concentrations of PAHs (predominantly FA, BbFA, PY, IP, phenanthrene) were observed in rainwater and especially in snow and fog. The typical concentration range for the sum of the selected PAHs in drinking-water is from about 1 ng/litre to worst cases of 11 µg/litre. According to the WHO guideline the main source of PAH contamination in drinking-water is usually not the raw water sources but the coating of the drinking-water distribution pipes.

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The threshold limits for water intended for human consumption is regulated in Council Directive 98/83/EC. It sets the individual parametric value for Benzo(a)pyrene to the 0,010 µg/l.

Air

PAH generation through agricultural sources can be the result of the burning of organic materials under suboptimum combustion conditions.

Target value for benzoa() pyrene in ambient air (DIRECTIVE 2004/107/EC) is 1 ng/m^3 (for the total fraction in the PM10 fraction averaged over a calendar year.

Food

Smoking, heating process can cause PAH contamination of foods but environmental pollution may cause contamination with PAH, in particular in fish and fishery products.

The EC No 1881/2006 regulation show the maximum levels of PAHs for different types of products. The limit values are given for Benzo(a)pyren and for the sum of benzo(a)- pyrene, benz(a)anthracene, benzo(b)fluoranthene and chrysene. The permitted maximum levels vary between around 5-6 µg/kg benzo(a)- pyrene for smoked fish products 3-5 µg/kg benzo(a)- pyrene for cocoa fibre and cocoa beans (measured in µg /kg fat) derived products. For specific target groups like infants, babies, medical products has to complies much lower limit values, it is set to maximum 1 µg/kg benzo(a)- pyrene.

Control measures

In developing a food safety management system based on HACCP principles, it is important to identify PAHs as a potential hazard and the risk of their occurrence needs to be controlled. Food business, need to identify any CCPs in their processes, such as combustion products and drying processes, that may be a source of PAH formation. For the general public it is suggested to avoid direct contact of oil seeds or cereals with combustion products during drying processes, to avoid contact of foods with flames when barbecuing, to use less fat for grilling and cook at lower temperatures for a longer time (Food Safety Authority of Ireland, 2015).

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Bibliographic references

COMMISSION REGULATION (EC) No 1881/2006 of 19 December 2006 setting maximum levels for certain contaminants in foodstuffs

DIRECTIVE 2004/107/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 15 December 2004 relating to arsenic, cadmium, mercury, nickel and polycyclic aromatic hydrocarbons in ambient air

COUNCIL DIRECTIVE 98/83/EC of 3 November 1998 on the quality of water intended for human consumption

Ambient air pollution by Polycyclic Aromatic Hydrocarbons (PAH) Position Paper, Prepared by the Working Group On Polycyclic Aromatic Hydrocarbons, July 27th 2001, ISBN 92-894-2057-X

World Health Organization (2003) Polynuclear aromatic hydrocarbons in Drinking-water Background document for development of WHO Guidelines for Drinking-water Quality, WHO/SDE/WSH/03.04/59

Food Safety Authority of Ireland (2015) Polycyclic Aromatic Hydrocarbons (PAHs) in Food, TOXICOLOGY FACTSHEET SERIES, ISSUE NO. 2 | JUNE 2015

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Research Summary Sheet

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"Key indicators and methodologies for assessing the impacts on soil, water, air quality and human safety of agro-waste management".

Indirect impact through Water-Air-Food

Source of harmful effect / Types of contaminants: PCB

Impacts on human health

Polychlorinated biphenyls (PCBs) are a group of 209 different congeners which can be divided into two groups according to their toxicological properties: 12 congeners exhibit toxicological properties similar to dioxins and are therefore often termed dioxin-like PCBs. The other PCBs do not exhibit dioxin-like toxicity but have a different toxicological profile. (No 1881/2006)

PCBs persist in the environment the reason for it their uncreativeness and the fact that they are largely resistant to breakdown by acids, bases and heat. It belongs to the group of persistent organic pollutants (POPs). Generally, PCBs are not very soluble in water, but readily soluble in fats this is the reason why PCBs can build up in animal fat and along the food chain. (Green Facts, last accessed in March, 2017). The critical endpoints for risk assessment of PCBs are identified as cancer, immunotoxic, neurotoxic, hepatotoxic, toxic to reproduction and behavioural effects.

Threshold levels in air, water and food

Water

The threshold limits for water intended for human consumption is regulated in Council Directive 98/83/EC but it does not contains specific parametric value for PCBs (just for other chlorinated compounds).

Industrial discharges are prohibited under the Clean Water Act Effluent Guidelines (EPA, U.S.). The PCB spills or accidental releases into the environment of 1 pound or more are needed to be reported to EPA. EPA's goal for drinking water's maximum contaminant level is zero, and the enforceable MCL (maxi-mum contaminant level) for PCBs in public water systems is 0.0005ppm.

Air

Few studies have been conducted to measure ambient air levels of PCBs, but concentrations appear to differ markedly between locations, eg.: type of areas, place of measurement. The lowest levels, from 0.002 ng/m^3 , are found in non-industrialized and non-contaminated areas, while industrialized zones may have higher levels such as f 3.3 ng/m^3 (e.g.: the Ruhr area in Germany). Nearby industrial plants the levels can reach 45 and 650 µg/m3. (WHO, 2000).

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Food

For the general public the food is the main source of exposure to PCBs. Exposure occurs primarily by ingesting high-fat foods—such as dairy products, eggs, and animal fats—and some fish and wildlife. Levels reported in drinking-water are typically between 0.1 and 0.5 ng/litre. (WHO, 2000).

The Food and Agriculture Organization (FAO) and the World Health Organization (WHO) allow a daily PCB intake of 6 µg/kg per day. (ATSDR, last accessed in March 2017).

The specific limit values for different product types can be found in EC No 1881/2006 regulation. There are differences in threshold limits by product type, terrestrial animals vs. fishery products, target groups (e.g. foods for infants and young children).

Control measures

In order to reduce the contamination of food, the following control measures need to be considered: developing Good Agricultural Practice, Good Animal Feeding Practice and Good Manufacturing Practice. Some examples: do not use contaminated soil / areas for production of feed crops, sewage sludge used in agriculture should be monitored for fulfilling the the threshold levels, animal derived feed should be monitored for dioxins, control critical feed manufacturing processes (e.g., drying , heating). (FAO 2008)

Bibliographic references

COMMISSION REGULATION (EC) No 1881/2006 of 19 December 2006 setting maximum levels for certain contaminants in foodstuffs

GreenFacts, PCBs Polychlorinated biphenyls, URL: http://www.greenfacts.org/en/pcbs/l-2/1-polychlorinated-biphenyls.htm, (last accessed in March, 2017)

WHO Regional Office for Europe, Copenhagen, Denmark, 2000 Air Quality Guidelines – Second Edition , Chapter 5.10 Polychlorinated biphenyls (PCBs)

ATSDR (Agency for Toxic Substances And Disease Registry), Polychlorinated Biphenyls (PCBs) Toxicity What Standards and Regulations Exist for PCB Exposure?
URL: https://www.atsdr.cdc.gov/csem/csem.asp?csem=30&po=8 (last accessed in March 2017)

FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS (2008) Fact sheet, Dioxins in the food chain Prevention and control of contamination, 2 April 2008

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Research Summary Sheet

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Indirect impact through Water-Soil-Food

Source of harmful effect / Types of contaminants: Pesticide

Impacts on human health

Pesticides are widely used in agricultural production to prevent or control pests, diseases, weeds, and other plant pathogens in an effort to reduce or eliminate yield losses and maintain high product quality. Due to their high biological activity, and, in some cases, long persistence in the environment, pesticides may cause harmful effects to human health and to the environment (Damalas- Eleftherohorinos, 2011).

Non-occupational exposure originating from pesticide residues in food, air and drinking water generally involves low doses and is chronic (or semi-chronic). However, clear links between individual pesticides and individual health effects can only be shown in animal studies, but the doses used in these studies are far higher than the enforced legally pesticide limits (Damalas - Koutroubas, 2016).

Threshold levels in air, water and food

Air

Pesticides can get into the air with fumigants (gasses), dusts or when liquid pesticides are applied as a very fine mist. Drift likely to occur on windy days and when temperatures are very high. Pesticides in the air can rise to very high altitudes and move for long distances attached to particles. There are no threshold levels in the regulation for ambient air. (DIRECTIVE 2004/107/EC and DIRECTIVE 2008/50/EC.)

Water

Pesticides can get into water via drift during pesticide spraying, by runoff from treated area, leaching through the soil. In some cases pesticides can be applied directly onto water surface e.g. for control of mosquitoes. Water contamination depends mainly on nature of pesticides (water solubility, hydrophobicity), soil properties, weather conditions, landscape and also on the distance from an application site to a water source. Rapid transport to groundwater may be caused by heavy rainfall shortly after application of the pesticide to wet soils.

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The threshold limits for water intended for human consumption is regulated in Council Directive 98/83/EC. It sets the individual parametric value for pesticides 0,10 µg/l, for total pesticide content 0,50 µg/l.

Food

The European Commission fixes Maximum Residue Levels (MRLs) for all food and animal feed. The MRLs for all crops and all pesticides can be found in the MRL database on the Commission website (EU Pestice database).

The MRLs for those pesticedes which were reported as most freqently detected in table and wine grapes are the followings for wine grapes: dithiocarbamates 5 mg/kg, ethephon 1 mg/kg, fenhexamid 15 mg/kg, boscalid 5 mg/kg, dimethomorph (sum of isomers) 3 mg/kg.

The MRLs for those pesticedes which were reported as most freqently detectedfor wheat are the followings : Chlormequat 2 mg/kg, Chlorpyrifos-methyl (F) 3 mg/kg, Glyphosate 10 mg/kg, Pirimiphos-methyl (F) 5(ft) mg/kg, Tebuconazole (R) 0,3 mg/kg, Deltamethrin (cis-deltamethrin) (F) 2mg/kg, Mepiquat (sum of mepiquat and its salts, expressed as mepiquat chloride) 3 mg/kg.

Control measures

Good Agricultural Practice can reduce exposure to pesticides. If the main aspects are kept, the contamination of the environment / potentially harmful residues on the crop can be prevented. It is essential to use permitted pesticide products, and only on crops specified and for weeds or pests indicated on the label. Application rates and recommendation for usage must be kept and the equipment need to checked / calibrated regularly in order to deliver the correct rate. Pesticides must be applied under the right environmental conditions to reduce the possibility of spray drift, run-off or leaching that may contaminate other crops. Appropriate clean instructions are needed for equipment to prevent carry over and contamination. The pre-harvest interval and the pre-grazing interval requirements must be followed.

Farmers and farm workers face greater risk of exposure to pesticides than typical non-agricultural workers, comprising a major group of workers that are consistently exposed to pesticides. The exposure of workers increases in the case of not paying attention to the instructions on how to use the pesticides and particularly when they ignore basic safety guidelines on the use of personal protective equipment and fundamental sanitation practices such as washing hands after pesticide handling or before eating. Training on good practice is essential.

The project leading to this application has funding from European Union's Horizon 2020 research and innovation programme under grant agreement No 688338.

Bibliographic references

Damalas, C. A., Eleftherohorinos, I. G. (2011). Pesticide Exposure, Safety Issues, and Risk Assessment Indicators. International Journal of Environmental Research and Public Health, 8(5), 1402–1419. http://doi.org/10.3390/ijerph8051402

Damalas, C. A., Koutroubas S. D. (2016): Farmers' Exposure to Pesticides: Toxicity Types and Ways of Prevention. Toxics 2016,4, 1; doi:10.3390/toxics4010001.

EU Pestice database. URL: http://ec.europa.eu/food/plant/pesticides/eu-pesticides-database/public/?event=homepage&language=EN

COUNCIL DIRECTIVE 98/83/EC of 3 November 1998 on the quality of water intended for human consumption

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Indirect impact through Water-Soil-Food

Source of harmful effect / Types of contaminants: Heavy Metals

Impacts on human health

Heavy metals can be potentially toxic chemical elements that are present in the environment, soil and in food products. The most frequent ways of human exposure is by ingestion (drinking or eating) or inhalation (breathing). The toxicity of these elements depends on several factors such as dose, route of exposure, and chemical species, on human dependent factors like age, gender, genetics, and nutritional status of exposed individuals. (Tchounwou et al, 2014) Arsenic, cadmium, chromium, lead and mercury have the greatest potential to cause risk for human because of their high degree of toxicity and extensive use. These elements are carcinogen and cause serve damage in human organs (lung, kidneys, lungs, nerve system) even in low exposure levels. High levels can cause irritating stomach, vomiting breathing problems (e.g.: cadmium, chromium VI compounds, mercury vapour) or immediate death because of serve damage of brain or other organs (e.g.: arsenic, lead, methyl -mercury). Plants and animals can accumulate heavy metals from the enviroments. Humans more likely to be exposed to heavy metals by the soil itself that sticks to the plant and hard to remove. Fish, especially bottom eater species can accumulate in higher amounts from water they leave in and also from the sediment. (Martin and Griswold, 2009)

Threshold levels in air, water and food

Water

Waters contains less than10µg/L arsenic although higher levels can occur near natural mineral deposits. The typical concentration of chromium in sea water 5 to 800 µg/L, and 26 µg/L to 5.2 mg/L in rivers and lakes. Cadmium, lead and mercury exposure can happen by consumption of contaminated water. (Tchounwou et al, 2014):

The **threshold limits** for water intended for human consumption is regulated in Council Directive 98/83/EC. It sets the following limits for the above mentioned heavy metals: 10 µg/l Arsenic, 5,0 µg/l Cadmium, 50 µg/l Chromium, 10 µg/l Lead, 1,0 µg/l Mercury.

COUNCIL DIRECTIVE 98/83/EC of 3 November 1998 on the quality of water intended for human consumption

Air

Exposure to heavy metals can happen through inhalation. Different studied showed the heavy metals concentration such as arsenic can vary by location: the exposure in remote locations 1 to 3 ng/m3, while in cities 20 to 100 ng/m^3 in cities. Individuals can be exposed to heavy metals such as cadmium or lead via inhalation of smoke, cigarette, dust particles and aerosols. (Tchounwou et al, 2014):

The heavy metal target values, threshold limits for air can be found in DIRECTIVE 2004/107/EC and DIRECTIVE 2008/50/EC. The target values for the total content in the PM_{10} fraction averaged over a calendar year are 6 ng/m^3 Arsenic, 5 ng/m^3 Cadmium, 20 ng/m^3 Nickel.

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The limit value for lead is 0,5 µg/m3 (averaging period is a calendar year).

DIRECTIVE 2004/107/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 15 December 2004 relating to arsenic, cadmium, mercury, nickel and polycyclic aromatic hydrocarbons in ambient air

DIRECTIVE 2008/50/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 21 May 2008 on ambient air quality and cleaner air for Europe

Food

Arsenic ranges in foods from 20 to 140 ng/kg. The typical concentration of chromium for fresh food is <10 to 1,300 µg/kg. Mercury, cadmium also can accumulate in seafood and fishes. (Tchounwou et al, 2014).

The EC No 1881/2006 regulation contains the complete list for different foods. For this summary we focused on the products that can be relevant for the NoAW project (animal, wheat / grain and grape based products – where available). Threshold for lead may vary between 0,02 and 0,5 mg/kg wet weight depending on type of the food. This threshold for cadmium can range from 0,05 to 0,2 mg/kg wet weight, for mercury from 0,1 to 1 mg/kg wet weight, for arsenic from 0,25 to 0,3 mg/kg wet weight. For specific limit values check the detailed list of EC No 1881/2006.

Control measures

FSAI (2009) describes the importance of use of control measures.

Companies should identify critical control points (CCPs) in their processes such as lead in the water supply.

The identification of appropriate CCPs along their process chain will enable them to develop and apply proper HACCP systems which will ensure that there are no unforeseen sources of metal contamination in the food.

Bibliographic references

Paul B Tchounwou, Clement G Yedjou, Anita K Patlolla, and Dwayne J Sutton (2014), Heavy Metals Toxicity and the Environment, NIH Public Access, Published in final edited form as: EXS. 2012 ; 101: 133–164. doi:10.1007/978-3-7643-8340-4_6.

Sabine Martin, Ph.D., P.G., Wendy Griswold, Ph.D. (2009) Human Health Effects of Heavy Metals, Environmental Science and Technology Briefs for Citizens, Issue 15, March 2009

COMMISSION REGULATION (EC) No 1881/2006 of 19 December 2006 setting maximum levels for certain contaminants in foodstuffs

DIRECTIVE 2004/107/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 15 December 2004 relating to arsenic, cadmium, mercury, nickel and polycyclic aromatic hydrocarbons in ambient air
DIRECTIVE 2008/50/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 21 May 2008 on ambient air quality and cleaner air for Europe

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