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 **Öko-Institut e.V.**
Institut für angewandte Ökologie
Institute for Applied Ecology

eco@work

Sustainable reading from the Oeko-Institut



Water

**Resource, habitat,
protected area**

Groundwater
Interview with Dr Heiko Gerdes

Water protection: exploring the depths

Access to clean drinking water is a human right. Following its formal recognition on 28 July 2010, states are now obliged to ensure that water resources are adequately protected. Although this primarily applies to the drinking water supply, it naturally also has a bearing on the conservation of biological diversity in our seas, rivers, wetlands and other water bodies. Here in Germany, we have made substantial progress on water resources protection since the 1960s: our rivers are much cleaner; inclusive and sustainable water resources management is widely practised; and water protection policy is firmly established at the European level with the Water Framework Directive.

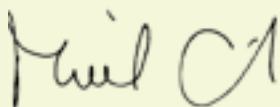
But when it comes to protecting the marine environment, we find ourselves in uncharted waters. We still know very little about the oceans' complex ecosystems. All too often, cities, shipping companies and other users discharge their pollutants and wastes into the sea without any controls. In 2013 – the International Year of Water Cooperation – this has to change: we need to focus urgently on the many problems affecting the sustainable management of the marine environment. Here at the Oeko-Institut, we are already addressing some of these issues. We are working on strategies to combat the growing problem of litter in our oceans and the threats that it poses to marine fauna and flora. We are devising sustainable aquaculture systems for the farming of fish and other marine organisms. And we are supporting sustainable groundwater management. All these topics feature in this latest issue of eco@work.

The interview on page 3 deals with a topic that, for me, is "close to home" in a very literal sense and therefore especially close to my heart: the region known as Hessisches Ried. Here, farmers, homeowners, nature conservationists, water companies and the forestry industry are attempting to find ways of reconciling their diverse but justified interests, with a focus on the drinking water supply, nature and forest conservation, agriculture, and the protection of property and residential areas. A round table has now been launched with scientific and technical input from our Oeko-Institut experts with the aim of achieving a workable and sustainable balance of all these interests.

As well as bringing you some very interesting articles, I'm also delighted to tell you that we've given the online edition of eco@work a bit of a facelift. Our new e-paper format (www.oeko.de/epaper_engl) offers you a more comfortable and convenient online reading experience – and with the browse function, you can leaf through the magazine page by page, just as you would in a printed version. We hope you will recommend it to other potential readers of eco@work.

I hope you enjoy this issue of eco@work and are excited by the insights it offers into our work.

With very best wishes



Michael Sailer
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"More research is needed!"

We may not be able to see it, but groundwater is as vital as our seas, rivers and streams. We need it for our drinking water supply and as an input for agriculture and industry. However, extremely high or low groundwater levels can have adverse effects: high levels can cause seepage and damage to homes and property, while low levels are detrimental to the natural environment. Will climate change affect groundwater levels? This question was investigated by BGS Umwelt GmbH in the AnKliG project (Adaptation Strategies for Climate Change and Extreme Weather Conditions and Measures for a Sustainable Groundwater Management). Managing Director Dr Heiko Gerdes talks to eco@work about the project findings and the need for further studies.

The Oeko-Institut provides expert input for the Hessisches Ried round table. You can find out more from the information box relating to this interview (link below).

Dr Gerdes, what was the main focus of the AnKliG project?

In our research project, which was funded by the German Federal Ministry of Education and Research (BMBF), we investigated the Hessisches Ried as a model region to determine the effects of climate change on the groundwater balance. We used various regional climate models to predict climate trends. However, the models contained considerable differences in relation to some of the relevant test variables. As regards temperature rise, for example, there was convergence between the models, but there was considerable variation in relation to factors such as precipitation and evapotranspiration.

Are you able, nonetheless, to draw any firm conclusions about the effects of climate change on groundwater?

Two of the climate models showed no relevant changes in groundwater recharge and levels. In the Climate Local Model (CLM), however, a widening of amplitudes could be observed, with stronger extremes of high and low groundwater levels. It was also apparent that soil moisture is likely to decrease for longer periods in summer and this will greatly increase the need for irrigation in agriculture – this was evident from all the climate models. The obvious conclusion that we must draw is that more research is needed.

What does this mean in practice?

We need more detailed data from regional climate modelling, and we need to step up the dialogue between groundwater and climate scientists. We also need to keep a close eye on developments, and that means intensifying soil and groundwater monitoring and evaluation, instead of making cutbacks. We will continue to need long time-series, and we should not make the mistake of trying to cut back on the acquisition of data that can help us to assess the impacts of climate change – change which is already happening.

What changes can be observed in relation to groundwater at present?

Rising groundwater has been a problem in many towns and cities for some time, causing seepage in people's homes and potentially putting infrastructure at risk.

Waterlogging is a problem in the Hessisches Ried as well, where a round table is currently attempting to reconcile different interests in groundwater management. You yourself were one of the experts who contributed to this dialogue.

Yes indeed. The problems are not only waterlogging, which can affect homes, and flooding of open fields when groundwater levels are high. A further problem is that woodland is at risk from extremely low groundwater levels. We


carried out a feasibility study to determine to what extent the groundwater level beneath the woodland can be raised so that it reaches the optimum level for trees while avoiding damage to homes and farms.

Is that possible?

Certainly. However, feasibility is only part of the equation: we need to consider sustainability and the ecological footprint as well, along with the annual operating costs of this type of scheme.

Thank you for talking to eco@work.

The interviewer was Christiane Weihe.

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Talking to eco@work: Dr Heiko Gerdes, Managing Director of BGS Umwelt GmbH (Darmstadt)

Marine litter

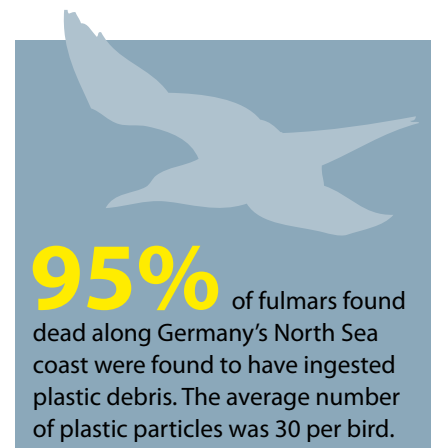
Trashing
the oceans



The volume of waste in the world's oceans is now estimated to exceed more than one hundred million tonnes, with as much as 25 million tonnes of plastic waste currently being added every year. For seabirds and marine fauna, it's a nightmare scenario: they can easily ingest or become entangled in this marine litter. Pieces of plastic are regularly found in various species' digestive tracts. The litter poses a threat to turtles and seals, fish populations and crustaceans. But this marine debris – three quarters of which consists of plastic – is not only a problem for the natural environment. Many potentially toxic chemicals adhere to microscopic breakdown products from plastics, which are then ingested by fish and shellfish and thus enter our food chain.

A plastic cup blown off the deck of a cruise ship, a cigarette end dropped overboard by a fisherman: the sources of marine litter are too numerous to count. In fact, only around one fifth of it comes from sea-based sources, in other words, is actually produced at sea. "Sea-sourced litter comes from ships, offshore facilities and aquaculture," explains Dr Georg Mehlhart from the Oeko-Institut. It includes waste that is customarily dumped overboard by ships, as well as lost cargoes and lost or abandoned fishing gear. Indeed, fishing nets and lines make up a good 10 per cent of marine litter. "But as much as 80 per cent of the marine debris is land-sourced litter," Dr Mehlhart continues. "Some of it comes from individuals, such as tourists, but some of it is from larger onshore facilities such as docks, sewage works and refuse dumps. A lot of waste from inland areas comes down drainage systems and from sewage plants. It then floats down the rivers into the sea."

In their recent "Study on Land-Sourced Litter (LSL) in the marine environment", a review of sources and literature commissioned by the German, Austrian and Swiss plastics industry, Oeko-Institut experts took a closer look at the current situation with regard to the waste that enters the European seas – the North Sea, the Baltic Sea and the Mediterranean Sea. "We analysed all the available studies dealing with land-sourced litter in these three seas," explains Georg Mehlhart. "What we found, however, is that unfortunately, a comparison of the results is very difficult." This is due to the different approaches used and the lack of a common methodology. "When we analysed the literature relating to litter items found on beaches, we also found that for more than 40 per cent, the origin cannot be classified definitively as land-sourced litter (LSL) or sea-sourced litter (SSL)." The researchers also found that most of the data related to litter found on beaches; very few studies have investigated debris



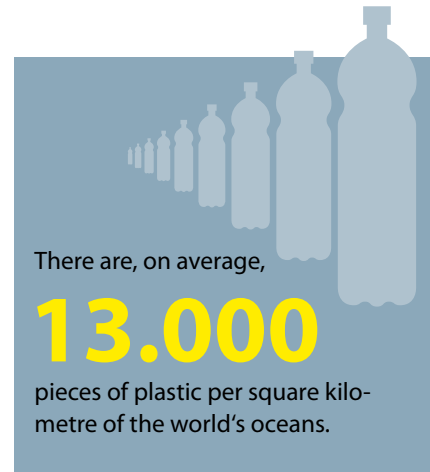
floating on the surface of the water or found on the ocean floor, even though around 70 per cent of litter sinks to the sea bed. "Nonetheless, the studies provide some very interesting information," says Georg Mehlhart. "For example, our analysis shows that the patterns for the three European seas in question differ from the global picture as fewer plastic bags were detected." It also confirms the predominance of plastics in marine litter: no report refers to plastics having

less than a 30 per cent share, and some reports refer to shares of up to 90 per cent. The researchers were also able to identify various potential indicators for the risk of plastic waste entering the marine environment: "Population density and the number of nights spent in tourist accommodation are very good indicators of the potential for marine litter, together with marine transport of freight, waste management and coverage of wastewater treatment and sewers," says Georg Mehlhart.

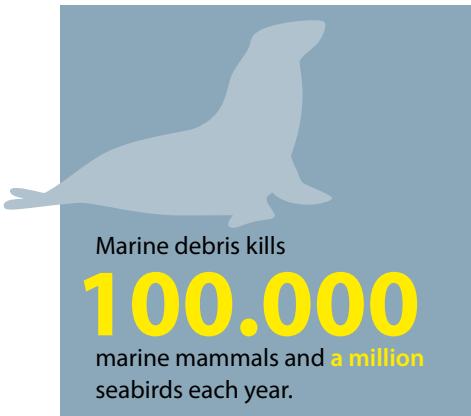
Once the litter has entered the ocean, it often persists in the marine environment for very long periods. Much of it degrades very slowly: a plastic bag takes between ten and twenty years to break down, a plastic bottle takes 450 years and a fishing line even 600 years. But these are merely the visible items of debris floating around our oceans,

sometimes for hundreds of years. The seas are also full of countless tiny fragments of plastic. Known as microplastics, they can enter the marine environment directly – for example, in the form of granules used for air blasting or as abrasives in cosmetic products such as toothpastes, but they may also consist of microscopic breakdown products from larger items of plastic waste. "Microplastics are less than five millimetres in diameter and in some cases are no bigger than nanoparticles," explains the Oeko-Institut expert. He emphasises that these tiny fragments of plastic pose a serious threat to the environment, marine fauna and human health. For example, when plastics degrade, toxic substances such as fire retardants and softeners can be released into the oceans. "Microplastic particles can also adhere to other noxious substances, causing them to aggregate and thus increasing their concentration in the given marine environment," says Georg Mehlhart. "They then accumulate in the food chain and are ingested when we eat fish or seafood."

This is a very serious problem. So what steps are being taken to stop the littering? "Various efforts are being made both internationally and in Europe to address the problem of marine litter," says Professor Rainer Griesshammer from the Oeko-Institut. "At European level, the most important instrument



is the EU's Marine Strategy Framework Directive (MSFD), which entered into force in 2008." This Directive identifies a common approach, comprising six steps, to achieve or maintain good environmental status in all Europe's marine waters by 2020: "The first step was an initial assessment of the current environmental status of the waters concerned, then the determination of what constitutes good environmental status for the waters, and the establishment of a series of environmental targets and associated indicators," says Professor Griesshammer. "Now, it's about establishing a monitoring scheme and developing and implementing a programme of action." Specific measures to reduce marine litter may include launching broad-based information campaigns, improving waste management on ships and in port, and optimising closed-loop systems within the economy.





The problem of marine litter is being addressed at the international level as well. "The first step which should be mentioned here is the Honolulu Strategy, a global framework of action launched at the International Marine Debris Conference in 2011," says Rainer Griesshammer. "Building on the Honolulu Strategy, the Global Partnership on Marine Litter was then announced at the United Nations Conference on Sustainable Development in Rio in 2012." This initiative, led by the United Nations Environment Programme (UNEP), aims to reduce the negative impacts of marine litter worldwide, enhance international cooperation, promote resource


efficiency and economic development through waste prevention and recovering valuable materials from waste, and increase awareness of the sources and impacts of marine litter.


But which options and solutions are available here in Germany? This question was addressed at a workshop commissioned by the German, Austrian and Swiss plastics industry and organised by the Oeko-Institut and team even in March 2013. The 45 participants, who came from a variety of sectors, including politics, business, NGOs and the waste management industry, met in working groups to discuss a number of key questions: how can marine litter be reduced? How should waste management be structured so that less plastic waste enters the oceans? And how should materials or items be best designed so that they cause the lowest possible environmental impact, particularly in the oceans? "Cutting down on short-lived products such as plastic bottles and plastic bags and providing consumer information and awareness-raising are two possible options for avoiding marine litter," says Rainer Griesshammer. "As regards product

design, a detailed analysis of the way in which plastics degrade in the marine environment would be very useful." And for the waste management industry, short-term measures to combat illegal and insecure dumpsites could also be considered.

"There are plenty of good ideas for dealing with marine litter," says the Oeko-Institut's expert. "So we need to act swiftly and put them into practice, particularly given that the total amount of marine litter is likely to increase further over the medium term." This, he explains, is because the consumption of plastic packaging is growing in densely populated newly industrialising and developing countries which lack proper recycling and recovery schemes. "We need to take swift and vigorous action to protect our oceans," says Rainer Griesshammer. "There are plenty of people who can make a contribution – businesses and politicians, researchers and consumers."

Christiane Weihe

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An estimated
20.080
 fishing lines are lost in the
 North Atlantic each year.

Factory fish

How can we make aquaculture more sustainable?

Is livestock welfare ensured during transportation? Do hens have enough space to move around? It seems that we are very willing to ask questions about animal welfare in our livestock husbandry systems, for we want to be certain that conditions are humane. And no wonder – we've all seen shocking images of abuse. But when it comes to the creatures that inhabit the aquatic environment, it's a different story. Aquaculture – the farming of fish and shellfish – attracts much less interest from the public. And yet aquaculture can have extremely harmful impacts on animal health and the environment. So what can we do to make aquaculture more sustainable? That's a question for the experts at the Oeko-Institut.

Aquaculture is a growth industry. Global production of fish from aquaculture has increased steadily over recent years, from 27.6 per cent in 2001 to 40.1 per cent in 2011, according to the Food and Agriculture Organization (FAO). The FAO's statistics, which cover a range of different marine creatures – fish, crustaceans, sea cucumbers and amphibians – quote a global production figure of 62.7 million tonnes for 2011: almost twice the figure for 2001 (34.6 million tonnes). This strong growth is a response to rising demand for fish, but also reflects the stagnating yields from marine fisheries, which are partly the result of overfishing.

But aquaculture is no panacea for these problems, for it can have many adverse

impacts on marine fauna and the environment. "Without proper closed-loop recycling and recovery systems, residues such as fish excrement, antibiotics and hormones can enter our waters," explains Martin Möller, Deputy Head of the Sustainable Products and Material Flows Division at the Oeko-Institut. "What's more, in South-East Asia, the construction of aquaculture facilities, such as ponds for prawn farming, has led to substantial interventions in the environment." In addition, large amounts of fish are processed into fish-meal to be fed to larger carnivorous fish in aquaculture operations: as Martin Möller explains, it takes between two and five kilos of other fish to produce one kilo of farmed salmon, for example – and that's really not sustainable.

What's more, rearing conditions often leave a lot to be desired. Poor conditions can result in disease, injury and behavioural disturbances. Making matters worse, fish sometimes escape from fish farm facilities, posing a genetic threat to wild fish populations. Aquaculture facilities also require large amounts of water and energy, which has a negative impact on their environmental performance.

Asia is the world's centre of aquaculture, accounting for 90 per cent of global production, compared with just 4 per cent for Europe. "The FAO has produced a list of the world's top 20 aquaculture producers of food fish for 2011, and it includes only two European countries – Norway and Spain," says Martin Möller.

"But of course, fish are reared in aquaculture facilities here in Germany as well." Germany's total output amounted to around 19,600 tonnes last year, according to the Federal Statistical Office. And although it is the Asian facilities which attract most criticism for alleged poor welfare and damage to the environment, Germany's fish farms are not above reproach. "In Germany too, there are open systems which can cause environmental problems," says Martin Möller. "So we need to take action to ensure that Germany's aquaculture systems are sustainable as well."

The Oeko-Institut is making an important move in this direction. It is acting as scientific advisor to ten research projects on aquaculture systems supported by the German Federal Foundation for the Environment (Deutsche Bundesstiftung Umwelt – DBU), assessing them in the light of sustainability criteria and identifying their potential for improvement. "The DBU is keen to support user-friendly, innovative technologies," explains Martin Möller. "Some of these projects aim to increase energy and resource efficiency or introduce environmentally sound methods of feed production." For example, one of the projects looks at ways of improving water treatment in closed-loop systems, while another investigates options for using by-products from carp farming in feed production. The use of new species in aquaculture is another area of research. "Until now, fish farming here in Germany has focused almost entirely on two species," says Martin Möller. "Germany's total output of around 19,600 tonnes of farmed fish comprises around 11,800 tonnes of trout and around 6,000 tonnes of carp." The Oeko-Institut's researchers will be monitoring, evaluating and providing consultancy services for the ten projects for a further




year. "These projects constitute important steps towards more sustainable aquaculture," says Martin Möller. "We hope that some of the techniques being pioneered will be incorporated into general fish farming practice over the long term – that would be a very significant success."

Dr Jenny Teufel is also exploring sustainability issues in fish production. As part of a research project commissioned by the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH, she and her colleagues at the Oeko-Institut have carried out a Product Carbon Footprint analysis of selected fish and shellfish all along the production chain, from larvae breeding to retailing of the final product. They investigated salmon reared in conventional aquaculture in Norway, pollock from deep-sea fishing in the North Sea, a type of wels catfish, known as Claresse, reared in closed-loop systems in the Netherlands, and Nile perch from artisanal fisheries in Lake Victoria in East Africa. The PCF analysis included an inventory analysis of the air-freighting of the fresh products and the shipping of frozen fish. "Originally, the analysis was to include Black Tiger Shrimps from a fish farm in Thailand as well," says Jenny Teufel. "But unfortunately, there were problems with data collection here."

The study found that pollock had the lowest Product Carbon Footprint of all the products investigated, although when the fisheries themselves were compared, pollock was beaten into second place by the Nile perch fishery in

Lake Victoria, which uses the most traditional approach to fishing. For all the products analysed – with the exception of air-freighted fish – it is the fishing or farming itself which accounts for the major share of greenhouse gas emissions. "In aquaculture, these emissions mainly come from feed production and the electricity required by the facility," explains Jenny Teufel. In her view, one of the study's key findings is the marked extent to which the Product Carbon Footprint varies according to the type of transport used. "We found that fresh fish may not necessarily be the most sustainable supply option," she explains. "From a climate perspective, air-freighting fish from Africa to Europe is not a sound approach." For Jenny Teufel, the study for GIZ has answered some of her questions, but it has also raised many new ones. "There is plenty of scope for further research in this area," she says. "There are still a great many cross-cutting issues that need to be addressed, particularly as regards feed production." In her view, consumers need to start asking themselves whether it might be better, in terms of sustainability, to give up eating some species of fish altogether, such as tuna from all sources and sole from the Mediterranean or the North-East Atlantic. After all, protecting the environment and living creatures is just as important in the aquatic environment as it is in livestock husbandry on terra firma.

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