Mikroplast i miljøet

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ATV Jord og Grundvand

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Indhold

FOREKOMST OG EFFEKT AF MIKROPLAST I ORGANISKE RESSOURCER OG JORD

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Baggrund og formål

Genanvendelse af organiske ressourcer, f.eks. kildesorteret organisk dagrenovation (KOD) og spildevandsslam, som gødningskilde medvirker til recirkulering af vigtige plantenæringsstoffer som fosfor og nitrogen, men udgør samtidig en risiko for udledning af miljøfremmede stoffer og partikler til landbrugsjord. Anvendelsen af organiske ressourcer til jordbrugsformål er derfor reguleret i forhold til indholdet af en række kemikalier, og i den nye bekendtgørelse om anvendelse af affald til jordbrugsformål er der endvidere grænser for indholdet af synlige fysiske urenheder (partikler > 2mm) herunder plast. En stor del af mikroplast partiklerne i organiske ressourcer vil dog forventeligt være mindre end 2 mm, og der er meget begrænset viden om: 1) i hvilket omfang mikroplast spredes og ophobes i landbrugsjord ved genanvendelse af organiske ressourcer til jordforbedring, og 2) hvorvidt vigtige jordbundsorganismer påvirkes af mikroplast i det omfang partikler og fibre kan forventes at ophobes i jorden.

I denne præsentation adresseres kort indholdet af mikroplast i organiske ressourcer og efterfølgende præsenteres resultaterne fra et effektstudium på en almindeligt forekommende regnormeart, den Grå Orm (*Aporrectodea caliginosa*) samt enkelte adfærdsstudier på kompostormen *Eisenia veneta*. Formålet med effektstudiet var at undersøge effekter af forskellige gødningsformer på regnorm, herunder spildevandsslam og komposteret husholdningsaffald, med særlig fokus på mulige effekter af mikroplast.

Metode

Indhold af mikroplast i organiske ressourcer: I tre uafhængige studier blev indhold og type af mikroplastpartikler i forskellige organiske ressourcer: spildevandsslam, komposteret spildevandsslam, KOD biopulp og bioforgasset KOD biopulp undersøgt. Prøver udtaget fra de forskellige prøvematricer blev forbehandlet for at reducere organisk indhold og efterfølgende filtreret ud på et 100 μm stålfilter. Antal partikler blev optalt under stereomikoskop og partiklernes form og farve blev registreret. Et repræsentativt udvalg af partiklerne blev analyseret med FTIR-mikroskopi for at verificere at talte partikler var plastik.

Effekter på regnorm: Effekter af tilsat mikroplast og jord gødet med forskellige gødningstyper blev undersøgt i to separate studier. Det første studium er et 12 ugers eksponeringsforsøg, hvor *A. caliginosa* blev eksponeret til jord som gennem 15 år er blevet behandlet med forskellige gødningsformer (hhv. ugødet, NPK, kvægmøg, spildevandsslam i to koncentrationer og komposteret husholdningsaffald i to koncentrationer). Desuden blev to ekstra behandlinger med NPK gødet jord tilsat ekstra mikroplast (0,1% på vægtbasis), i form af polyethylen (PE) mikroplastflager (klippet af ziplock poser) og akryl (PMMA) mikroplastfragmenter (filet af fast akrylblok) inkluderet i forsøget som positive kontroller. I forsøget blev ormenes overlevelse, vækst, reproduktion og nedgravningsadfærd undersøgt efter 3, 6, 9 og 12 uger. Det andet studium består af 9 undvige forsøg, hvor *A. caliginosa* og/eller *E. veneta* i løbet af 48 timer vælger mellem to eller tre jordtyper, og det efterfølgende registreres om ormene har præference for en af de tilbudte jordtyper.

Resultater
Resultaterne fra de tre studier af mikroplast forekomst i organiske ressourcer indikerer at indholdet af mikroplast i KOD og spildevandsslam varierer over tid og i forhold til opland, men at der ikke er nogen systematisk forskel på antallet af mikroplast partikler i gødningsprodukter baseret på hhv. KOD og spildevandsslam. Der er dog forskel på typen af mikroplast partikler i hhv. KOD og spildevandsslam idet KOD i særlig grad indeholder flager og folier (f.eks. fra plastposer) mens spildevandsslam i særlig grad indeholder fibre.

Effektstudiet viste ingen effekter af tilsat plast i form af mikroplastflager (PE) eller mikroplastfragmenter (PMMA) på overlevelse, vækst eller reproduktion hos *A. caliginosa*. Dette resultat er i kontrast til et studium af Lwanga et al (2016), hvor forfatterne fandt signifikante negative effekter på overlevelse og vækst, men ikke på reproduktion ved 60 dages eksponering af en anden regnormeart *Lumbricus terrestris* til PE mikroplast partikler i føden. Effektstudierne viste endvidere at *A. caliginosa i* højere grad påvirkes af fødetilgængelighed og -kvalitet og i mindre grad af forekomsten af urenheder i form af mikroplast, hvor særligt nogle gødningsformer giver bedre forhold for *A. caliginosa*. Dette viste sig især ved forøget reproduktion ved eksponering til accelererede niveauer af slam og komposteret KOD og præference for slam og KOD frem for kvægmøg gødet jord i undvigeforsøgene. Undvigeforsøg med *E. veneta* viste dog også at når fødekvaliteten er den samme, kan ormene detektere og undvige mikroplast i form af både PE flager og PMMA fragmenter.

Konklusion og perspektivering
Konklusionen er at udledning af mikroplast til landbrugsjord må forventes ved genanvendelse af organiske ressourcer. Der bør derfor fremadrettet arbejdes på at udvikle metoder og teknologier til begrænsning af mikroplast indholdet i organiske ressourcer. Samtidig tyder effektstudierne dog på at mikroplast i landbrugsjord har begrænset påvirkning på en af de mest almindeligt forekommende regnormearter, men effekter af mikroplast i det terrestriske miljø bør undersøges yderligere med studier på andre vigtige jordbundsorganismer.

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MIKROPLAST I GRUNDVAND

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Microplastic (MP) pollution has become an emerging issue in the recent years, and studies have shown that MPs are omnipresent in various environmental compartments. Microplastics do not degrade easily, and it is unknown to what extent they are mobile in soil environments, and how likely it is that they could reach the groundwater and consequently end up in the drinking water.

The aim of this study was to first investigate the potential of microplastics to reach the groundwater by performing a literature review, and then to design an experimental study to investigate whether MPs are present in Danish groundwater. In collaboration with drinking water suppliers, six boreholes in different locations in Denmark representing different geological features (limestone or sand aquifers) were selected for testing. The groundwater was sampled directly out of the boreholes before entering any water treatment. Special sampling device was created to filter the water through steel filters with 10µm pore size. For each sampling location, various volumes were pumped through the filters – 1x 10L, 3x 50L and 1x 100L. The steel filters were thereafter analyzed by light microscopy to visually identify potential plastic particles. Thereafer, 10 individual samples were selected for more detailed analysis. These steel samples were resuspended in deionized water and deposited on Anodisc filters to perform Frourier transformed infrared spectroscopy (µFT-IR) analysis, which allows identification of MPs with help of specialized microplastic-identification software MPhunter.

According to the literature review, it is highly unlikely that microplastics in sizes above10µm will be mobile enough to reach groundwater, which is also in line with our experimental findings. Light microscopy analysis of the particles collected through groundwater filtration showed that majority of particles were most likely composed of sand, rust or limestone. Results obtained from µFT-IR analysis revealed presence of different types of MPs in the samples, such as polystyrene, polypropylene, polyester, polyamide, together with many natural particles that were protein-based or cellulose-based. Similar particles were also found in the control samples, indicating that the detected MPs are likely a result of contamination during sampling, sample transport, storage and treatment. In general, it can be concluded that it is highly unlikely that microplastics (>10µm) are present in Danish groundwater, according to locations sampled in this study.

Full report is available at https://mst.dk/media/148257/bilag-3-notat-mikroplast-i-grundvand.pdf.

MIKROPLAST I REGN- OG SPILDEVAND
– FOREKOMST, ANALYSEMETODER, OG USIKKERHEDER

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Baggrund og formål

Plastik har mange anvendelser i et moderne samfund, og er på mange måder en forudsætning for, at et moderne samfund kan fungere. Bagsiden af medaljen er, at noget af plasten ender i miljøet, enten i form af henkastet plastaffald eller i form af direkte udledning af små stykker plast, kaldet mikroplast, hvis stykkerne er mindre end 5 mm på den længste led. Det store plastaffald bliver med tiden nedbrudt til mikroplast. Mikroplast kan optages af dyr og muligvis give anledning til skader på individer og økosystemer. Effekten afhænger formentlig dels af partiklernes størrelse, deres form og af den polymer, de består af.

Det er derfor væsentligt at kunne måle mikroplast ude i miljøet, samt i de kilder der er til mikroplastudledning. Nærværende indlæg gennemgår, hvordan man måler mikroplast samt de udfordringer, der er i analysen. Indlægget præsenterer data fra måling af mikroplast på danske renseanlæg samt giver en indikation af, hvad der findes i afstrømmet regnvand.

Metode, teknik,

Analysemetoden, der er anvendt til analysen, baserer sig på infrarød spektroskopi (IR), hvor man skaber et kort af IR-spektre med en meget fin opløsning. De data, der præsenteres, er gennemført med et Cary 620 FT-IR microscope fra Agilent Technologies koblet med et Cary 670 IR spektroskop. Mikroskopet er udstyret med 15x Cassegrain objektiv og en 128 × 128 Focal Plane Detektormed 5.5 µm pixel opløsning.

Resultater

Der vil blive vist resultater fra to undersøgelser på spildevand, det ene hvor 10 danske renseanlæg er screenet for indløb og udløb, det andet hvor renseanlæg er undersøgt for forskellige rensetrins evne til at tilbageholde plast. Der vil endvidere blive vist data for indholdet af mikroplast i 7 regnvandsbassiner.

Konklusion og perspektivering

Renseanlæg er i stand til at tilbageholde hovedparten (omkring 99%) af den mikroplast, der er i spildevand.

Første studier på mikroplast i afstrømmet regnvand viser, at der er mikroplast heri, og at indholdet ser ud til at afhænge af, hvilken slags opland vandet kommer fra.

Evt. **Litteraturhenvisning**

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MICROPLASTICS IN THE MARINE ENVIRONMENT

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Abstract

Our marine environment is heavily polluted with anthropogenic litter including plastic particles in a broad variety of sizes, from macro to micro and even nano. Microlitter is generally defined as particles smaller than 5 mm and microplastics are particles in the same size range but only includes polymeric particles. The microsized particles are known to be mistaken as food by marine life and pose a threat of transfer to higher levels in food webs. In the last years, researchers as well as the public has raised their interest for this issue.

There are a lot of data available regarding the distribution, abundance and size of particles in specific locations. However, the available data is hard to quantify and compare since there are no standardized methods for sampling or detection. Many studies only visually identified the particles which are dependent on the operator and the detection limit.

However, spectroscopic techniques are also used but the identified particles are often first identified visually. Moreover, the identification of environmental weathered particles are often hard to match to a reference spectra. To improve the situation, we work on the development of a correlative microscopy system for analysis of marine anthropogenic particles.

MICROPLASTICS TO THE ENVIRONMENT: MODELLING OF RELEASES AND IMPACTS IN A GLOBAL PERSPECTIVE

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Baggrund og formål

Marine plastic pollution has gained much attention over the recent years and several initiatives have already acted on the need to prevent further releases of plastic debris to the oceans. Yet, science is lagging behind to comprehensively assess the magnitude and severity of the damages of plastics in the environment and on human health (e.g. through seafood ingestion). In this presentation, a state-of-the-art mapping of global losses of plastics to the environment will be presented, with a dominant focus on microplastics (macroplastics will also be covered). Research needs to quantify the impacts of those plastics losses will be developed in a second time.

Metode, teknik,

To assess the impacts from plastics in the environment, a framework was developed, consisting of 3 components: (i) losses of plastics to the environment, (ii) environmental fate of plastics, (iii) effects of plastics in the marine environment. A first step to operationalise this framework was taken by modelling and quantifying global losses of plastics and providing recommended approaches for modelling the fate and effect components, for which knowledge gaps prevents a consistent operationalisation. The entire value chain of plastics was encompassed, i.e. from their production through their use up to their end-of-life.

Resultater

A global plastics mapping with an unprecedented level of details was developed. It included a differentiation into macro- and micro-plastics, 23 polymer types, 13 types of products and applications, and 11 geographical regions or countries. Sensitivity and uncertainty analyses were applied to characterize the uncertainty of the estimates. Total losses of microplastics amounted to 3.1 Mt with 95% confidence intervals of 2.5-5.8 Mt. An example of the framework application will be presented to illustrate its applicability and relevance in an environmental sustainability context.

Konklusion og perspektivering

The operationalisation of the proposed framework is regarded as essential to assess the actual damages of plastics in the oceans and identify sources and types of plastics, which cause the largest impacts. This approach will enable policy- and decision-makers in authorities and industry to prioritise their actions for curbing plastics pollution, while ensuring that no other relevant environmental impacts are generated elsewhere in the plastics value chain.

MICROPLASTICS AND HUMAN HEALTH: A CRITICAL PERSPECTIVE

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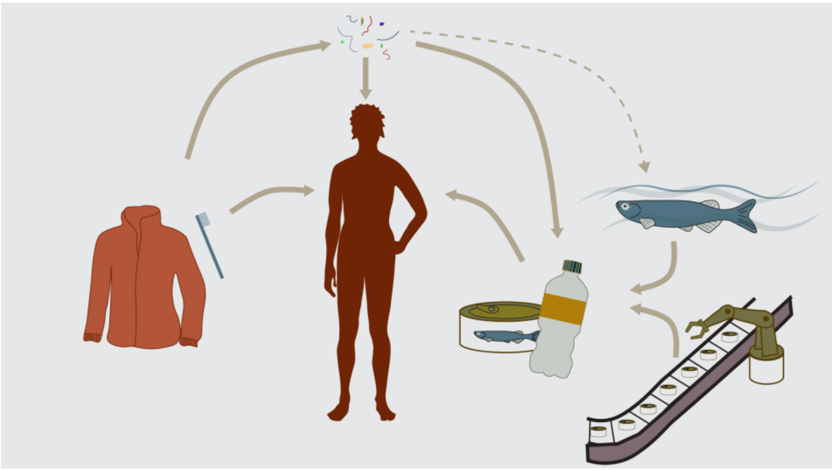

Abstract:
Microplastics are ubiquitous in all environmental compartments, including sediments and water in marine and freshwater systems as well as soils in terrestrial ecosystems. Furthermore, small plastic particles have been found in aquatic species intended for human consumption, such as fish, mussels and oysters, and they have been reported in individual food products and beverages, most prominently in salt, tap and bottled water, honey and beer. This has led to a strong focus on potential implications of microplastic ingestion for human health in the public and scientific debate. However, there is a large discrepancy between the focus of this debate and current scientific knowledge as research on microplastics has so far merely demonstrated their presence in different compartments and examined the interaction with different animal species, not humans. Also, the debate often misses the broader perspective of human exposure to plastic particles[1].

To evaluate potential mechanisms of plastic-related adverse effects on human health we can draw on knowledge from other fields, such as chemicals, air pollution and engineered nanoparticles. Microplastics can potentially constitute particle toxicity and/or chemical toxicity due to additives and residual monomers. For the production of plastics with different properties a multitude of chemicals is used of which some are known to be hazardous. Prominent examples are bisphenol A, an endocrine disruptor associated with reproductive abnormalities, and phthalates that have been shown to adversely affect development and reproduction[2]. Microplastic uptake could therefore lead to exposure to these and other chemicals. Particle toxicity is mainly expected to take place if the plastic particles are translocated into tissues in the gastrointestinal tract or in the lungs where they could trigger inflammatory reactions[3]. This is however only likely for the smallest particle fraction (few µm and below) and has not yet been demonstrated to occur for microplastics taken up with food products.

It is important to consider the magnitude of microplastic exposure that can be expected from the consumption of individual food products and beverages. Estimated maximum numbers of microplastic particles are 11,000 annually per person from consuming shellfish[4], 4,000 from tap water[5] and 1,000 from sea salt[6]. While this has received massive attention in the media, leading to strong negative reactions, other more direct exposure pathways are often neglected. Airborne plastic fibers constitute a substantial exposure as they may be ingested after deposition on food products and beverages or inhaled. Ingestion of fibers depositing on a dinner plate alone can sum up to more than 68,000 annually per person[7]. Other overlooked exposure pathways include abrasion from plastic consumer products and building materials.

The focus on human health implications of microplastics in food is therefore disproportionately high when considering all exposure pathways which are mainly related to the use of plastic materials in our everyday life. In this way we risk missing the root of the problem: the way in which we consume, use and dispose of plastics leading to their ubiquitous presence. We therefore need a more careful and balanced discussion that includes a broader perspective on human plastic exposure.

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Notater

Notater