HALF A CENTURY OF ENVIRONMENTAL HEALTH

‘We must keep the earth habitable’

Concern about polluted wastewater from the food industry led to the formation of the Water Purification chair group in the 1960s. Wageningen would help tackle water, soil and air pollution. Now its environmental expertise is a Dutch export product. Not that all the country’s own environmental problems have been solved.

TEXT RENÉ DIDDE **PHOTO** ANP **ILLUSTRATION** PETRA SIEBELINK

'Well, solved, solved... let's just say we have made a considerable contribution to tackling many environmental problems,' says Arthur Mol, rector magnificus and professor of Environmental Policy.

Mol sings the praises of Wageningen water purification techniques, which have contributed to cleaner wastewater around the world, as well as its more basic research on the impact on soil and air of spreading animal manure on the land. 'We have done a lot of research work on that since the 1980s, especially Professor Frans de Haan, who died recently. The problem is not solved yet, unfortunately,' says Mol.

Another strong Wageningen research field which has developed since the 1970s, says Mol, is toxicology and expertise on the accumulation of dangerous substances such as heavy metals and persistent pesticides in soil and water. 'And Wageningen researchers are still working on relevant issues, a current example being the effects of microplastics in the sea.'

DUMPING GARBAGE

Huub Rijnaarts, professor of Environmental Technology, points out another soil-related issue on which Wageningen has made a significant contribution. In the late 1970s, the Netherlands was presented with the bill for decades of dumping toxic, mainly industrial waste. The matter came to light in the South Holland town of Lekkerkerk, where an entire residential neighbourhood turned out to have been built on land that had been raised with industrial waste. Residents became ill and had to vacate their homes.

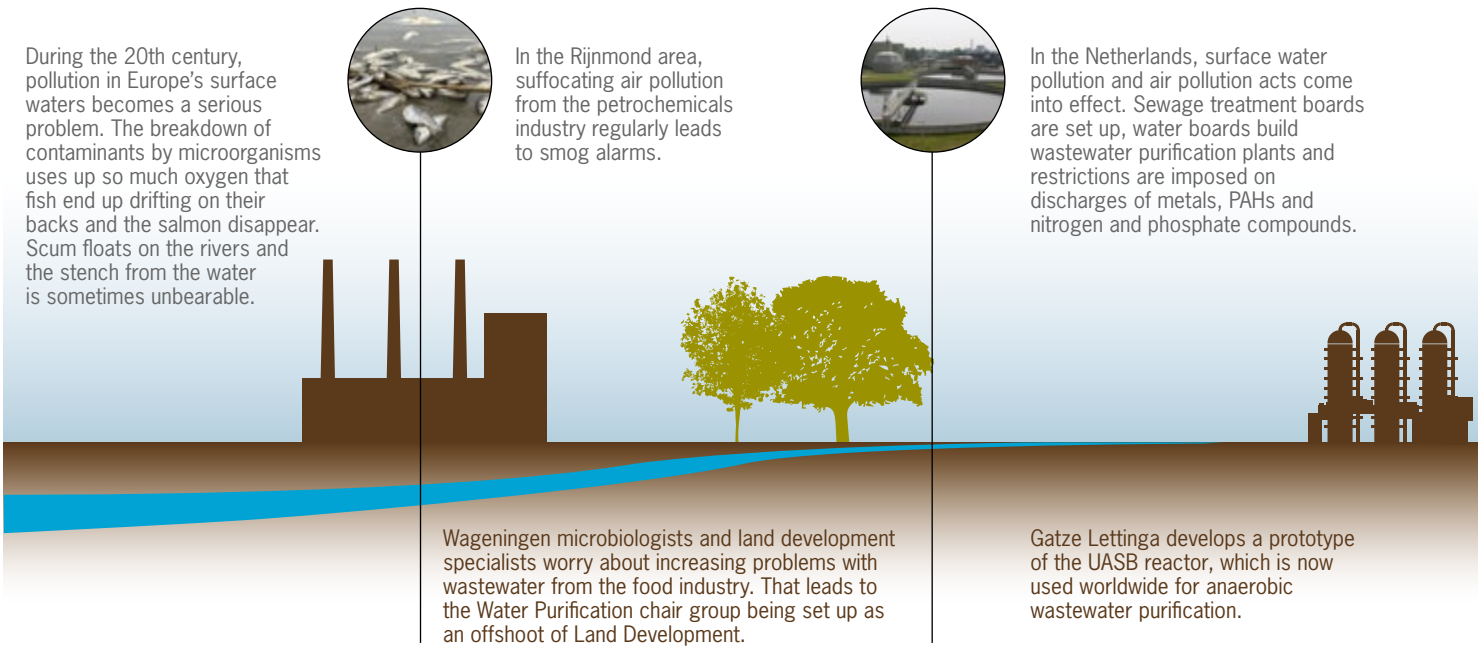
'At first, the approach to soil decontamination was to dig up huge mountains of soil and burn the pollution out of it in the oven, or get it out with chemicals. That left you with clean, but totally "dead" soil,' says Rijnaarts. 'Thanks to our knowledge of microbiology and process engineering, we found out how to deploy bacteria as garbage collectors. We let groundwater containing the micro-organisms flow over the pollution in a controlled fashion, and slowly but surely the bacteria consumed the muck.' The result, says Rijnaarts, is still living soil that has been decontaminated on the spot, and savings of 100 billion euros since 1990, mainly on the costs of digging, transporting and processing the soil.

Rijnaarts and Mol agree on what has been Wageningen researchers' biggest contribution to solving environmental problems: the anaerobic purification of industrial wastewater, pioneered with beet sugar producer CSM. Scientific discoveries are always teamwork, of course, but much of the credit goes to Gatze Lettinga, who moved to Wageningen from Delft in the late 1960s. 'I knew nothing about anaerobic purification,' says the authority on the subject, now 81. 'I just wanted a change from my Delft research on radioactivity in wastewater. I stumbled upon an article about how mother nature could do the purification work using bacteria that could survive without oxygen.'

BACTERIA PRODUCE BIOGAS

Lettinga developed a prototype for a reactor in which the wastewater from food companies is transported over a bed of sludge: the UASB (upflow anaerobic sludge bed) reactor. 'That process does not require any oxygen and takes up a lot less space than the large conventional concrete water purification tanks with their energy-guzzling aeration pumps,' says Lettinga. As a bonus, the bacteria also produce energy in the form of biogas (methane and a little CO_2). Much less sludge is created and the sludge is well-drained, so useful fertilizer ingredients such as phosphate can be extracted.

The rest is history. There are UASB reactors all around the world, most of them at facto-



> ‘We have realized by now that waste is not waste’

ries. Dutch technology companies such as Paques and Biothane make a good living out of the invention. Lettinga came in for numerous prestigious prizes and honorary doctorates. Conventional, aerobic water purification plants are still in use, especially for the purification of household wastewater (sewer water). But even there, anaerobic methods are gaining ground.
For the past 15 years researchers including the Wageningen environmental health expert Mark van Loosdrecht (in Delft) and microbiologist Mike Jelten (in Nijmegen) have been developing processes which link up oxygen-free, low-oxygen and oxygen-rich technology. Lettinga sums up developments: ‘Cees Buisman has led work on expanding the process to include removing sulphur from wastewater and gases; Grietje Zeeman is getting more and more support for decentralized sanitation, in which faeces no longer go into the sewer diluted with lots of water, but are digested in the neighbourhood in concentrated form.’ Lettinga recently visited the water company Waternet in Amsterdam, which is designing a decentralized water purification system for the planned homes and hotels at the Marine complex in Amsterdam. ‘Even a big city such as Amsterdam is increasingly working on decentralized solutions.’

WASTEWATER

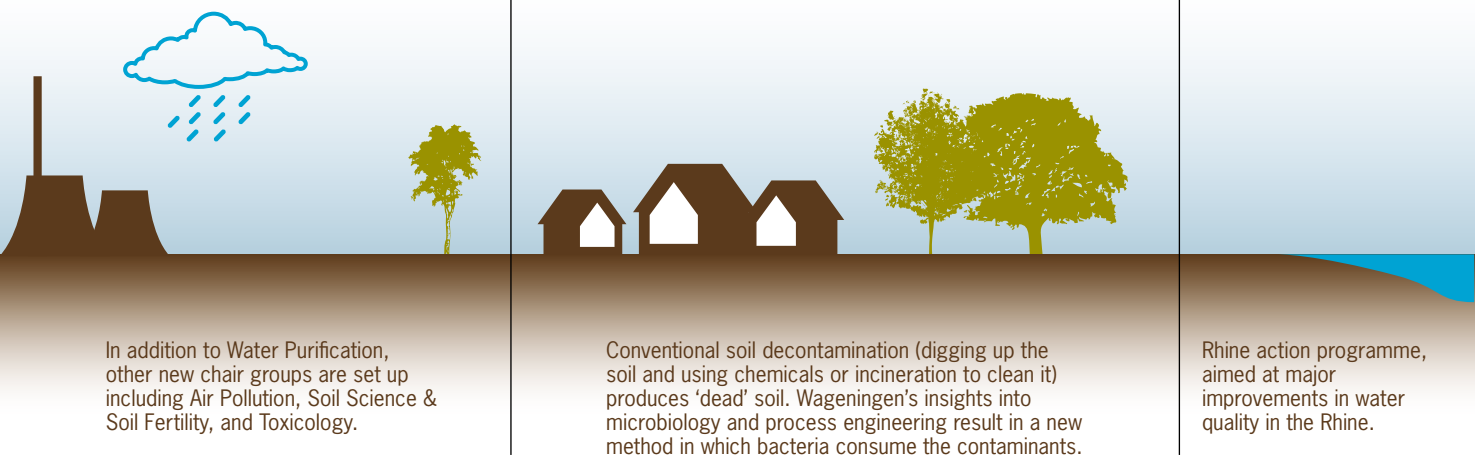
The Water Purification chair group was established in 1965 as an offshoot of Land Development. Microbiologists and land developers were worried about the growing problems with wastewater from the dairy industry and the potato starch company Avebe. In 1970, the Water Purification department was renamed Water Purification/ Environmental Health, and the degree programme in Environmental Health started up not long after that.

These were the years in which environmental awareness was growing worldwide, partly as an effect of the publication of the Club of Rome’s 1972 report. Post-war economic growth in the Netherlands, which had been stimulated by the discovery of natural gas, ran up against its limits. The Rhine was heavily polluted by chemicals and it took so much oxygen for micro-organisms to break it down that large numbers of dead fish often floated down the river on their backs and salmon had disappeared. The French salt mines with their cartloads of salt waste almost turned the Rhine into seawater. And in the Rijnmond area, the suffocating air pollution from the petrochemical industry frequently caused a smog alert. The Dutch central government responded with legislation on surface water pollution (1969) and air pollution (1970).
The new Environmental Health degree programme was a magnet for engaged students who wanted to enlist scientific arguments to call a halt to environmental pollution, or to work in government or consultancy firms on controlling pollution. Other departments were founded besides Water Purification, including Air Pollution, Soil Science and Soil Fertility, Nature Management, and Toxicology. Jan Hein >

Acid rain: forests and fish die off as acidic air pollution is spread by rain.

The Netherlands pays the price for decades of toxic waste dumping, mainly from industry. In Lekkerkerk, local residents become sick and have to evacuate their homes.

The Soil Protection Act comes into effect on 1 January 1987.



In addition to Water Purification, other new chair groups are set up including Air Pollution, Soil Science & Soil Fertility, and Toxicology.

Conventional soil decontamination (digging up the soil and using chemicals or incineration to clean it) produces ‘dead’ soil. Wageningen’s insights into microbiology and process engineering result in a new method in which bacteria consume the contaminants.

Rhine action programme, aimed at major improvements in water quality in the Rhine.

1980

1986 - 2000

PAUL ROELEVELD,
Royal Haskoning DHV

Drug residues in water

Drug residues in water in sewerage are a growing problem. 'Wageningen University & Research saw this problem coming some years ago, and has done a lot of research on it', says Paul Roeleveld of consultancy firm Royal Haskoning DHV. The search for a solution focuses on a combination of biological and chemical techniques such as reed filters that can capture micropollution and ozone with which waste products can be broken down. 'Even though the concept hasn't totally crystallized yet, we have recently embarked on a collaboration with Environmental Technology. As environmental consultants we are keen to be involved in potential solutions from the early stages of the process.'

Koeman, who created a furore in the late 1960s with a study of the effects of pesticides on Sandwich terns in the Wadden Sea, applied for the chair of the Toxicology chair group. Koeman proved that the wastewater from a factory in Rijnmond, which contained dieldrin, aldrin and telodrin, was behind the drop in the numbers of breeding pairs of Sandwich terns from about 40,000 to 600. His findings got into *Nature*. Shell shut down the factory, Environmental Toxicology was born, and Koeman was welcome in Wageningen. His work there included research on the harmful impact of PCBs.

STUDENT REBELLION

In the 1990s, Environmental Health's basis in the natural sciences was broadened with socio-economic disciplines such as Environmental Sociology, Environmental Policy and Environmental Economics. Thanks to the students, says Arthur Mol, in a reference to the 'Wageningen Spring' in 1980, when students occupied the main building on the Salverdaplein. Across the country students were protesting against the cabinet's plans for a two-phase structure for university studies, but in Wageningen, students also took up the cudgels to defend project-based education and the inclusion of the social, economic and management aspects of agricultural and environmental issues. Interdisciplinary education and research became an article of faith.
So somewhat reluctantly, the university changed tack. Students started to work on actual problems in project groups. Mol: 'The strength of a scientist's mentality is that we come up with all sorts of real, often technical solutions, but since the 1980s we have also realized that we should think about the role of politics, policy and administration and above all, how citizens and companies embrace the solutions we offer.' That was a success, says Mol. The interdisciplinary graduate school WIMEK (Wageningen Institute for environmental and climate research) has since become the biggest research institute in the field of sustainability in the Netherlands.
As an example of a contemporary approach, Mol points to the trend for labels and certification for products. 'That has a scientific side to it in things like the calculation of dust flows and issues related to waste, product life cycle analysis, or how to help consumers understand all the labels, to steer retailers and to involve NGOs.'
It was not all plain sailing in Wageningen over the past 50 years, though. A severe dip, says Mol, was the period just before the turn of the century, when Wageningen started focusing more on agriculture. 'One of the consequences of that was that the Health Studies research group, with epidemiologist and air quality specialist Bert Brunekreef, went off to Utrecht University.' Brunekreef proved that damp houses with mould increase the risk of asthma in children, and he was one of the first scientists to study fine particles. After Brunekreef's departure, Wageningen research on air pollution lost impetus.

ACID RAIN: FOREST DIE-OFF BELOW PREDICTIONS

'We first heard about acid rain in the 1970s. Fish in Scandinavian lakes were dying because of acid air pollution from the UK among other places, falling with the rain. In Germany the issue got rather blown up and politicians were talking about 'mass forest die-off'. Wim de Vries, a professor of integral modelling of nitrogen effects, has been studying the effects of acidifying air pollution on forests for a quarter of a century. There are two broad categories: sulphuric pollution from industry and nitric pollution from animal manure and from traffic.
'Mass forest die-off did not occur, fortunately, mainly because industry introduced measures, such as burning low-sulphur coal and installing filters,'

For a while, Wageningen had a monopoly on academic environmental education in the Netherlands. 'When I came here as a student at the end of the 1970s, apart from Wageningen the only places you could study environmental issues were Leiden and VU Amsterdam, but only at Master's level. A friend and I looked at Environmental Chemistry at the University of Amsterdam too, but we thought it was too limited.' Nowadays there are environmental degree programmes at numerous universities, including applied sciences ones. The Wageningen programme pays a lot of attention to the international nature of environmental issues and is very flexible, says Huub Rijnaarts of Environmental Technology. 'Students here take compulsory core environmental studies courses, but they can then pursue their own interests in elective courses and an element of completely free choice. So if you wanted to, you could focus entirely on the plastic soup issue and study that problem from the technical, policy and ecological angles.'

GLOBAL PERSPECTIVE

This flexibility goes some way to explain the big influx of foreign students, thinks Rijnaarts. 'Plus the fact that we are an international university with English as the language of instruction at Master's level. Dutch students get a global perspective here, and international students go on to get policy, advisory or technical jobs in their own countries, using the environmental knowledge they gained here,' says Rijnaarts. 'There are many examples of Asian graduates who have become contact persons in Asia for Dutch companies and research institutes, contributing to efforts to clean up the soil, water and air in those rapidly growing environmental markets. We support that at the university. Gatze Lettinga pioneered it, and we are carrying it on, especially in China, India, Vietnam and Bangladesh. We have the same ambitions for a number of African countries.'

> 'New chemicals can ruin the whole recycling show'

MANURE SURPLUS

In spite of all the successes of the past 50 years, Gatze Lettinga has no trouble listing several challenges for the future. 'The manure surplus remains a problem that cannot be solved by technical means such as digesting the manure or exporting it as dried pellets,' he says. 'The problem is the structure of intensive farming, which systematically produces a surplus of manure because we don't have enough land. The dumping of a scarce resource such as phosphate is a disgrace. We are destroying agriculture elsewhere in the world, we are laying waste to nature and we don't look after animals properly. I think the answer lies in a regional approach to agriculture and food supplies. That would reduce environmental problems at the same time.' For Huub Rijnaarts, the most important research themes for the future are climate change and the circular economy. 'We have realized now that waste is not waste, but consists of resources which we should reuse with minimal energy consumption and use of space and natural resources. Gatze Lettinga understood that long ago and set to work locally. We should go on doing that sort of thing, inspired by science and focusing on implementation. We need that kind of basic, purposeful commitment to recycling if we are to keep the earth habitable in the long term.
Closing cycles, reusing more material without compromising on quality, and not wasting minerals. There is cause for concern here: all those new chemical substances we produce in increasing amounts and variations, such as drugs, colourings and nanoparticles. That could seriously mess up the recycling game. We must make sure those substances do not get into the water or into materials for reuse, or else that they are removed again promptly. That is an important part of our current research.' ■

www.wur.eu/ete

says De Vries. In manure treatment too, many technical measures were taken, from slurry injectors to gas filters in barns. And yet the problem of acidification from nitrogen is far from solved. 'What the Wageningen research achieved was that we led the way in Europe in creating models that calculate the critical load of nitrogen and sulphur for forests and nature reserves,' says De Vries.
With the Rains model – at IIASA - emeritus professor of Environmental Systems Analysis Leen Hordijk was a pioneer in the development of those models. 'For each region of Europe we calculated what a forest can cope with, which neutralization reactions take place in the soil, and then by how much emissions from industry, traffic and agriculture have to go down. The European administration made use of this data in assigning national emissions ceilings.'