Bayer and National Geographic support nine projects to conserve drinking water

Water for life

Thirst-quenching: in megacities like Rajasthan, India, in particular, few people have access to clean drinking water like this boy (right). Professor Heinrich Hühnerfuss (above) is conducting research into a water treatment device that could help to solve the problem.

The Global Exploration Fund, a foundation set up jointly by National Geographic Deutschland and Bayer, is sponsoring nine research projects on drinking water. This edition of research presents Helios, a device developed by Professor Heinrich Hühnerfuss, a chemist from the German city of Hamburg, which could soon improve the supply of drinking water on the periphery of megacities like Karachi or Hanoi.

The rather ordinary looking device standing in Professor Hühnerfuss' laboratory in the basement of the Chemical Institute at Hamburg University has recently been undergoing some particularly rigorous testing – and with considerable success. It means that Helios, as the device is called, could soon be supplying clean water to the world's major conurbations. The device uses ultrasound and ultraviolet light to destroy bacteria and organic compounds in the water. It is just one of nine projects involving drinking water that are being sponsored by the Global Exploration Fund, which was set up jointly by National Geographic Deutschland and Bayer with a total budget of EUR 250,000 (see box on page 71).

Hühnerfuss originally designed the unit to sterilize dialysis fluid. Four years previously, a friend of his called Klaus Büttner – an engineer and Managing Director of the medical technology company Promedt – had asked the chemistry professor to come up with a system for safely and reliably removing bacteria from dialysis fluid. Because Helios destroys all kinds of bacteria in the dialysis fluid without exception, Hühnerfuss hit on the idea of also using it to clean drinking water. His ambitious aim, however, was not just to free the water of bacteria but also to destroy organic compounds such as polychlorinated biphenyls (PCBs), halogenated cyclical hydrocarbons (HCHs) and other harmful compounds found in the global environment.

Dr. Hai Pham Tuan is all too familiar with the problem from his own experience at home. The post-doctoral chemist working in Heinrich Hühnerfuss' laboratory is Vietnamese and comes from Hanoi. His parents live there on the first floor of a high-rise building. Running water is only available for a few hours a day, which is why the Pham Tuan family had a 2,000-liter water tank installed in the cellar. Over time, however, brown sediment settles on the bottom of the tank so that it has to been cleaned every few months. But even when the tank has been freshly cleaned, caution is essential: "Nobody in Hanoi would even dream of drinking water without boiling it first," says Hai Pham Tuan.

Light and sound destroy bacteria and toxins

Perhaps, some day, one of the Helios units that Pham Tuan has helped to develop will take over the job of treating the water at his parents' house and save them and the other inhabitants of Hanoi the time-consuming task of boiling all their drinking water. Trials performed so far have, at any rate, proved promising. According to Hühnerfuss, the process not only eliminates the bacteria, it also dramatically reduces the concentration of PCBs.

The design of the unit is actually very simple: behind a metal housing the size of a shoe cupboard is a 30 cm tall steel cylinder with a capacity of about four liters. From above, a UV

Water test: In Professor Hühnerfuss' laboratory, various water samples (right) are examined before and after purification with Helios. Clean water is rare on the periphery of megacities like Cairo (above right). In Karachi, Pakistan, clean water is even sold at the roadside (below right).

lamp projects light into the liquid column. Ten ultrasonic generators are positioned on the bottom and at the sides to acoustically irradiate the water. For his experiments, Pham Tuan mixes the water with precise quantities of various compounds. After they have passed through the cleaning process, he collects the water samples, transfers them to an organic solvent such as hexane, and measures the quantities of substances by gas chromatography.

The apparatus in Hühnerfuss' laboratory where Hai Pham Tuan is currently performing his experiments is still relatively inflexible. Only the throughput rate and the intensity of the ultrasound can be regulated, but not the sound frequency. With the new, more flexible unit currently at the planning stage, Pham Tuan hopes to be able to crack the HCHs, too, because, until now, they have stubbornly resisted the Helios process.

Flexibility thanks to solar power and a low-maintenance design

In November this year, Helios is to be tested under real-life conditions. Instead of adding a defined list of contaminants to pure water, the research team then wants to treat water specimens that correspond exactly to the water in Karachi. The capital of Pakistan serves Hühnerfuss as a model for mega-cities with more than ten million inhabitants. On the periphery of the city, thousands of people live in rough housing and draw their "drinking water" from canals from the Indus or a nearby lake. Particularly in the dry season, these water sources turn into what can only be described as muddy water, says Hühnerfuss.

Because Helios units are so undemanding, there is no reason at all why they could not be used in any large

Potable water for the world

The Global Exploration Fund established jointly by Bayer and National Geographic currently supports nine projects involving drinking water, and has a budget of EUR 250,000. The background behind this involvement is that more than one billion people have no access to clean drinking water. "By supporting research into the protection of potable water, we want to make a contribution to solving this global problem," says Dr. Wolfgang Plischke, member of the Bayer Board of Management responsible for Innovation, Technology and the Environment. This edition of *research* reports on Professor Hühnerfuss' project.

The nine projects:

1] Professor Heinrich Hühnerfuss from the Chemical Institute at Hamburg University has developed a unit called Helios, with which bacteria and organic compounds can be destroyed with the aid of ultrasound and ultraviolet light (see main story).
2] The "sloping hose" method developed by Professor Dietrich Maier from the Center for Water Research in Karlsruhe, Germany, is intended for use in the event of a catastrophe. In a ten-meter long plastic film hose, air bubbles generated by a pneumatic pump rise to the top of the hose and produce enough turbulence to mix the chemicals with the water to clean it.
3] Dr. Andreas Kappler from Tübingen University intends to adsorb arsenic contained in the soil with the aid of bacteria. Arsenic pollutes groundwater throughout the world.
4] Professor Jörg Venske from the University of Bremen is running a project in Yakutsk, Siberia, in which plant-based water treatment technology is used to purify surface water in permafrost.
5] Dr. Hans Jürgen Hahn from the University of Koblenz-Landau is performing research into the eco-systems that exist in the groundwater and how they are affected by surface water.
6] Dr. Herbert Weingartner from the University of Salzburg aims to document the water transportation system in Greece, the origins of which date back to ancient times.
7] In the high Andes in the north-west of Argentina, bog-like cushion plants are growing that serve as pastureland and also as a water supply. Karsten Schittek from the University of Trier is planning to investigate man's influence on these plant habitats.
8] Under the title "The Green Desert Project", Dr. Kai Tiedemann from the Rheinisch Westfälische Technische Hochschule Aachen is investigating the possibility of utilizing the mist and fog on Peru's Pacific coast to boost forestry and agriculture.
9] Professor Rainer Mohn from the Laboratory for Hydraulic Engineering and Water Management at Münster University aims to improve the water supply in the arid areas of Ethiopia.

town or city. Solar units can provide sufficient electricity to operate them, and because the compounds are destroyed and not simply "fished out", there are no membranes or filters to be changed. For this reason, says Hühnerfuss, the units "remain maintenance-free over a prolonged period." Calculations have shown that a unit weighing 20 kg with an energy consumption of 400W, could clean 72,000 liters of water a day. The cost per unit is currently around EUR 10,000, but with mass production, prices of less than EUR 1,000 would be quite conceivable, he says. However, until that stage is reached, many of the parameters need to be better coordinated and the field trials must be successful.

First test passed: muddy ditch water turns clear

There could always be unpleasant surprises around the corner. Experience has shown that natural samples contain vegetable residues and other substances that mask the toxic substances and protect them from degradation, but Hühnerfuss is confident: "We'll get a grip on it – not least thanks to the Global Exploration Fund."

That Helios can produce the desired success even under difficult conditions is shown by a simple experiment that Hühnerfuss carried out with one of the first prototypes: he took some water from a north German ditch and passed the cloudy liquid through the device. What came out the other end a few minutes later was absolutely clear.

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The homepage of the German edition of National Geographic has a special button leading to the Global Exploration Fund.