# What Water Needs A Path to Sustainable Management

THE 2012 HANSGROHE WATER SYMPOSIUM



# hansgrohe



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# What Water Needs -

A Path to Sustainable Management

THE 2012 HANSGROHE WATER SYMPOSIUM

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## Words of Welcome

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#### SIEGFRIED GÄNSSLEN AND KLAUS GROHE

Water is unique! In the course of our history, we humans have learned to avail ourselves of water's wonderful qualities and properties: as food, medicine and cleanser, as a means of transportation and source of energy, and as an element that affords us well-being and enjoyment.

We need water for almost every aspect of our lives and we must take care of it – this concern is reflected in the title of the fifth Hansgrohe Water Symposium which took place in November 2012 at the Hansgrohe Aquademie in Schiltach.

But our increasing use of water has a dark side, especially wherever the use of this life-giving element is taken for granted because it is available in best quality and within easy reach at all times. In many places, the outright exploitation and wasteful consumption of this precious and most important resource threaten the health of our oceans, rivers, lakes and ground-water.

This brings us to another aspect of the deliberately ambiguous topic of our symposium. "What Water Needs" also looked at how we can use water without interfering in its cycles, damaging its quality, or wasting it as a resource.

Contributions by nine water experts from different fields of science, industry and culture explored how this can be achieved in everyday life. They presented examples from very different areas of activity, ranging from hydropower generation and the role of hot water in preparing tea in Japanese culture to the development of water legislation and water-friendly agriculture, illustrating how water can be used if we are careful and conscientious about protecting it and its special properties.

During the symposium it became clear that a great deal still remains to be done. It is time for a real water revolution, brought about by innovations that allow us to use water more responsibly, and characterized by respect for this elixir of life.



In this sense, the 2012 Hansgrohe Water Symposium and this publication have been conceived as an urgently needed contribution to the global debate on climate change and to Germany's efforts to further an energy transition.

In short, first and foremost, water needs our attention and our interest. With this in mind, we would like to thank all those who dedicate themselves to this task.

Siegfried GOULALEN

Siegfried Gänsslen Chairman of the Management Board Hansgrohe SE

Maus Can

Klaus Grohe Chairman of the Supervisory Board Hansgrohe SE

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## Dr. Klaus Lanz Chemist, journalist and water researcher

After studying chemistry, Dr. Lanz worked as an environmental and water researcher in the United States and in Switzerland. Early in the 1990s, he managed Greenpeace Germany's water campaign. In 1995, Dr. Lanz founded International Water Affairs, an independent research and consulting institute in Hamburg, today based in Evilard in the canton of Berne, Switzerland. Dr. Lanz has written several books on water and environmental issues.



## Andreas Steinmann

Civil engineer, former president of the Cooperative Gravitation Water Vortex Power Plants, Switzerland

Andreas Steinmann was the manager and co-owner of a civil engineering company until 2007. By that time he had already discovered his interest in renewable energy and decided then to make a career change. Recognizing the potential of gravitation water vortex power, he has since dedicated himself to researching and implementing this innovative way of generating electricity.



## Kerstin Mechlem

Consultant and lecturer, Heidelberg and Belfast

Kerstin Mechlem is a human rights and environmental activist who specializes in water legislation. She worked for several years at the Max Planck Institute for Comparative Public Law and International Law in Heidelberg, and for the Legal Office of the Food and Agriculture Organization of the United Nations (FAO) in Rome. Since 2007, Ms. Mechlem has been a freelance consultant for the FAO, GEF and UNESCO, and a lecturer on international law and human rights at the University of Ulster in Belfast.



## Dr. Andreas Fliessbach

Research Institute of Organic Agriculture in Frick, Switzerland

Dr. sc. agr. Andreas Fliessbach specializes in the field of soil microbiology, and studies soil fertility and the effects of heavy metals and pesticides on soil microorganisms. An agricultural scientist, he has been a researcher at the FiBL Institute in Frick, Switzerland since 1995, investigating among other things the impact of climate change on agriculture.

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#### Linda Thomas

Head of cleaning services at the Lukas Klinik in Arlesheim, Switzerland

Linda Thomas was born and raised in South Africa. After marrying a Swiss citizen, she moved to Switzerland where she has lived for 35 years. She ran her own ecological cleaning company for 21 years until 2009, working in Waldorf schools, special education institutes, private households and businesses. Ms. Thomas was also responsible for cleaning services at the Goetheanum anthroposophy center in Dornach, Switzerland, for nearly 21 years. Today she lectures and holds seminars around the world, and is head of cleaning services at the Lukas Klinik in Arlesheim, Switzerland.



#### Mario Sommer

BBA, market manager at Hobart GmbH, Offenburg

Mario Sommer studied business administration at the Berufsakademie Villingen-Schwenningen. He began his professional career as a management assistant in the upholstery furniture industry. He then worked as field representative for a cosmetics company, and as commercial manager in the tool industry. He has held the position of market manager at HOBART since 2007 and is responsible for large industrial machines.

#### Frank Schlegel

Dipl. Ing. in mechanical engineering, managing director of H2O GmbH

Frank Schlegel founded H2O with two partners in 1999. The company manufactures industrial wastewater treatment systems and has the long-term goal of achieving wastewaterfree industrial processes in the future. Under his leadership, the business has become the market leader in vacuum distillation systems. Today Frank Schlegel is one of two managing partners and responsible for after-sales services. He has also been a guest lecturer in international business administration and international marketing at the European Business School since 2002.



#### Prof. Dr. Andreas Fath

Furtwangen University (HFU)

Prof. Dr. Andreas Fath studied chemistry at the University of Heidelberg, earning his doctorate in 1996. Upon completion of a DAAD research project at the University of Valencia, he worked as a research assistant at the University of Vienna. From 1998 to 2000, he did research at the Institute of Microstructure Technology of Karlsruhe Institute of Technology. He was responsible for the development of new processes and surfaces at Hansgrohe AG from 2000 to 2011. He has been a professor at Furtwangen University and a consultant for Hansgrohe SE since 2012.



## Daniel Albiez Architect and founder of BAUPLAN ARCHITEKTEN

Daniel Albiez was born in 1964. Prior to his studies in architecture, he completed his training as stonemason and sculptor in Heidelberg. After graduating in 1995, he worked for various architectural firms and founded BAUPLAN ARCHITEKTEN in 1998. The firm specializes in commercial and residential construction in the Rhine-Neckar region. In 2010 and 2011, Albiez carried out two pilot projects using SolarEis heating technology; one of them was the Seehotel in Ketsch, and the other a single-family home in Heidelberg.



## Roland Zipfel Alias Ziro!

Roland Zipfel was born in 1963 in Freiburg and now lives in Gundelfingen. Following periods of his life as a policeman, a businessman and an IT manager, these days he concentrates on composing poems and poetic texts. As an enthusiastic reader he has developed the ability to give words wings and touch people deeply with his own lyrics.



## Ulrich Haas

Head of the branch of the Urasenke Foundation in Freiburg-Vörstetten

Following his engineering studies in Berlin, Ulrich Haas worked in personnel training in Germany and abroad. During a stay of several years in Singapore, he decided to train as a tea master and professional tea instructor at Japan's most important tea college, the Urasenke Gakuen Chado Semmon Gakko [Urasenke Gakuen Professional College of Chado]. Upon completing his studies, he attended a threeyear Zen training program in the Rinzai tradition at Tenryū-ji temple. Hass was ordained under Zen master Seiko Hirata in 1986.

# What Water Needs – A Path to Sustainable Management

#### ESSAY BY KLAUS LANZ

When society and the state address water issues, they usually do so from the consumer's perspective and focus on the needs water is expected to meet. The goal of the fifth Hansgrohe Water Symposium was to overcome this one-sided perspective. Instead of approaching the topic from the human point of view, it was discussed from the perspective of water, as reflected by the title, "What Water Needs". The symposium consisted of presentations and workshops dedicated to the question of what water and its various cycles need to be able to continue life-sustaining functions. The central idea of the symposium was to emphasize that the water cycle is much more than just a simple convenience for human needs – it is a prerequisite for life on Earth.

The human compulsion to make ever more water available for industrial use, irrigation, and the generation of electricity has made us, and our economies, highly dependent on the constant availability of water. We are aware of this dependency and are intent on exploiting any new water reserves we can find, but in doing so we lose sight of another, deeper interdependency. Namely, that we are above all dependent on water cycles which connect and keep all life going. Water cycles allow food to grow, trees to provide shade, the dew at night to refresh landscapes, valleys and hills to turn green; in short, they regulate and moderate the Earth's climate, making our blue planet habitable. Science has only a cursory understanding of these fundamental processes. Once we realize how little we know, questions inevitably arise. What actually makes these cycles function, what does water need? What can we do, what action must we take, how can we manage water so that global water cycles keep going, and the planet's precious water resources are preserved?

## Challenges

Much has already been done. Billions have been spent on water treatment plants in Germany alone to protect natural water sources. Ever more stringent laws are supposed to ensure the sustainable use of water. But the following three examples show that, despite these good intentions, even western societies are still far from undertaking what is possible and viable.

Hydropower is considered one of the greenest types of energy generation. After all, it is renewable and free of harmful emissions. But we still generally ignore the fact that dams, weirs and the withdrawal of water do massive damage to river habitats. According to Germany's Federal Environment Agency, only 8 percent of the country's waterways were in a relatively untouched state in 2009, and only 2 percent were thought to be in their original natural state. Comprehensive measures are needed to restore rivers and creeks and protect them from further intervention – measures that support and enhance the Earth's water cycles.

The manufacturing industry has also made great strides in terms of wastewater management since the 1970s and 1980s. But in spite of industrial compliance with legal limits, the Rhine, for instance, carries a load of some 200 tons of highly persistent, non-biodegradable chemicals across the border into the Netherlands every day. The fact is, it would be possible to drastically improve this situation without saddling industry with an excessive financial burden. Affordable technologies that could put an end to the discharge of production residues into waterways are available today for treating most types of industrial wastewater, but so far only a small vanguard of companies have made use of these technologies.

Agriculture, as the largest user of land, bears a high degree of responsibility for water because soils are crucial for water balance. Well cared for and healthy topsoil can absorb large amounts of precipitation and retain and purify rainfall that seeps into groundwater. Improper tilling methods, heavy agricultural machinery, and the use of synthetic fertilizers and pesticides jeopardize these vital qualities. The result is that farmland in Europe continually looses biomass and humus, which are fundamental for soil fertility and water retention. Agricultural policy and farmers can take responsibility here by promoting gentle tillage methods that lead to a more natural water balance.

The abundance of water in our latitudes results in careless indifference in how we use it. Society is not yet aware of the fact that we are far from having a functioning and sustainable water balance in our natural world. It was the intention of the fifth Hansgrohe Water Symposium to raise awareness of this crucial issue by inviting speakers whose ideas and innovations advocate truly water-friendly management and thereby help preserve the Earth's water cycles.













## CHAPTER 1

# Water needs justice

Where there is no water, there is no development. But who controls access to water supplies? Who has the rights to the water in transboundary rivers and lakes? Are the current allocation rules fair and sustainable? These questions are all of key importance to the welfare of water and people. Water rights activist Kerstin Mechlem provided answers in a global overview.

# The Changing Face of International Water Law

#### KERSTIN MECHLEM

Water resources across the globe are at risk. Economic development, population growth, and climate change are taking their toll on both the quality and the amount of water available to us. In her presentation, Kerstin Mechlem explored how law can help us deal with these challenges. After providing a historical overview of international water law, she focused on current trends and discussed the question of how, in view of dramatic global changes, water law could provide the rules and standards we need to protect our water.



Scientists predict that in the future, renewable water resources throughout the world may decrease by up to 20 percent. Climate change will cause river and groundwater levels to sink, while floods and droughts will become more frequent. At the same time, higher temperatures will result in an increased demand for water, especially for agricultural irrigation, and will lead to the salinization of freshwater reserves.

What answers do the principles of international, national and regional water law provide regarding the use and protection of water resources? In what direction could and should water legislation progress? Here I will discuss trends that are currently emerging in international water law – the set of binding rules that exists between states and nations regulating the way we use water. Finally, I will cite examples of recent developments in domestic water protection laws.

#### The development of international water law

Intergovernmental treaties that regulate the way we use water resources have existed for a long time. The earliest known example is a treaty between the Mesopotamian city-states of Umma and Lagash negotiated in 3200 BC. Since then, hundreds of treaties have been signed for the more than 260 transboundary river basins shared by two or more states. Earlier treaties were often limited to establishing boundaries, or regulating navigation rights. Later on, treaties also dealt with non-navigational uses of bodies of water. Freshwater reserves were regarded primarily as resources that could be used for agriculture, industry and to generate electricity. Pollution and overuse were not yet pressing concerns.

In the 1960s, the International Law Association (ILA) developed a principle that became the basis of the Helsinki Rules and which viewed an entire river basin as an economic unit. Since the environmental movement gained strength in the 1990s, its concerns reflected in the 1992 Rio Declaration, the principles of environmental protection and ecosystem considerations have also become more prominent in international legislation. The growing importance of environmental protection is clearly visible, for example, when we compare the Helsinki Rules adopted by the ILA in the 1960s with the more recent Berlin Rules on Water Resources adopted by the same organization.

The newer rules expand pollution prevention, adopt the precautionary principle, and define environmental flows; they also call for the conservation of entire river ecosystems. Moreover, in 2010, following a dispute between Argentina and Uruguay concerning wastewater from a pulp mill, the International Court of Justice in The Hague reaffirmed the obligation to conduct environmental impact assessments.

Another new legal instrument introduced was the application of the integrated water resources management approach in river basins. Modern water treaties regulate the use and protection of water resources, and incorporate detailed codes of practice such as joint forms of coordination, administrative commissions, and implementation mechanisms and sanctions. However, contractual arrangements for about 60 percent of transboundary rivers and



The Aral Sea has shrunk at an alarming rate in just a few decades due exclusively to the excessive withdrawal of water for irrigation. lakes are still lacking. And in other cases, where treaties have been negotiated, important partners have yet to sign. China for instance, an upper basin country, is not party to the Mekong River agreement. Egypt, the primary user of Nile water, and Sudan refuse to adopt the Nile basin framework agreement. In such cases, regional and international water law must be applied.

Until recently, water law dealt almost exclusively with rivers and lakes at regional, national and international levels. But the realization that groundwater is being increasingly overused has made lawmakers take a closer look at underground water resources. But the density of regulation here is still low, especially in terms of international law. There are several reasons why scant attention has been paid to groundwater in the past. First, its cross-border character is invisible. Second, due to low flow rates, adverse effects usually become apparent in

neighboring states only after a considerable delay. Furthermore, groundwater has traditionally been considered a natural resource and it was widely believed that all states could claim sovereignty over natural resources that lay within their boundaries. Added to that, the exact extent and water yield of many groundwater reserves (aquifers) is often unknown.

#### Higher-level legal systems

Wherever there are no specific treaties for transboundary waters in place, international water regulation instruments apply, either at the regional or global level. Both levels are outlined below.

#### Regional level

At a regional level, Europe, with its EU Water Framework Directive of 2000 and the agreements signed within the framework of the United Nations Economic Commission for Europe (UNECE) Water Convention, has become an international pioneer in the protection of water resources. Comparable regulations do not exist in other parts of the world. The EU Water Framework Directive is the most advanced and comprehensive water management framework in the world. The aim of the directive is to achieve and maintain "good ecological and chemical status" in all European waters. Water management in the EU Water Framework Directive is intended to protect natural river ecosystems, obliging EU member states to fulfill a comprehensive package of measures.

Given the fact that environmental protection in the European Union initially arose from the idea of creating equal conditions for competition, the strong role of water conservation is quite remarkable. The Single European Act (1987) made environmental protection a legitimate Community objective in its own right.

The legal instruments of the UNECE are equally important. One of the most notable is the 1992 water convention; its full name is the Convention on the Protection and Use of Transboundary Watercourses and International Lakes (also referred to as the Helsinki Convention). It was supplemented by the Protocol on Water and Health in 1999 and other agreements. Non-European member states will soon be able to become signatories too. In addition to these treaties, which apply to all of Europe (from the Atlantic coast to Central Asia), a great number of bilateral and multilateral agreements have been negotiated that concern individual rivers and lakes, or specific projects.

#### Global level

At the global level, legislation is much less developed. The most important legal instrument of international water law is the United Nations Convention on the Law of Non-Navigational Use of International Watercourses, adopted in 1997. This framework agreement, still not in force, was worked out and negotiated by the International Law Commission of the United Nations for over 30 years before being adopted by the United Nations General Assembly by 103 votes. The convention declares many important principles of applicable customary international law as binding, and contains detailed procedural rules as guidelines for planned projects.

But the UN convention can enter into force only after it has been ratified by at least 35 states. Following years of stalemate, the ratification process has recently accelerated, partly because a number of players, including the World Wide Fund for Nature (WWF), have actively lobbied for this nearly forgotten convention. Thirty states ratified the convention by February 2013 (four other states have also signed but not yet ratified). Since some states have announced their intention to ratify the convention, there is hope that this important treaty can go into effect in the foreseeable future.

#### Basic principles of international water law

All water law instruments are based on three basic principles, which are binding and explicitly reaffirmed in the UN Water Convention. The first is the principle of equitable and reasonable utilization; the second is the obligation not to cause significant harm. Both principles refer to each other and do not provide clarity on how much damage any utilization is allowed to cause and still be considered equitable. The third principle is the general obligation to cooperate, which is delineated and supplemented by procedural rules.

#### "Equitable utilization" versus "no significant harm"

The ambiguity of the UN Water Convention ultimately reflects the profound differences in interpretation that have been a feature of international water law for such a long time. Probably the most prominent controversial issue is how the right to reasonable use can be reconciled with the obligation not to cause significant harm. Behind the various answers we can sense the presence of diametrically opposed extreme positions that have actually long since been overcome.

In the past, some players embraced the principle of absolute territorial sovereignty, which granted a state complete control over water resources in its territory without consideration for its neighbors. This is referred to as the Harmon Doctrine. The United States in particular

The Aswan Dam in Egypt: The wall, 111 metres in height and 2,800 metres long, holds back the Nile within the huge Lake Nasser with a depth of 180 metres and 10 times the size of Lake Constance.

advocated this principle in its dispute with Mexico over the Rio Grande; the Harmon Doctrine serves the interest of upstream users only. This position is echoed by Turkey's stance on the use of the Euphrates and Tigris. In the 1980s, Turkey started work on a project in the upper reaches of these two rivers, the Southeastern Anatolia Project, consisting of more than 20 large-scale dams, numerous hydroelectric power plants and extensive irrigation systems. Downstream states Iraq and Syria have both raised a variety of objections to the project. Turkey was one of only three states that voted against the UN Water Convention in 1997.

Those who took the opposite point of view, now equally outdated, advocated the doctrine of absolute territorial integrity and demanded that increased utilization should not have any kind of negative impact on neighboring states. This point of view was often taken by downstream states that had, historically speaking, been using a river for much longer than the upstream states. If we look at Egypt for example, this is very much the position the country takes in the Nile negotiations.



Neither extreme lends itself to developing a sustainable water management framework that balances the interests of both sides. These positions were therefore superseded by a tandem arrangement consisting of the "right to equitable utilization" and the "obligation not to cause significant harm". Similar conflicts of interest have always existed, of course, not only internationally. A classic textbook example is the case of Christian Arnold, a miller in Oderbruch, Germany, at the time of Frederick the Great. The case triggered not only a protracted legal dispute concerning the utilization of a small millstream, but also led to a veritable government crisis.

How can the principles of "equitable utilization" and the "obligation to not cause significant harm" be reconciled? This question complicated the drafting of the UN Water Convention to such a degree that the process dragged on for 30 years. It posed a difficult problem for the representatives of the International Law Commission of the United Nations who had to draft the convention and the diplomats who had to produce the final text. The convention has already been adopted, but debate continues and positions are still very much entrenched. Countries that need and lay claim to large amounts of water, such as China, Egypt and Turkey, are therefore not expected to ratify the UN convention in the near future.

#### Water and sovereignty

Another area of conflict, especially evident in groundwater law, concerns the question of who should have the power to decide on the use of water resources. Theoretically, sovereignty claims to transboundary water resources are a thing of the past, but because of a newly discovered aquifer in South America, the final set of Draft Articles on the Law of Transboundary Aquifers (see below) and the Guarani Aquifer Agreement have recently put the issue back into the limelight. The Guarani agreement concerns one of the largest aquifer systems in the world, which extends beneath Argentina, Brazil, Paraguay and Uruguay. National interests play a considerable role in this treaty, something NGOs and the scientific community rightly denounce as a step backward. The idea of state sovereignty is not compatible with the flowing, transboundary nature of water, and undermines the adoption of proper management and protection measures.

This aspect of state sovereignty at the international level has its counterpart at the national level in the question of whether water can be owned and controlled by an individual. In some states of the United States and India, the rule of capture still applies. If a person finds, or "captures" groundwater on his or her land, he or she may claim ownership and extract it without authorization. In such cases, the state's ability to regulate and intervene is limited. However, the idea of considering groundwater public property, which benefits the common good and should therefore be managed by the state, is gaining ground worldwide.

## Challenges

What are the major challenges of the future? How should international water law develop to protect water resources and contribute to sustainable and equitable water management? Four points seem especially important if we wish to address these questions.

1. The continuing development and consolidation of appropriate protection laws The sustainable management of water resources depends on how we ensure the protection of water quantity, water quality, and aquatic ecosystems. Legal instruments play an important role as they define measures and standards. Room for improvement is nevertheless still great, as the 2010 ruling of the International Court of Justice showed when the court reaffirmed the obligation to conduct environmental impact assessments in the pulp mill dispute between Argentina and Uruguay.

We must however realize that the introduction of overly ambitious, inflexible international laws would not be productive. Protective measures that are too strict, for instance a complete ban on any kind of water pollution, or a law to minimize even negligible damages, are not appropriate for international legislation because these laws would have to be applied in the same way to a variety of different situations worldwide. Such advanced measures are more suited to national legal systems, where they can actually be enforced. Bilateral, multilateral and even regional agreements can include ambitious obligations; the best example of this kind of agreement is the EU Water Framework.

#### 2. Strengthening international cooperation

Cooperation is an important goal when dealing with transboundary water resources. We can see that throughout the world, bilateral and multilateral water commissions offer great advantages, and are much more effective than mere negotiations between government officials or other forms of relations between non-governmental or non-institutional parties. Examples are the Mekong River Commission, the Lake Chad Basin Organisation, the Organisation for the Development of the Senegal River, the International Boundary and Water Commission (Mexico and the United States), the International Joint Commission (Canada and the United States), the International Committee of the La Plata Basin (Argentina, Bolivia, Brazil, Paraguay, and Uruguay), and the numerous commissions that deal with European rivers (Danube, Elbe, Rhine, Meuse, Oder, and so forth).

However, cooperation must not necessarily be accompanied by legal instruments. Even less formalized and institutionalized forums can contribute to the exchange of data and information, encourage dialogue on technical matters, and build trust. International sponsors can also start up such projects.

#### 3. Strengthening groundwater protection

It is only recently that groundwater has become a focus of attention in legal debate. Until recently, the protection and utilization of groundwater was hardly discussed on an international level, and even more or less neglected by national legislation, despite the fact that groundwater makes up more than 97 percent of Earth's freshwater resources (the polar ice caps not included). Groundwater resources cover roughly 50 percent of the world's drinking water needs, in some countries even more than 90 percent. Groundwater consumption more than doubled between 1960 and 2000. At the same time, the quality and quantity of groundwater sources have strongly decreased across the globe, in part because modern technology makes it possible to extract groundwater from ever greater depths.

International law neglected groundwater for such a long time partly because of the poor level of information available on the incidence and extent of transboundary aquifers. When UNESCO published the first survey listing of known transboundary groundwater reserves throughout the world in 2008, it identified 273 aquifers. The United Nations International Groundwater Research Center (IGRAC) in the Dutch city of Delft continually updates the database, and year after year, describes and evaluates newly discovered transboundary groundwater sources. The number of aquifers has risen to 445 in the meantime.

Some aquifers are of enormous size and significance, even in very arid regions such as northeastern Africa. The Nubian Sandstone Aquifer System for instance, is located underground and shared by Egypt, Chad, Libya and Sudan. It contains an estimated 375,000 cubic kilometers of ancient, non-renewable fossil groundwater, most of which originated as precipitation during glacial epochs. It holds approximately as much water as flows down the Nile in 500 years, but most of the water cannot be commercially exploited because of its great depth.

Despite the huge importance of groundwater and the large number of transboundary aquifers, so far there are agreements for only five international aquifers: the Geneva aquifer, a small reserve between Switzerland and France; the Nubian Sandstone Aquifer System; the North-Western Sahara Aquifer System (Algeria, Libya, and Tunisia); the Iullemeden Aquifer System (Mali, Niger, and Nigeria); and the Guarani Aquifer System already mentioned above. Some of these treaties have not yet gone into effect.

Europe tries to meet the challenge of groundwater protection with the EU Water Framework Directive and the associated Groundwater Daughter Directive. However, the level of regulation and the protection goals are considerably more modest than those for surface waters. The United Nations Economic Commission for Europe (UNECE) has also drafted model articles concerning transboundary groundwater resources to supplement existing treaties.

In 2008, the international community took a very important step toward the protection of groundwater. The United Nations General Assembly welcomed the Draft Articles on the Law of Transboundary Aquifers developed by the UN International Law Commission. These articles are intended to encourage bilateral and multilateral treaties, and could become the basis for a convention on transboundary groundwater resources. It is expected that the UN General Assembly will make a decision regarding the development of such a global convention in late 2013. Due to long neglect, the need for international cooperation on groundwater is huge, but there is hope that the great dynamism behind the further development of this law will do justice to this need.



Malta has no rivers or lakes and a freshwater lens under this very arid island is Malta's only water resource.



Malta relies on expensive seawater desalination plants and knowingly allows its precious water resources to be destroyed forever.

#### 4. There is no law without enforcement

However international water law develops, it can only provide a general framework. Actual water management takes place at national and local levels, and this is where laws must be implemented. Mechanisms are needed to manage water, to plan water management, to allocate resources, to collect fees, to set pollution limits, and so forth. To this end, increasingly stringent water laws are being passed all over the world, and authorization systems are being put into place that make any use of water, excluding the minimal quantities needed for domestic use, subject to government approval. Changes in legislation do not always produce the desired results. Many poorer countries have modern water laws, but they are only on paper

and their implementation leaves room for improvement. Even South Africa, where a model water law with administratively ambitious regulations was adopted with the best of intentions, sees itself confronted with major difficulties given the cost and effort of implementing these regulations. Laws often go unenforced, which ultimately diminishes people's respect for them. Law alone cannot stop the overuse and pollution of water in places where the authorities lack qualified personnel and financial means, and where at the same time it is profitable for some to use and contaminate water on a large scale.

Enforcement problems exist in Europe as well. When Malta joined the EU, the government pledged to implement the EU Water Framework Directive. This includes, among other things, achieving good groundwater status and making groundwater extraction subject to authorization. Malta has no rivers or lakes and a freshwater lens under this very arid island is Malta's only water resource. Excessive and frequently illegal extraction since the 1980s, aggravated by EU agricultural subsidies and improper extraction methods, threatens to cause the irreversible salinization of the freshwater lens. So far, measures such as authorization requirements, water meters and water fees have not been introduced for political reasons, even though they are legally and technically feasible. Some of the arguments used are that water must remain a common good with free access, that agriculture is no longer competitive without free access to water, and that there is no funding available to enforce the law. Instead, Malta relies on expensive seawater desalination plants and knowingly allows its precious water resources to be destroyed forever.

Authorization processes cannot be put into effect in many countries because of the lack of efficient state administration. In places where millions of small farmers are confronted by a badly equipped administration, permit requirements alone lead nowhere and undermine the public's sense of justice rather than strengthening it. Additional mechanisms can be useful in such cases. One example is the COTAS (Comités técnicos de aguas subterráneas [technical groundwater committees]) system in Mexico. COTAS are civil society committees backed by the government. Each committee is responsible for a particular aquifer. Its job is to promote the implementation of plans and authorization processes, assist the various groundwater users, facilitate consensus-building processes, and collect data and information.

Which approach works in which situation is in many respects still open to debate. Many other factors have to converge to facilitate the ability of legislation to contribute to the sustainable use of water resources. The first prerequisite is the availability of adequate information on water resources and their utilization. Furthermore, governments should not provide counterproductive incentives for water-intensive agriculture or subsidize the electricity used



Groundwater resources cover roughly 50 percent of the world's drinking water needs, in some countries even more than 90 percent.

to operate illegal pumps, as is the case in Mexico and India. In short, whether law succeeds or fails also depends very strongly on local conditions.

#### Outlook

Water law has made great progress in the past 50 years and is increasingly able to respond to overuse and pollution issues at regional, national and international levels. Water management is being approached more and more at the level of entire river basins, and environmental principles are increasingly included in international water treaties. The two formerly irreconcilable extremes in water law have crystallized into two core principles of international water law: equitable utilization coupled with avoidance of significant harm. The conviction that water cannot be privately owned and that transboundary resources can never be controlled by a single state is finally becoming generally accepted.

But water law still faces many unresolved problems, and new ones will arise when resources need to be redistributed due to climate change. No matter what law is actually adopted, it rarely includes everything that is technically feasible or politically desirable. The stimuli provided by forward-thinking scientists and non-governmental organizations can be implemented to achieve legislative progress only if the political climate is favorable. It is likely that the EU Water Framework Directive of 2000 would no longer be adopted today in its present form. Environmental issues have clearly taken a back seat as a result of the financial crisis.

The creation of trust and transparency is the most decisive factor for the success of international water treaties dealing with the utilization of water resources. The practice of establishing joint commissions at the technical level and ensuring regular contact at the political level has proven a success. The mutual exchange of data and information and the financing to implement treaties must be safeguarded in the same way that the mechanisms for enforcement, conflict resolution, and adjustment clauses are. It is equally important to engage the public and make sure that all parties involved see an agreement as beneficial. A good example for successful burden sharing is the Columbia River Treaty between Canada and the United States. It is advantageous for both parties because the dams on the Canadian side were built in a way that allows both countries to benefit from them. The agreement for the utilization of the Geneva aquifer is also exemplary; France and Switzerland are committed to sharing the costs of an artificial groundwater recharge system. Such positive examples of successful bilateral and multilateral agreements also foster the development of global and regional rules and standards. And they do something that goes beyond their actual legislative function. They guarantee sustainable water management and ensure that people treat water with the respect and care it needs.











## CHAPTER 2

# Water needs visionaries

Water plays a central role in human civilization, but frequently our use of this resource is barely sustainable. How could we use water more efficiently, without compromising its purity and integrity? Hydropower visionary Andreas Steinmann, agricultural engineer Dr. Andreas Fliessbach, and green cleaning specialist Linda Thomas presented both proven and surprising new approaches and technologies.

# Are the Days of Dam Building Over? Working in Harmony with Rivers to Generate Electricity

#### ANDREAS STEINMANN

Hydropower is considered clean and environmentally friendly. It does not release  $CO_2$  emissions and therefore does not contribute to climate change. But hydropower also involves building dams and weirs which interrupt the natural continuity of rivers and have serious ecological effects on river ecosystems. In some cases, the amount of water diverted from rivers and streams and channeled through turbines is so great that plants and animals cannot survive in watercourses.



Swiss hydropower pioneer Andreas Steinmann explains how we can harness the power of flowing water to generate electricity without the need for dam walls or river weirs. Why is it important to avoid damming rivers and streams as far as possible when we tap into hydropower? First, weirs are insurmountable obstacles for a river's inhabitants, whether fish, water snails, crabs or water fleas. Many species need to migrate between different parts of a river to reproduce and forage. Second, cross-sectional structures such as weirs and dams slow down river currents and interrupt bed load transport. The clear water which flows over a dam scours missing bed load from the riverbed and banks below the dam, which lowers ground water levels and causes significant damage to riverbanks. Added to that, a considerable share of a river's water upstream from the weirs is frequently diverted to achieve higher drop heights. This leaves entire sections of the river without enough water to sustain aquatic life.

This is the reason Swiss authorities today effectively no longer grant building permits for small, conventional hydropower plants with weirs and turbines. In fact, existing small dams and weirs are already being dismantled with funding of about 100 million Swiss francs a year from the Swiss government. The energy potential of many smaller rivers and streams with low drops in height, or heads, cannot be exploited using conventional hydropower technology.

#### Gravitation water vortex power plants are a new alternative

Gravitation water vortex power plants offer a new way of making use of the hydropower potential of smaller waterways without causing damage to river environments and aquatic life. Basically, when an existing weir is replaced by a gravitation water vortex power plant that has no weir, that section of the river is also renaturated and revitalized, restoring continuity for fish and other river creatures. Gravitation water vortex power plants are small and robust river power plants. They require a minimum water level of 0.7 meters and a minimum water flow of about 1,000 liters per second. Thanks to innovative, simple and low-maintenance technology, they are designed to operate for about 50 to 100 years, making them quite cost-effective.

The technology used in gravitation water vortex power plants – also called water vortex power plants – is completely different from that of conventional small hydropower plants with their ponds and turbines. A water vortex plant consists of a circular tank or basin with a central drain (see Figure. 1). A symmetrical vortex automatically forms above the drain, as it does when we drain water from a bathtub. The vortex drives a vertically placed rotor turbine at a rate of about 20 rotations per minute. This rotor powers a generator that produces electricity and then transmits it to the power grid. There is no backflow or any increase in water pressure, allowing fish to easily swim upstream and downstream through the power plant.



Diagram of a gravitation water vortex power plant (Fig. 1)

The basic idea for this kind of a power plant is not all that new. The Austrian naturalist and water scientist Viktor Schauberger first described its principles in the 1930s. In contrast to impoundments with conventional turbines, water flow in vortex power plants always preserves its natural dynamics, unconstrained and free. If water vortex power plants were to replace the many weirs and cross-sectional structures found in rivers today, the entire vertical drop of a river could be utilized in numerous small and decentralized units. Several rotation basins could also be placed directly one after the other in places where thresholds are high.

Most of the electricity produced can be used locally, almost like solar panels on a roof. But water is more diligent than the sun and works year round, day and night, even Saturdays and Sundays, 8,760 hours a year. According to the Swiss Federal Office for the Environment, there are currently at least 100,000 artificial barriers in Switzerland's waterways. Roughly 12,000 of these have heads of one to three meters and a flow volume of two to ten cubic meters per second, making them suitable as locations for water vortex power plants. This potential could be used without any negative effect on river biology to supply one to two million people with electricity – exclusively from hydropower generated by small rivers that are currently not being utilized for this purpose for environmental reasons.

These figures may sound utopian, and this undertaking cannot be accomplished in a week, especially because approval processes in Switzerland are very drawn-out. So far we have been able to build only one such power plant. The approval process for a second plant was initiated two years ago and could take another year. This of course hinders the rapid spread of a technology that would be so useful for the energy transition.

#### River renaturation and revitalization

It would be conceivable to construct water vortex power plants in rivers that do not have retaining structures and still flow freely. But we do not think this makes sense. Rivers that are not exploited and still have room to flow naturally are rare in Central Europe and should be left alone. Water needs room to flow as it is meant to flow. Left alone, water never flows in a straight line. It does not take to being constrained but seeks to make its way freely through the landscape. However, people also have the wish to spread out and multiply, and thereby occupy more and more space. In the past in Europe, we took away the space we needed mainly from rivers. Rivers used to meander in wide floodplains and were free to change their courses. Today, urbanization, roads and farmland confine them and hinder their movements.

The path of a naturally meandering river from source to mouth is a long one. Viktor Schauberger once said that the length of a freely flowing river was longer by a factor of  $\pi$ , therefore 3.14 times longer, than the linear distance from its source to its mouth. We can confirm this by measuring the length of the few naturally flowing rivers we still have. There is good reason for the leisurely pace of these waterways. Enough water space, meandering flow paths, and flow speed are important as they prevent rivers from gaining too much momentum and causing damage. The increased straightening and narrowing of waterways has caused the gradient of many rivers to become too steep to allow them to flow naturally. Straightened rivers with accelerated flow rates eat away at their banks and gouge riverbeds deeper, one of the major reasons why springs dry up and groundwater levels drop in entire valley plains.

#### Working with, instead of against, water

Viktor Schauberger began developing new ideas for river engineering as long ago as the 1930s. The methods he proposed alter the inner movement patterns of flowing water. For instance, riverbanks can be stabilized at regular intervals by placing tree trunks that are 30 to 60 centimeters thick, rounded at one end and with lateral grooving, at an angle in the water-course (see Figure 3). This cost-effective and natural method encourages a river to meander. The water begins to furl inward towards the center of the river, and even though there is no change in the gradient, the speed of flow increases. But water no longer tears at the river-banks; instead the river has calmer waters near its banks and even eddies with upward flow.



A river section with hard bank stabilization structures (Fig. 2)



Renaturation of a river section according to Schauberger (Fig. 3)



View of a river section that has been renatured using Schauberger's methods (Fig. 4)

We could have done without many of the hard, expensive, and denatured cement and stone structures that have been built in the last few decades. They have turned out to be devastating for river ecosystems, and ineffective in the long run. Now with the new Water Protection Act of 2011, we in Switzerland have the opportunity to rehabilitate canalized rivers using natural methods, or even better, by giving rivers the space they need. It is a gargantuan task, and a very expensive one. We believe the dismantling of most weirs and cross-sectional structures could be combined with the new construction of water vortex power plants. Low construction costs mean that the proceeds from these power plants could be used to finance the renaturation of large and mid-sized rivers. This would save taxpayers a lot of money, and at the same time we would be giving back to rivers what they need the most: space and natural flow conditions.

#### Aquatic life on the move

The most decisive advantage of water vortex power plants is that, unlike power plants with conventional turbines, they allow river life to move freely. There is an apple tree directly above our pilot power plant in Schöftland and apples sometimes fall from the tree into the water. These apples survive the rotation basin without any bruising whatsoever. Although there is no problem moving downstream, moving upstream is a bit trickier. Fish caught in nets above and below the rotation basin show that this is not a problem for strong and agile fish. But we are not sure whether small fish and other creatures are able to swim through the basin against the current.

That is why we have been striving for years to collect reliable research findings. Despite our efforts, to this day we have not been able to observe fish up close as they move through the power plant. Research methods today involve the placement of tiny transmitters in fish to determine their migration routes and swimming behavior. The problem here is that the interference current generated by the electronics of the power plant renders these transmitters useless. The Swiss Laboratory of Hydraulics worked on this problem for six weeks, but was unable to come up with a solution. We, as operators of the plant, cannot and do not wish to take responsibility for an experiment in which active transmitters are implanted into fish. We know for sure that these animals – about 100 fish would be needed for the experiment – would not survive the test. Researchers are currently developing a system that involves the use of a software-controlled video camera. We expect it to be ready in a year or two, and then we will be able to provide scientific evidence of the ability of fish to pass through the plant.

Conditions for the construction of a water vortex power plant are most favorable in locations where there is enough room to create a natural bypass channel. Such bypass channels are like

natural streams that flow parallel to the power plant. In such cases, we could be absolutely certain that living creatures would be able to freely move up and down the river, even against the current.

#### Grey energy

When undertaking a construction project, it is always important to ask about "grey energy", the total energy needed for construction work and for manufacturing construction materials. This applies to water vortex power plants as well, and we attach great importance to conserving as much energy as possible.

Most of our projects are located in river sections that have been stabilized with stone blocks. The construction of our power plants, which also involves widening the river, makes these stones redundant. They can be reused as a primary building material once they are replaced by the flow management measures designed by Viktor Schauberger. This allows us to accomplish the renaturation of the river, the construction of a natural bypass channel and the water vortex plant with a minimum of energy.

If there aren't enough stone blocks available, wood can be taken from surrounding forests. Many engineers question the use of wood in water and prefer to use cement. But our ancestors left enough examples to prove that wood has had many uses in hydraulic construction: wooden bridges hundreds of years old are supported by wooden pillars, historical weirs are made of wood, and wooden water pipes, wells, and wine barrels have been in use for tens and even hundreds of years. The durability of wood is limited only where it is subjected to a mixture of water, oxygen and organic material. These critical sections of a structure must be built so that wooden parts can be replaced if necessary.

Only technical and electrical components such as the rotor turbine, the generator, power cables and the switch cabinet must be made of steel, copper and plastic. But given the long operating life of 80 to 100 years for a water vortex power plant, the grey energy used for material and construction is of minimal consequence, and of much lesser magnitude than in conventional power plants.

#### Efficiency and effectiveness

Water vortex technology is far from mature. Today the plant in Schöftland has an efficiency of only 50 percent, like a conventional water wheel. Although its electricity yield is much lower than that of a conventional turbine, the technology is already competitive, even with this limited efficiency. At the pilot plant in Schöftland, we are currently investigating how we

can make use of the vortex's suction force in the sense described by Viktor Schauberger to further increase the plant's efficiency (Figure 5).

Schauberger's water vortex (Fig. 5)

Three-dimensional optimized rotor (Fig. 6)

It is essential to make use of rapidly rotating layers inside the vortex without destroying the vortex. We recently started using the gear mechanism as a supporting element instead of rigidly mounting the rotor's axis by means of spherical roller bearings. A flexible Cardan joint now connects the gear mechanism and the rotor. This places the rotor in the exact center of the vortex where it can absorb energy more efficiently and transmit it to the generator. We are also experimenting with different rotor positions and shapes, and testing them in the pilot plant. In this process, the rotor is taking on the shape of a vortex more and more. Our partners in Dresden will soon connect their first plant to the grid using a sophisticated three-dimensional optimized rotor with much higher efficiency (Figure 6). By utilizing a slow-speed generator, there will be no need for a gear mechanism, which will increase efficiency even further.

We would like to make use of our latest research findings in a project on the Murg River near Wängi in Thurgau. In experiments in a small stream, we were surprised to find that having a walled basin was not absolutely essential to create a strong vortex. All that needs to be done is to channel upstream water downstream through an opening in the riverbed and a drainpipe. The opening in the riverbed and the drainpipe are the same size they would be in a conventionally constructed rotation basin. The only difference is that the system is hidden because it is in the ground. Instead of having an inlet and a basin, a natural pond is created that can be planted with vegetation typical for the area. The rotor, equipped with a generator, is suspended from an excavator arm and can be precisely centered in the vortex – and easily lifted out of the water for maintenance, or in case of flooding. This makes the water vortex plant almost invisible. Moreover, such a plant is considerably less expensive and its construction requires only a minimal amount of grey energy.



Gravitation water vortex power plants offer a new way of making use of the hydropower potential of smaller waterways without causing damage to river environments and aquatic life. (Fig. 7)

#### Future Projects

#### The river Thur near Ebnat-Kappel, Canton of St. Gallen, Switzerland

The river Thur today is heavily engineered and confined in many areas. A section of the upper reaches of the river near the village of Ebnat-Kappel is particularly narrow, and is ear-marked for quite a bit of widening as part of the country's statutory river rehabilitation project. In this context, the construction of a water vortex power plant would still leave enough room for a natural river channel, allowing aquatic life to move freely. The power plant, with a head of three meters and an average flow volume of 18 cubic meters per second, could generate about 800,000 kilowatt-hours per year (see Figure 8). At the same time, widening the river would create a diverse and natural river landscape. The river can take care of this itself, as widening allows its waters to redistribute sand and gravel. All that people have to do is provide the space and set limits by constructing an earthen embankment planted with willows, for instance. The river can determine its own course within these limits. Islands, gravel banks, ponds and riverside forests can develop where plants and animals live, breed and spread out. Once the project is completed, the generous amount of space provided means that this rehabilitated section of the river Thur will never overflow again.



Ebnat-Kappel rehabilitation project (Fig. 8)

#### The middle and lower reaches of the Thur

Even the middle and lower reaches of larger rivers such as the Thur are suitable locations for constructing water vortex power plants. We plan to build a plant with a head of 1.5 meters and a volume flow of 50 cubic meters per second, generating roughly two million kilowatt-hours per year. Here again, we will be taking advantage of the fact that a stretch of 50 kilometers of the Thur has already been earmarked for rehabilitation. Plans involve making the river twice as wide as it is now, expanding it from its current width of 50 to 60 meters to 100 to 120 meters, which will create an extensive natural river landscape. Our project foresees building

six consecutive basins near the riverbank. The basins can be put into operation depending on the amount of water flowing in the river. Water will pass through two basins when there is a flow volume of 15 cubic meters per second, and through four basins when the flow volume is 40 cubic meters. By activating and deactivating the basins, we will be able to adjust the capacity of the plant to accommodate a flow volume ranging from 5 to 55 cubic meters. The basins



Planned water vortex power plant on the Thur (Fig. 9)

can be easily protected from drifting trees, bed load, and other debris carried by the river in times of flooding because they are located near the riverbank. Even higher heads of up to three meters can be put to effective use by regulating the number of active basins. Considering that there are about a hundred rivers the size of the Thur in Switzerland alone, we see huge potential in the application of water vortex technology here.

#### The Birs River near Aesch, Canton of Basel-Landschaft

Conditions on the Birs River, the main river in Switzerland's northwest Jura region, are completely different from those on the Thur. The section of the river that flows through Aesch has been straightened and is confined by a solid embankment. It cannot be widened due to existing buildings. The only solution here is to remove the existing embankment structure and substitute it with the flow management measures designed by Viktor Schauberger. This would create more diverse flow patterns and protect the banks (Figure 10). There is not enough room to allow for a bypass channel for migrating aquatic life, so we are planning to build a pendulum ramp to slow down the flow rate and let river creatures migrate upstream.



Planned water vortex power plant near Aesch on the Birs River (Fig. 10)

The pendulum ramp is also based on Viktor Schauberger's principles. It guides water in waterways with steep gradients over several steps from one side to another so that water flows much more slowly and calmly. Fish can migrate downstream by swimming down the pendulum ramp or through the water vortex basin. In Aesch, we plan to build a power plant with a head of three meters and an average volume flow of 28 cubic meters per second, which can generate roughly 1.3 million kilowatt-hours of electricity per year.

#### Conclusion

The potential of this natural method of generating electricity could be exploited soon provided the authorities involved in the approval process show a bit of good will, and politicians take the transition from nuclear power to renewable energy sources seriously enough to support the development of water vortex power. The advantages are obvious: the minimal use of grey energy for construction, the generation of inexpensive base load power, the safe passage upstream and downstream of aquatic life, and optimal incorporation into needed river rehabilitation measures. Everything speaks in favor of using this technology, especially in the case of small and medium-sized rivers where conventional methods of generating hydropower have unacceptable ecological consequences. Unfortunately, it is still uncertain whether society will seize the opportunity water vortex power has to offer.

# Water-Friendly Agriculture – What Farmers Can Do For Water

#### DR. ANDREAS FLIESSBACH

Dr. Andreas Fliessbach of the Swiss Research Institute of Organic Agriculture (FiBL) provided insight into one of the least researched areas of the hydrologic cycle: the water-soil system. What gives soil its capacity to retain water? How can farmers contribute to healthy soils and an intact water cycle? And what has this all got to do with climate change?

Water is agriculture's most important and essential resource. The constant availability of water is the basis for all plant growth and thereby of livestock farming, which would be impossible to support without plant fodder. It is therefore not surprising that agriculture is the largest global consumer of water. In fact, roughly 70 percent of the water we take from rivers, lakes and other natural sources is used for agricultural irrigation – in spite of the fact that not even one-fifth of the world's agricultural areas depend on irrigation. The rest gets enough rainfall for crops to prosper.

So in many places, agriculture profoundly alters the natural water cycle, especially where it consumes large amounts of water from rivers, lakes and groundwater reserves. The best-known example is the Aral Sea, which has shrunk at an alarming rate in just a few decades due exclusively to the excessive withdrawal of water for irrigation. We use more land world-wide for agriculture than for all other activities, and agriculture's expansion over the past decades has, next to the clearcutting of rainforests, taken place predominantly at the expense of water-rich areas. In Europe today, the vast majority of flood plains, marshes and wet meadows have disappeared. In Germany, 57 percent of its wet meadows were lost between 1950 and 1985 alone because of drainage and subsequent agricultural use.

The aspect of agriculture that affects the water cycle most is the cultivation of soil. Farming practices determine quite obvious differences in soil structure and fertility, in the way rainfall and dew are absorbed and retained by the soil, and how rain seeps into the ground and evaporates. These soil processes have not yet been fully researched, but they have a strong impact on local water cycles and should therefore be looked into more closely. They are outlined below.



Long-term research has come up with important findings. A field trial in Therwil, Switzerland, for example, has been continuously comparing different farming practices since 1978. Several plots with identical soil have been cultivated there for decades, some of them according to the principles of organic farming, some according to biodynamic methods, and others using conventional farming systems – all of them with the same level of fertilization. The crop yields from these different methods have been studied, as has long-term soil development. Research has shown that the use of plant nutrients such as nitrogen, potassium and phosphorus is roughly 40 percent lower on the organic plots. The use of synthetic fertilizers und the subsequent risk of these chemicals leaching into rivers and groundwater is of practically no concern in these plots. Although fertilizer use is 40 percent lower than in conventional farming, long-term average organic crop yields are only a bit lower (17 percent) than conventionally cultivated crop yields. Or better said, organic farming has proven to be a much more effective system in terms of fertilizer utilization.

Soil biomass content is important for the regulation of the water cycle, and again a marked difference has been seen. Biomass content is 40 percent lower in conventionally farmed plots than in the soil of organic plots. Similarly, humus content is significantly higher in organi-

cally farmed soils than in conventional plots. Biodynamic farming methods have yielded the best results. This applies in particular to the humus content, which is highest due to the exclusive use of composted farm manure.

High humus content has a favorable effect on soil organisms, root penetration and fertility. Water retention also improves; this means that humus-rich soils retain moisture longer after rainfalls. Rain can seep into the ground better instead of just wetting the surface of fields (see Figure 1). High humus content also protects fields from erosion and from valuable topsoil being washed away. Erosion is one of the most serious threats to agricultural cultivation and food security because it removes the fertile topsoil responsible for the supply of nutrients and for providing plants with a place to root. Soils loose their fertility without this layer.



Comparison of a humus-poor and a humus-rich field after heavy rainfall (Fig. 1). Source: Andreas Fliessbach

Because high humus content promotes the rapid infiltration of rainfall, it also reduces rainwater surface runoff and with that, the risk of flooding. For farmers, the increased stability of the topsoil has the advantage that soil retains more water and crops do not require additional irrigation, even during prolonged periods of dry weather.

Over the past decades, the humus content of nearly all arable land in the European Union has decreased at an alarming rate. It is unclear whether the increase in intensive farming alone has been the cause of this decline, or whether rising temperatures have also played a role. In any case, the losses are considerable and have already had a noticeable effect in Germany too.

There is a great deal of intensely cultivated, humus-poor farmland in Mecklenburg-Western Pomerania and Brandenburg. The topsoil is often so unstable that much of it is swept away by high winds during extended spells of dry weather. In April 2011, poor visibility due to such a dust storm caused a pileup on an autobahn near Rostock. Extensively cleared acreage with mile after mile of monotonous farmland, devoid of hedgerows or wooded areas that could offer protection against the wind, promotes wind erosion. How soil fertility can be restored in such areas is now the subject of intense research.

#### New approaches in agriculture

The more we understand processes in the soil, the clearer it becomes that it is worth identifying and making use of the advantages that natural ecosystems offer us. In other words, we should work with nature and not against it. Earthworms, for instance, are ideal soil engineers and chemists; they loosen the topsoil and transform substances such as minerals and plant nutrients so that plants can make use of them. We are also finding out more about the living conditions that foster those animal species that feed on unwanted pests, making the use of chemical pesticides unnecessary.

The least understood is the role of arable flora, those plants traditionally considered unwanted weeds. It turns out that a "clean" and "weed-free" field is not necessarily more productive. The coexistence of different plants also benefits crops. Thus, for example, the roots of a variety of plants use fungi to communicate with each other and optimize nutrient intake. It is indicative that in natural ecosystems we practically never find larger populations of a single plant species, but always several species whose metabolisms complement each other. We can also identify synergies when it comes to water supply. Plants with deep roots draw up water, which also benefits neighboring plants with shallow roots.

There are new findings, especially regarding soil conservation and soil management. The aim is always to increase topsoil stability, improve the absorption, retention and infiltration of rainwater, and of course to provide nutrients. In this way, soil fertility can be increased while crop yield losses in times of drought are minimized. A covering layer of mulch, for instance, stabilizes the topsoil, reduces evaporation and promotes soil fertility. Green manure crops, also called cover crops, fix atmospheric nitrogen, protect the soil from erosion, and provide nutrients for subsequent crops. In agroforestry systems, trees provide shade for farm crops. A very important finding is that plant remains left on fields after harvesting should not be removed; they should be left to decompose and turn into humus, which greatly helps the soil.

For farmers, the advantage of intelligent nutrient management is that they can use fertilizers efficiently and avoid losses. For instance, replacing mineral fertilizers with organic fertilizers reduces the seepage of nitrates into groundwater by more than 50 percent, saves fertilizer, and benefits the environment at the same time. However, when we use organic fertilizer we must make sure that plants can absorb the nitrates formed in the soil as promptly and completely as possible. This requires new methods of cultivation with reduced tillage, for example, replacing a conventional plow with a stubble plow.

In terms of water balance, it is generally better to keep machines off the soil as much as possible. The less frequently a tractor is used on a field, the less the soil is compacted and compressed, allowing more rain to seep into the ground. Moreover, the type of fertilizer used has proven to be highly important as this has a particularly strong effect on humus content and soil structure, determining how much water the soil can absorb. Finally, the tillage method also helps conserve the topsoil and the integrity of the uppermost layers of soil. Chisel cultivators, stubble plows and Rototillers are good replacements for conventional plows (see Figures 2 and 3). Conservation tillage methods result in a classic win-win situation in which fostering the good water retention capacity of soil means consistently better crop yields.



The tillage method also determines how much water the soil can retain (Fig. 2). Source: FiBL



Rototiller



Stubble plow



Chisel cultivator

Modern tillage machines for gentler soil cultivation (Fig. 2, 3)



#### Humus and climate change

The massive loss of biomass and humus in farmland across the globe means that large amounts of organic carbon formerly bound in the soil have been released into the atmosphere as CO<sub>2</sub>. Analyses of comparison data collected around the world show that on average about five tons more carbon per hectare are bound in organically cultivated farmland than in conventional fields. Seen on a global scale, this is a huge amount. It affects the CO<sub>2</sub> content of the atmosphere and is relevant to climate change. In other words, conventional agriculture has been contributing to climate change for decades because it degrades organic matter in the soil.

On the other hand, appropriate management holds the potential to regenerate the  $CO_2$ content in agricultural soils and actively counteract climate change. In addition to the many other benefits of organic farming, this is perhaps the most important incentive for switching to organic agricultural practices. Nevertheless, systematically thinking of soil as a carbon sink and cultivating it accordingly remains a major undertaking for the future.

## Water-friendly agriculture

Overall, no other human activity is as massively and extensively disruptive to the water cycle as agriculture is. While excessive water withdrawal for irrigation has long been recognized as a problem - and water-saving irrigation systems have therefore long been promoted - agricultural soil management still has major shortcomings. Even though not all soil processes have been studied in detail, the differences between varying farming practices are significant. Organic methods have in many ways proven to be superior to conventional practices in
terms of soil health and water balance. They reduce the contamination of water with nitrates and pesticides, slow down and stabilize the runoff of rainfall, and increase the retention of rainwater in topsoil and groundwater. Farmers stand to profit because their crops get enough water, even during hot spells. This in turn has the positive effect that in times of drought, less water for irrigation is taken from rivers and lakes that are already depleted.

In view of climate change and the more frequent and much heavier rainfalls expected to come with it, farmers who practice good soil management are making a major contribution to flood protection. This is because humus-rich soils can retain significantly more water per hectare, an aspect which is important for reducing surface runoff into waterways.

Agricultural intensification across the globe in past decades has resulted in a considerable increase in food production, but its negative side effects on water and climate suggest that current agricultural practices are irresponsible in the long run and do not make economic sense for farmers. Three basic principles must be observed if we want to ensure long-term food security for people everywhere. First of all, nutrients must be used as sparingly as possible in the interest of resource efficiency. Second, a systematic build-up of humus in agricultural soil is necessary to secure long-time fertility. Finally, farmers must again become aware of how they can work with, instead of against, natural processes.

Clearly, this will work only if the buying public becomes involved. We can all support this urgently needed change in agriculture by buying foods that are in season and locally grown with sustainable methods of agriculture. When we do this, we help to slow climate change, reduce the incidence of floods, and keep our waterways free of nitrates and pesticides.

## Water and the Art of Cleaning

#### LINDA THOMAS

Linda Thomas started a cleaning company 25 years ago. She specializes in using the most environmentally friendly methods available. She held a workshop at the symposium during which she talked about her experiences with water as a cleaning aid and cleanser, and about things we can experience while cleaning if we are receptive and increase our awareness. Water acts as an element of renewal and regeneration and while we clean it can provide us with deep insight into the workings of the world.



Throughout the ages, water has been our most important cleanser. We use water constantly: when we bathe, do the laundry or clean the house. Water is transparent, has no color, soaks, dissolves, absorbs, and disperses. All these properties make it easier for us to clean. Imagine having to wash dishes with red water, or wipe furniture with green water! Water is so effective precisely because it is neutral. Water is universal. It comes to us from the sky, clean and pure, absorbs earthly substances and in the process becomes dirty itself. That is the quintessence of cleaning.

If we take a dry cloth and wipe it over a kitchen counter, it glides over the surface smoothly unless something sticky gets in its way. But if we dampen the cloth, even just lightly, its contact with the surface of the counter becomes much closer. In this case, the surface resists the cloth ever so lightly, somewhat like skin being stroked does. Water is a bonding agent. Water is a godsend; clear and transparent, it bonds, absorbs and carries away dirt. Altruism at its best. Water enables us to do amazing things: we use it to clean and treat furniture, floors and our skin. This miracle worker imbues everything with a special sparkle when we use it to clean: stone floors shimmer when damp, but as soon as the moisture evaporates, they look ordinary again.

A glance at the contents of most cleaning cabinets makes one wonder whether water really is our most important cleaning aid. It is possible to clean using only water; there is no need for commercial cleaning aids, but we cannot use cleaning aids without water. Today we have a spray for everything – just squirt, wipe and abracadabra: clean! But truth be told, all we are really doing is dispersing and redistributing dirt more evenly.

Water drops are enclosed in a thin elastic film created by surface tension. It is like a skin – a tense, extremely sensitive skin. Surfactants, used to increase cleaning power, dissolve this surface tension, effectively causing the film to collapse. But surface tension release causes water to loose its vitality. Most of the cleaning agents we add to water jeopardize its unique properties. It takes courage and sometimes a bit of patience to refrain from using additives. But soaking things in water is still the best way of dealing with encrusted pots and pans, and laundry stains.

Fortunately cleansers that conserve, and even maximize the energy in water are also available. The best-known product of this kind is Butzwasser\*. This particular kind of water is treated with Light Matrix technology for several weeks. The result is a product with special cleaning properties. Butzwasser does not dissolve and disperse dirt; it actually wipes away and removes dirt. I have often succeeded in motivating entire school classes for a clean up with the help of spray bottle filled with just seven drops of Butzwasser in a liter of tap water. First graders to twelfth graders all wanted to try out the magic water that makes it possible to wipe away the sticky, black dirt on the underside of chairs in a matter of seconds. Other products also conserve water's energy. For example there is the Zylka Propolis Company, which recommends the use of sodium carbonate. If we dilute sodium carbonate in warm water (the temperature has to be at least 32 degrees Celsius), every molecule of sodium carbonate decahydrate splits off nine molecules of highly vital water, which in turn accelerates the cleansing effect. It is easy to produce decahydrate by dissolving dry sodium carbonate in water. Deposits of sodium occur naturally in practically all top layers of soil, but high concentrations can also be found in several lakes. Sodium bicarbonate is a salt developed from sodium carbonate and carbon dioxide. Together with water it forms a decahydrate (ten  $H_2O$  molecules per grain of salt), or a monohydrate (with one  $H_2O$  molecule). Deca- and monohydrate do not commonly occur naturally as salts of other elements.

A project in northern Germany has very successfully used water in combination with cosmic rhythms and eurythmic processes in dishwashers and even in the washing and disinfecting of medical equipment at a dentist's office.

The Hoshizaki Company uses ROX machines to turn tap water into what they call E-water. It is a highly efficient cleaning aid with antibacterial qualities comparable to the best of detergents.

Time is still the most important factor. Cleaning results are better, even when cleaning a kitchen, if surfaces are treated with abundant amounts of water over a longer period of time. This procedure is both less expensive and more ecological than adding chemicals to cleaning water.



#### Questions from the audience:

It seems that you are interested in more that just cleaning. How did you get started? When my daughter was four years old, I decided to send her to a Waldorf school. The father of my children made it clear that I would have to pay for the additional expense. I was a total loss. I had worked as a director's secretary at an American company before my children were born, but I no longer wished to do that kind of work. A friend, who owned a factory that produced eco cleansers in Arlesheim, recommended I start up an ecological cleaning company because at the time this kind of business did not yet exist.

#### *In the beginning, how did you feel being a cleaner?*

On the job I discovered that it is possible to experience cleaning and maintenance work in a different way from how we normally perceive it. Women who are mothers and housewives usually lack social recognition, and I sympathize with women who insist on their right to a career. I however, in the many years of carrying out this very basic kind of work, have experienced and learned many new things. I even believe that cleaning and maintenance can provide a certain kind of education. Women who do not have a career outside the home would probably feel more fulfilled if they could also experience this.

#### Why are you often invited to give talks on this subject?

The great demand came as a surprise to me too. The only explanation I can offer is that I talk about my own experiences and discoveries. People are able to identify with personal stories. Everything I communicate is directly connected to my activities and the things I experience on the job. Many people feel personally inspired by my experiences. When they go home and try out new things, results are immediate. Many discover that everyday activities have a spiritual quality they would never have suspected. It is probably the constant search for something tangible – a real experience – that holds this appeal. Cleaning is also an activity in which the age-old human conflict between meaningful and meaningless is manifest: when we clean, we start from scratch every day. It is even often referred to as a Sisyphean task.

#### How do we go about cleaning a room in a meaningful way?

Before you start to clean, you should stop for a moment at the door and take a look at the room. Look at it in its entirety and ask yourself, "What bothers me most?" It is usually something that you would normally put off doing. Then start working on this trouble spot. For these are places where something has developed on its own, and that is the reason we are so ready to overlook them. If we do not tackle these areas, they become like hurdles we shy away from. But once the hurdle has been removed and the most difficult spot tackled, an incredible amount of energy is released and spurs us on to continue. Normally, work is supposed to make us feel tired. What makes us feel tired is not so much the work we have done, but rather the thought of the work we still have to do; it can be overwhelming.

#### So there is another dimension to the act of cleaning?

Everything we do has another dimension if we put care and love into it. When we clean with love and dedication, we attain a higher level of achievement; a clean room becomes a room

that has been cared for. A room that is cared for has a totally different effect on us than a room that is merely clean. Something that has been cleaned is clean, but it does not stay that way very long. When we care for something, we do our work more thoroughly, and the effect is significantly more glowing and radiant. There are spotlessly clean rooms that lack any kind of atmosphere because they have been almost cleaned to death. But in a room that has been cared for, even if it is slightly messy, we can still feel the difference, for instance because the plants look healthy. Plants are good indicators of how much care a room receives, of the life it experiences.

When I work I try to connect to the room and the objects in it, to dedicate myself to my task and to intensify my awareness. This manner of working sharpens our perceptions, and the resulting attitude shows even in our gestures. Whether my movements while I clean are hectic or harmonious; whether or not I pay attention to my body; how I reach out for something; how carefully I handle it – these are all important questions. This also applies to our perception of the elements: earth, water air, and fire. Sometimes when I watch people cleaning, I get the impression that they are struggling with the dirt. And if I ask them about it, they say, "Well, it is after all a daily battle." But wherever there is a fight, there is also aggression. I however, maintain that we can transform dirt, and this also leads to a more serene attitude toward work and more relaxed physical movements while we clean.

#### Was this something you knew intuitively?

Oh no! About half a year after I started doing this work I fell into a deep crisis. I asked myself whether I would be able or even wanted to last another 19 years. It was not easy for me to accept being continually confronted with indifference and occasionally even disrespect. People would often not even say hello to me. Why is it that clients have more reservations against cleaning than those who clean for them? While I was undergoing this identity crisis, three questions kept coming up. The first was: How can I stand this? The second question was: How do different rooms affect people? I perceived strong differences and asked myself for example, what effect this or that classroom had on children. And the third question was: What does a room feel like after I have finished working on it? What do I have to do to make the room feel better?

I allowed these central questions to develop, and by and by the answers started to materialize. I answered the endurance question with a sentence I had heard somewhere: If you can't do what you love, learn to love what you do. And soon I started remembering things from my childhood. How we children were shaking our grandmother's pillow out a window, and since she was in mourning at the time, our mother said, "You have to shake it really well so that all the tears fall out and your grandmother can again safely lay her head down to rest on it." In the beginning, I performed these tasks as I would basic exercises. I tried to see if I could shake something out of things, or stroke them until smooth. At some point, it became a part of me.

While I learned to carry out my work with love and dedication, I also learned to step into a room without judging it. It was simply my job, and the worse the room looked, the more interesting my task became. I did not even feel disgusted anymore, even when confronted with the worst of toilets. I never thought, "My God, what a mess", instead I would tell myself "This is now your task."

#### What cleaning aids do you use?

I used fewer and fewer cleaning aids over the years. I now only need three cleansers for normal maintenance cleaning. In addition I need some cleaning tools and cleaning agents for especially challenging dirt.

- Microfiber cleaning cloths They can be used in all areas and on nearly all surfaces. The use of a cleanser is rarely necessary. Take care to select good quality fibers. Use as little water as possible, in other words, the cloth should be only slightly damp.
- Glass scrapers Professional blades help remove adhesives, insect stains on windows, encrustations and charred food in ovens, lime scale deposits, and built-up grease. This way you can avoid using solvents.
- Neutral cleansers such as all-purpose cleaners, neutral soap and Butzwasser can be used on surfaces that do not require special care (e.g., synthetic surfaces, doors, frames). All-purpose cleaners are not suitable for use in wet areas, as they do not remove lime scale. Butzwasser is available at select natural food stores or directly from its producer Lichtmatrix.
- Acids such as citric acid, vinegar and lactic acid are suitable for all wet areas in the home. Products used to treat bathroom fixtures made of stainless steel should not contain high acid levels as they can cause discoloring and damage to the finish.
- Alkaline cleansers such as sodium carbonate, potash soap, bile soap and baking soda are used to remove grease and stains. They are very effective for use on kitchen vent hood filters. They should not however be used on surfaces that contain oil such as linoleum or wood as alkaline cleansers will remove the oils.
- Abrasive materials such as bath bricks, Vienna polishing chalk, quartz, ash, chalk and pumice should be used only very selectively since they can damage surfaces. They are excellent for removing pencil and other black marks from floors, doors and walls.

#### You mentioned the elements. What role do the elements play in cleaning?

Earth, water air and fire – the elements are the basis of all life on our planet. Empedocles, who lived in Greece in the 5th century BC, established the theory of the four elements as the roots of all matter on Earth.

The elements play a central role in our everyday lives as we are in constant contact with them: when we clean and tidy up, when we wash our hair, when we air rooms, when we light candles or cook. In the flame of a candle we can experience all four elements at the same time – in a solid state in the wax and the wick, in wax in its liquid state, in the necessary element of air without which the flame would be smothered, and in the light and heat of the flame itself. The elements are helpful to us, but on the other hand they depend on us to perceive them and learn to use them consciously.

Children can teach us to live with the elements. They love water and feel its vitality and the joy of life it gives them. On a swing they delight in flying through the air and feeling the wind in their hair. They enjoy feeling the wind in their faces when riding a bike or through the open window of a car. Children can spend hours using their imagination to play in a sand box or on the beach. And they love fire. Every child loves lighting candles and watching the swirling smoke when they are blown out.

How nice it would be if we adults could rediscover what it is like to experience the elements directly in everyday life the way children do, and if we could learn to be friends with the elements. The elements are everywhere – around us and in us. They make life possible, but they can also snuff it out in a matter of seconds.

Where I grew up there were often long periods of drought. It was so dry sometimes that our chickens died off. We learned not to waste water at a very early age. Each child was given a small schnapps glass of water to brush its teeth with. We took baths two at a time and only once a week, on Sundays. We were only given a shallow basin of water to wash ourselves with on weekdays.

But then: what a wonderful moment it was when finally the smell of rain announced the long awaited wet season! The animals would go crazy and the cows romped like young calves in the meadows. As soon as the first drops fell, the entire family would stand in front of the house, our father with his hat on his chest, and we would all thank the Lord.

#### How do the elements show themselves?

The Earth carries us and gives us our shape; it is a pillar of our existence. In earlier times, people had a much closer connection to their surroundings and to themselves. They experienced their earthliness in every cell of their bodies. Water forms and creates us, refreshes and flows through us, air surrounds and invigorates us, and warmth (fire) keeps us alive and makes it possible for us to be active and develop will power. Just like the different peoples, each with characteristics of their own, who inhabit this Earth, from the Arctic Circle to the Kalahari Desert down to the Cape of Good Hope, elemental beings also exist, each with specific characteristics, depending on the element they are related to.

Earth, water air and fire – the four elements are present during all our activities throughout our lives, either individually or together; while we eat, drink, breathe, think, and love. We can only live on this Earth because of the existence of the elements and the beings related to them. We were graced with earth, water, air and fire and it is our duty to heed them and use them with respect. We are never separated from the elements, we are just very rarely aware of their presence – especially while cleaning.

Sometimes I have the feeling that cleaning allows me to strike a balance, create a sphere in which thought, feeling and will power can develop in a healthy, constructive way. Cleaning is an activity during which we – more or less consciously – are constantly on the threshold of the elemental and spiritual world. If we keep trying to develop our awareness of the elements and the elemental beings that surround us, we can enrich and nurture our inner lives. A person who cleans, works with all four elements and in doing so transforms the Earth:

In the earth element we clean and nurture, we transform. A dirty bathroom becomes a work of art and chaos becomes living order.

Water cleanses, liberates. Before exams or when I was lovesick, my mother used to say, "Go and wash that out of your hair!"

Air purifies: When I enter a room in which the air is full of tension, I spontaneously open the windows and after a while I call out, "The air is clear!" In special cases, we can use smoke to fumigate once everything has been cleaned and washed.

The element of fire continually transforms itself. In many cultures fire rituals are used to achieve sublimation, purification and healing.

We owe purity and cleanness, regeneration and refreshment to water. But do we express our thanks? Do we still wonder at the miracle that takes place when we do the household cleaning and wash mountains of laundry? What do we do for water in return?











## CHAPTER 3 Water needs innovation

Although people have been using water intensively for centuries, our technical knowledge is still in its infancy. New processes that further reduce consumption and the pollution of water resources are constantly being developed. Chemists Frank Schlegel and Prof. Dr. Andreas Fath, both specialists in wastewater treatment, and Mario Sommer, warewashing technology expert, reported on such innovations. Architect and energy planner Daniel Albiez explained how water left to itself can also help solve environmental problems in amazing ways.

### Is Wastewater-Free Industrial Production Realistic?

#### FRANK SCHLEGEL

In Germany, roughly one-third of the water needed for the industrial production of consumer goods is used several times. The other two-thirds are treated just enough so that wastewater can be discharged into the sewer system or directly into rivers. Modern water treatment processes make it increasingly cost-effective to reuse water in a closed recycling system. In this way, we can drastically reduce the industrial consumption of freshwater and the pollution of our rivers. Frank Schlegel, managing director of H2O GmbH, explained how industrial production that does not generate any wastewater at all could become a reality.



H2O GmbH has its headquarters in Steinen, in the district of Lörrach near the Swiss border. We specialize in processing highly polluted industrial wastewater, and have been manufacturing vacuum distillation systems for 25 years (see Figure 1). More than 1,000 such systems, called VACUDEST, have been sold worldwide. Originally the company was a division of the



Mannesmann group, but it underwent a management buyout in 1999. At that time, H2O had eight employees; today we have 90 employees throughout Europe. Our turnover this year is expected to exceed 14 million euros. In recent years, H2O has experienced an average annual growth of 15 to 20 percent.

Our company is highly technology-driven. One of our aims is to make wastewater management systems as energy efficient as possible, but we place even more importance on the quality of the water that has undergone the treatment process. We constantly work at improving and developing these processes at our center for zero liquid discharge. Patents on modules and technologies safeguard new developments. Our main task is to focus on the needs of each client. Whether we are dealing with a car manufacturer, a window production company, or a car wash facility, each kind of wastewater requires a custom-tailored treatment system. To date, companies in 45 countries use our systems, with the majority of them located in Europe.

H2O supplies wastewater treatment equipment and increasingly offers on-site support for the operation of our systems. We have had a branch in Sweden for 10 years, and Poland is another important market for us. Because of its history, H2O has a strong presence in Asia, especially in South Korea, China and India, where the Mannesmann group used to manufacture roller mills. At the time of the buyout, the parent group took over customer service at the plants in Asia. We plan to continue to expand in Asia, but in emerging countries elsewhere there are also large industrial sectors with high water consumption that must comply with increasingly stringent environmental regulations. In these countries too, there is high demand for the water-saving circulation technologies of H2O which protect the water supply from contamination as well.

#### Industrial water consumption

Today, about 18,000 liters of water, in other words 18 cubic meters, are needed to produce one ton of steel. One ton of paper requires 7,000 liters, and some 15,000 liters of water are used in the production of a laptop or a desktop computer. Water consumption in the automobile industry has been greatly reduced. Now the estimated average is 400 cubic meters or 400,000 liters of water per car. Industry across the globe is making significant efforts to reduce water consumption. In Germany, the industrial use of water sank from 1,910 million cubic meters in 2007 to 1,770 million cubic meters in 2010, a decrease of more than 7 percent in just three years. The most important incentive is money because every cubic meter saved lowers the amount of money spent on freshwater and wastewater fees, which are extremely high in Germany due to the Wastewater Charges Act. But another motivating factor is becoming increasingly important, namely the responsible use of this precious resource and the reduction of wastewater, meaning that fewer contaminants are released into our rivers.



Industry traditionally located production sites near rivers, partly for waste disposal purposes (Fig. 2)

Industry has operated near rivers since time immemorial because of its need for water. It is less commonly known that the proximity of rivers also has considerable advantages when it

comes to waste disposal (see Figure 2). Legislation today allows only the industrial wastewater that has been treated with the best technology available to be discharged into rivers. There are several conventional industrial wastewater treatment processes available that achieve the kind of quality required. But residual impurities remain in wastewater even after it has been treated. They are discharged into rivers, especially heavy metals and persistent organic substances, because they cannot be filtered out in sewage treatment plants.

If we take the Rhine as an example, we can get an idea of the extent of industrial residue still being discharged into European rivers. On the German-Dutch border in Lobith, a load of at least 200 tons of organic carbon compounds [carbon-based contaminants measured as TOC, or total organic carbon] is recorded on a daily basis. These are considerable amounts if we bear in mind that theses substances, which have survived modern wastewater treatment technology, degrade very slowly or not at all once they are released into the environment. An additional 50 tons of heavy metals from industrial sources make matters worse. Some of these chemicals reach rivers and gradually seep into groundwater, thereby endangering our drinking water supply.

Applicable law currently tolerates the discharge into rivers of treated wastewater that meets certain standards even though it may still contain residues of chemicals and heavy metals. This state of affairs is not ideal, and the situation could in fact be improved with a reasonable amount of effort. Our intention at H2O is to put a complete stop to the discharge of industrial wastewater. A wastewater-free industry would of course not have to abstain from using water in its factory buildings; the water would simply have to be recycled and used multiple times. H2O's VACUDEST technology is already able to install closed circulation systems in many areas of production.

#### Recycling - how does it work?

The VACUDEST process is based essentially on the principle of distillation. Distillation is an ancient method used to separate volatile components from a liquid mixture, widely applied to produce alcoholic beverages, for instance. In our case we are not interested in obtaining a fine cherry brandy, but the purest water possible. Only a small part of industrial wastewater consists of waste substances. Regardless of whether the wastewater contains oils, greases, detergents, organic residues or heavy metals, its water content is still frequently as much as 98 percent (see Figure 3). So the challenge is always to separate the water from the waste to obtain water in the purest form possible as distillate.



After the evaporation process, substances such as salts, oils and heavy metals remain in the distillation residue, a leftover liquid that adds up to 1 to 5 percent of the original amount, depending on the industry. It can be worth the trouble to recycle some of the substances, such as valuable metals, but other waste materials are disposed of separately and usually incinerated. The water however, which constituted up to 98 percent of the original wastewater, can be reintroduced into the production process. This saves enormous amounts of freshwater and at the same time, it keeps pollutants from being discharged into waterways and public sewage



Wastewater generated by the metalworking industry: a typical wastewater treatment process using a VACUDEST vacuum distillation system (Fig. 4)

systems.

Technically speaking, distillation is based on the different boiling points of substances. Water evaporates at 100 degrees Celsius while salts and other less volatile substances remain behind. In this way we can obtain clean water from the wastewater generated in the metalworking industry, for example. The conventional method of disposal is costly; waste disposal companies remove wastewater in tank vehicles. VACU-DEST technology makes it possible to treat this wastewater to produce clean water, reducing the amount of waste residue to less than 5 percent.

By means of distillation, the recycled water is so pure that it can even be used for high-quality surface finishes in the production of automobiles, furniture and windows.

Figure 4 shows how this technology works, using a typical industrial plant as an example. In this case, the wastewater has a greenish color. First, if necessary, it is pretreated and then distilled in the VACUDEST system. The pure water obtained in this way can be recycled into the production process. The water content in the green wastewater is frequently about 99 percent. Once purified, it can be reused in the closed circulation system. We aim to design decentralized systems that treat wastewater on site, making pumps, storage tanks and longdistance transportation unnecessary. The basic principle is simple. Used water is collected as wastewater and pretreated with sludge or oil filters if need be, and then it is evaporated, distilled, and fed back into the production cycle.



Energy recycling in the VACUDEST process (Fig. 5)

#### Energy consumption

It takes a great deal of energy to evaporate water and therefore this technology appears at first to be economically unsustainable. But what is crucial here is that in these systems, the evaporated water is condensed to recover the heat energy in an integrated recycling of energy. Energy consumption is further reduced because distillation takes place under a slight vacuum, which is what makes this technology so cost-effective. Vacuum pumps lower the pressure in the system to 600 millibars, making the pure water evaporate at 85 degrees Celsius instead of 100 degrees. In the vapor compressor, the 85-degree steam is compressed to atmospheric pressure and heats up to 120 degrees. This thermal energy supports evaporation in the system by preheating the cold wastewater that enters it (see Figure 5). The residual heat in the wastewater is also used whenever possible. In many cases, for instance at cleaning facilities, the wastewater temperature is already at 40 or 50 degrees Celsius.

With vacuum evaporation technology, the heat required for distillation is significantly lowered so that this method provides an attractive alternative even in regions with high electricity rates. But in places like North America, where electricity rates are extremely low, it cannot compete with less expensive technologies that do not use vacuum evaporation and require a lot more energy. Overall costs are the decisive factor – the higher the cost of electricity, the higher the demands on technology in terms of efficiency and energy consumption. Moreover, if government regulations are in place that make the discharge of wastewater more costly – and this is a situation we can expect throughout the world in the future – the cost-benefit of the VACUDEST system improves and with it the likelihood that such systems will be used.

#### Where can VACUDEST technology be used?

VACUDEST is a technology used today mainly in surface engineering and metalworking. Cleaning solvents for degreasing are needed wherever metal is processed. Surface engineering plays a major role in the production of aluminum die casting, for instance, which is used to manufacture lightweight parts like those needed in car manufacturing to reduce vehicle body weight. Demands on surface quality are constantly increasing in the production of axle parts, motor blocks and other vehicle components. Vibratory finishing and polishing systems can achieve extremely smooth surfaces, but they also require considerable amounts of water. The same applies to high-grade galvanic surface coatings that require very clean surfaces.

VACUDEST technology is also used to treat leachate from landfills. Old landfills can leak and pose a threat to groundwater. Rain can leach medications, batteries, solvents, oils and many other things out of landfills where mixed industrial and household waste was dumped decades ago. For the complex, diverse and mostly unknown chemical cocktails that seep out of such landfills, distillation is superior to all other methods in terms of processing quality. An important field of application for VACUDEST technology is therefore in southern European countries, where waste management issues have been seriously neglected for a long time and have created an urgent problem.

Costs	VACUDEST evaporator	Conventional disposal
Interest on capital	EUR 6,000/year	
Operating costs (electricity, consumable supplies, operation and maintenance, replacement parts)	EUR 40,000/year	
Freshwater	EUR 600/year	EUR 9,000/year
Disposal of evaporation residue/ used emulsion	EUR 12,000/year	EUR 150,000/year
Total	EUR 58,600/year	EUR 159,000/year
Annual savings	EUR 100,400/year	
Return on investment	1.9 years	

Sample cost calculation for a medium-sized enterprise with 500 to 1,000 employees (Fig. 6)

The VACUDEST system is also very effective in treating wastewater from the cleaning of packing drums and containers. Industrial operations often leave casks and barrels dirty. The water used to clean them does not become very dirty and can be easily recycled. In fact, most of the water can be recovered, reducing the need for freshwater down to a negligible amount. H2O specializes in manufacturing and supplying fully automatic recycling systems for such applications. Two of the largest systems ever manufactured by H2O were installed in Peugeot's new transmission plant near Paris. Everything down to the smallest detail was custom-tailored for specific processes in the plant. These systems are in operation 24 hours a day. They are able to automatically and exactly measure the amount of wastewater generated, precisely adjust the treatment process, and of course, supply purified water in the quality needed.

#### Goodbye to wastewater?

How do we motivate companies to invest in advanced, wastewater-free water treatment systems? H2O does not believe that legal regulations and taxation are the best way. The most important reason for the purchase of a VACUDEST system is still its cost-effectiveness. Due to the high cost of conventional waste disposal, VACUDEST systems often pay for themselves within just one to two years. A typical cost comparison is shown in Figure 6. The conventional method of removing waste in tankers with a load of 3,000 cubic meters, the typical amount of waste generated by a medium-sized enterprise with maybe 500 to 1,000 employees, and then incinerating or dumping it in landfills, costs 160,000 euros a year. The alternative is to invest in a wastewater recycling system that operates for up to 10 or 12 years. Interest, depreciation and amortization, operation and maintenance, and freshwater add up to a total annual operating cost of 60,000 euros, which means that the investment pays for itself in less than two years. These enormous savings are the main incentive for potential

customers. In addition, more and more companies are becoming interested in wastewaterfree production because it benefits not only the environment, but also a company's image. Coupled with the cost savings, a company can enjoy a rather pleasant win-win situation.

I am convinced that we are now just at the beginning of wastewater-free production. Coming generations may find it absurd that wastewater chemicals were still being discharged into rivers in the 21st century. VACUDEST technology can help closed water circulation systems make the breakthrough to become standard technology in industrial production – and thereby do the right thing for our water supply even in the production of consumer goods.

## "Wash without water" – the ultimate goal for commercial and industrial warewashing technology MARIO SOMMER

Rarely do we think about the enormous amounts of dirty dishes that pile up on a daily basis in the large kitchens of student cafeterias, company canteens, on cruise ships and in the airplane catering business. We think even less about how these plates, glasses and cutlery are washed after we place them on the dirty dishes counter. HOBART GmbH in Offenburg, Germany specializes in developing commercial and industrial warewashers. Mario Sommer, the company's marketing manager, offered participants insight into the complex technology of industrial warewashing, and in the efforts of the HOBART GmbH to progressively lower the amount of water used in their appliances.



HOBART GmbH has been a subsidiary of Illinois Tool Works (ITW) for 13 years now. The ITW group comprises more than 800 companies, with more than 60,000 employees worldwide. The turnover of the group as a whole amounts to USD15.9 billion. Its core business areas are industrial food service equipment and building materials. The HOBART subsidiary is part of ITW's food equipment sector. With nearly 7,000 employees and a turnover of USD 1.5 billion, HOBART is the undisputed world leader when it comes to industrial and commercial dishwashing equipment. HOBART accounts for almost 10 percent of the ITW group's turnover and employees. HOBART GmbH has its headquarters in Offenburg-Elgersweier located almost directly next to the local Hansgrohe plant. In Elgersweier some 900 employees produce nearly 27,000 machines per year and an annual turnover of EUR 191 million.



Different types of industrial dishwashers (Fig. 1)

What kind of appliances does HOBART GmbH produce? For example, special glasswashers, because glasses cannot be washed like dishes, or even pots and pans (Fig. 1, transparency 3). They should not be washed in water that is too hot otherwise the glass corrodes and becomes milky and dull. Glasswashers, as undercounter models, are needed mostly in bars where most of the things that need to be washed are glasses. Another range of products comprises universal undercounter dishwashers, similar to the household appliances we know, suitable for all kinds dishes. Hood-type dishwashers are available for more demanding cleaning performance and speed. These are also more ergonomic in terms of working height, as it is not

necessary to bend down in order to operate them. Universal dishwashers can also cope with heavily soiled pots and pans, trays and gastronorm dishes. High pressure coupled with high water temperatures can remove the most stubborn food leftovers.

Finally, HOGART GmbH offers rack pass through, and conveyor belt dishwashers for very large kitchens. Dishes and glasses are placed in racks on a special conveyor belt and automatically moved through the individual washing cycles, similar to the way a car is put through a car wash. Such large industrial machines are used in the restaurant and catering industries; most hotels also use rack pass through, or conveyor belt dishwashers. Bakeries and butcher shops also require commercial warewashing technology. They need these appliances to clean the containers used to transport baked goods and meat. These containers must be cleaned in compliance with strict hygienic standards. Other important customers are community care centers such as hospitals, retirement homes, canteens and student cafeterias. Washing dishes by hand in a student cafeteria that serves several thousand meals at lunch is unthinkable. Such situations call for large semi-automatic or fully automatic conveyor belt systems.

There is a 90-percent chance that anyone who has ever been on a cruise has eaten off a plate washed by a HOBART appliance. Nine out of ten ships launched every year are equipped with custom-tailored HOBART warewashing systems. Then there is the airline catering industry, which needs to operate warewashers 24 hours a day. Pots and pans, glasses and dishes, but also the trollies that the cabin crew use on board, must be hygienically cleaned. In addition to the food service sector, HOBART GmbH also supplies warewashing systems to the manufacturing industry. For example, automobile manufacturers use our machines to remove grease and metal shavings from oil pans.

#### Who uses less water to wash up: households or businesses?

Lowest possible operating costs are critical to HOBART customers. In addition to saving energy, the most economical use of water, the procurement of which poses a significant cost factor, is of central importance. This is why we at HOBART GmbH consider it one of our most important goals to continue to lower the amount of water used for the washing process.

A comparison between an industrial appliance and a domestic dishwasher shows how well we have already succeeded. A family of four that eats three meals a day loads a dishwasher on average once a day. This corresponds to 12 place settings per day; i.e., a plate, a cup a glass and cutlery for every meal. That adds up to 4,380 place settings per year. A modern dishwasher uses about 5,500 liters of water, or 1.25 liters per person and meal. A commercial conveyor belt dishwasher of the kind used for example in a retirement home, which washes the plates, glasses and cutlery of 500 persons, has to clean 547,000 place settings per year. It uses about 164,000 liters of water or 0.30 liters per person and meal. As we can see, commercial dishwashing uses 75 percent less water.

These low consumption rates are the result of long years of research and development. Figure 2 (transparency 7) shows that over the past 20 years, we have been able to lower water consumption in HOBART dishwashers by 75 percent. The company's innovations contribute significantly to the conservation of water resources. Our ultimate goal is to totally eliminate the need for fresh water in our dishwashers by 2025 – to "wash without water" so to say.



Development of water consumption in HOBART dishwashers (Fig. 2)

#### Progress in the conservation of energy and use of chemical cleaners

Of course lower water consumption should not result in higher energy costs. Everyone knows that hot water cleans better than cold water. But hot water requires a lot of energy. HOBART developers have succeeded in decreasing energy consumption by 56 percent over the past 20 years – among other reasons, because less water used means that less water needs to be heated. We are

in the process of developing appliances that are even more energy efficient with the ultimate goal of reducing energy consumption by another 30 to 40 percent.

Energy savings were not achieved through the use of more aggressive chemicals, as is the case with many household detergents. Of course commercial warewashing is impossible without the use of cleaning chemicals, but our engineers have been able to reduce the amount of chemicals required by 87 percent over the last 20 years. A conveyor belt dishwasher used to require 3.5 tons of detergent per year, compared to only 450 kilograms today. If we compare these savings with the decrease in consumption of 23 percent in Germany's state-of-the-art automobile industry in the same period of time, we realize how remarkable these achievements are.

The amount of cleaning chemicals used has changed, but so have the chemicals. Just 20 years ago, chlorine, used as a disinfectant, was still an important ingredient in detergents – and posed a constant health hazard to personnel. Today, chemical formulas the industry uses are being continually improved; even detergents made of 100 percent natural ingredients are now available on the market. The trend towards biodegradable products made from natural and sustainably grown raw materials will continue. These environmentally friendly products may be more expensive, but in the future we can expect to see a complete switch to natural products.

As far as water itself is concerned, not only is the amount used important, but also its quality. Washing results depend greatly on the mineral content of the water used. If the water is highly mineralized, like water from the Lake of Constance, used to supply large areas of Baden Würt-temberg with water, it can cause unsightly spots on clean wine glasses and cutlery. To guarantee first-class cleaning results, the minerals must be filtered out of the water. Therefore in many regions, it makes sense to treat water before use in commercial dishwashing.

#### Environmental benefits and conservation of resources

If all commercial dishwashers in use in Europe today were retrofitted with the latest technology available, we could save as much as the annual water consumption of 860,000 people. Energy savings through increased efficiency would be even greater: the decrease in consumption would correspond to the energy needs of 2.7 million people. The greatest change would be in the amount of cleaning chemicals used. By replacing old commercial warewashing technology, we would lower the detergent needed by an amount equal to the detergent needs of 22 million people. So obviously, the application of modern technology makes it possible to significantly conserve resources.

#### State-of-the-art warewashing technology

Already today HOBART GmbH equips its dishwashers with sophisticated and modern technology such as the world's only intelligent dishwashing technology SENSOTRONIC, which helps keep water consumption to a minimum. It works with a sensor that detects actual load conditions in the dishwasher and automatically responds with the right cleaning program. The first SENSOTRONIC module is an active filter system. It removes leftover food particles as early on as possible in the washing cycle. This is important because leftovers like noodles and sauces dissolve and then bond with suds and contaminate the water in the machine. Once the dishwashing water is dirty, fresh water and more chemicals have to be added to ensure proper cleaning results. Therefore, it is important for the sensors to detect contaminants quickly and remove them before they can spread in the dishwasher. This technology makes it possible to maintain effective suds in the machine and thus obtain quality results over a longer period of time. It also means that it is unnecessary to add more fresh water during the washing cycle.

A second sensor-driven process is the supply of fresh water. Sensors measure how soiled the washware in the machine is and add water accordingly. This makes sense, as some dishes are much dirtier than others and dishes that are not as dirty need much less water. The system uses sensors to auto detect even empty sections – which, for organizational reasons, cannot always be avoided in large conveyor belt dishwashers – and adjusts consumption automatically without operator intervention. Finally, the sensor is able to determine what kind of items have been placed in the machine – for example metal pots and pans, or trays. The cleaning of such utensils requires mechanical treatment in the form of increased water pressure, slower transport speed and higher temperatures. Glasses on the other hand, are treated much more gently– and also automatically detected. This means that the machine automatically consumes only as much water, energy and chemicals as are actually needed to wash the load.

#### The future of commercial warewashing

What does the future hold for commercial warewashing technology? Is washing without water realistic? We at HOBART GmbH believe that it is certainly possible to develop technologies with which we can achieve this goal. But whether or not they will ever be marketable depends less on technology than on the awareness of the users. It is questionable whether caterers and canteen operators will be willing to invest in technologies that promise even higher water savings. But these technologies do exist. HOBART GmbH has patented a system that cleans water by means of a micro or ultrafiltration cycle, (micro 0.5 - 0.1 micrometer / ultra 0.1 - 0.01 micrometer). The water is filtered and then disinfected. The result is clear and clean water that can be used in the machine again. So water is indeed used for washing, but the water used is recycled without any significant need for additional fresh water. In this way we would only need perhaps 10 percent of the water we require today, and could also save even more energy. The water is disinfected using either ozone or UV purification methods. The recycling of water gradually increases its salinity. Therefore, water purification by means of reverse osmosis is necessary to desalinate it. HOBART GmbH has also patented such a purification method.

It would in fact be possible, by using ultrasound for instance, to eliminate the need for water completely. Perhaps you have seen opticians use this method. Again, the appropriate technology has most probably already been developed. But for such future technologies to actually be put to use – or to create demand for them – would require users to become more aware of these issues. Only once they actually realize that they are also responsible for the conservation of water, energy and resources will other significant innovations be introduced.

## Changes in Manufacturing – How Is Water Used and Treated During Production at Hansgrohe?

#### PROF. DR. ANDREAS FATH

In production processes at Hansgrohe SE, water is used primarily in the electrochemical plating of fixtures with metal. Parts made of brass and plastic are coated with copper, nickel and chrome in electroplating baths. A tour of the company's wastewater treatment facilities with Hansgrohe's former chief chemist, Andreas Fath, illustrated how the rinse water thereby generated is cleaned of toxins.



The process of electroplating to coat workpieces with metal requires large amounts of water. Before a faucet or shower head has reached the end of production at Hansgrohe, it has gone through as many as 14 different baths with varying chemical compounds. Water as a reaction medium and cleaning fluid in rinse baths is thereby indispensable. Each step in the process puts individual demands on the quality of water needed – electroplating at Hansgrohe sometimes uses well water, sometimes recycled plant circulation water, and sometimes even very pure deionized water.

#### How is wastewater generated?

The manufacturing of faucets for the top-of-the-line Axor collection, which is cast in brass, provides a good example with which to track the flow of water in Hansgrohe's factory buildings. Rough castings must first be deburred, ground and polished before they go through a complex process of pre-cleaning in several pre-treatment baths. Each pre-cleaning step involves using baths with chemical compositions that are precisely calibrated and carefully monitored. To prevent the contamination of any pre-cleaning bath with chemicals from a different bath, additional rinsing baths are needed in the sequence of the process. Rinsing baths are continuously fed with fresh water which, when it overflows, carries off unwanted chemical residues. This overflow runs to the wastewater treatment area where it is processed and freed of chemicals.

This flow rinsing process requires significant amounts of clean water. Therefore, wherever possible, Hansgrohe uses recycled plant circulation water instead of fresh water. Circulation water is extracted from relatively uncontaminated rinse water which – purified through filtration systems and ion exchangers – is again suitable for rinsing. These circulation systems have enabled Hansgrohe to reduce its use of fresh water by 60 percent.

#### Wastewater is a resource

The manufacturing process produces three fundamentally different kinds of wastewater: effluent which contains phosphates from pre-cleaning processes, effluent with nickel from the electrochemical nickel deposition process, and effluent with chrome from the actual chrome electroplating process. These three wastewater streams are always kept apart and collected in separate tanks. Keeping these streams separate facilitates their cleaning and allows their ingredients to be recycled.

In the actual cleaning process, a batch of two cubic meters at a time can be processed in a collection tank. First, through the addition of the proper chemicals, the substances that are dissolved in the wastewater are converted into solid compounds that form a sludge, which



is then separated from the wastewater in a chamber filter press. Separation and filtration are used in all three wastewater streams, but the wastewater containing chrome needs an additional pre-treatment step. The readily soluble chromates used in the chrome baths cannot be separated from the water and are therefore first converted into trivalent chrome when a reducing agent is added. Since chromates are highly toxic, the complete conversion process is electrochemically controlled. In the subsequent step, chrome can be precipitated out and separated from the remaining wastewater through filtration.

Each of these three separate wastewater streams in Hansgrohe's brass electroplating process goes through one of three large chamber filter presses: the first separates the chrome sludge, the second the nickel sludge, and the third the phosphate sludge from the remaining wastewater. Pressed until they are dry, these sludges are collected in containers underneath the presses, and can be reused to a certain extent. Nickel sludge is reprocessed into nickel metal in the nickel refinery, chrome sludge is used in the glass industry, and phosphates can be converted into fertilizer.

The wastewater produced as clear filtrate in the chamber presses is still not clean enough to be processed by the municipal wastewater treatment plant. Particulate matter must be separated in gravel filters beforehand, and heavy metal residues extracted in cation exchangers. Before water is released to the treatment plant, its degree of acidity (pH value) is adjusted to be within the predetermined range of 6.5 to 9.5. It is also crucial that this wastewater no longer contains hazardous chromates. In a final photometric monitoring, a color reaction with a special reagent shows whether the tolerated limit of 0.1 mg of chromate per liter has been exceeded. If this standard has not been met, the batch is sent back and treated again. Concentrations of ingredients are documented for each batch so that its residue content can still be traced at a later time.

#### Three proprietary developments in Hansgrohe's wastewater research

#### 1. Recycling chrome

The treatment of wastewater containing chrome is complex and expensive. That is why Hansgrohe has developed a recycling process for the chrome wastewater generated during the electroplating of brass. It is based on evaporating the rinse water from the first rinse after the chrome bath. Evaporation is accelerated in a special countercurrent process. Warm waste air (35 to 40 degrees Celsius) from the chrome bath in the electroplating system is blown into the bottom of the evaporation basin and sprayed from above with a fine mist of rinse water containing chrome. Ingredients are removed from the rising waste air in scrubber systems and collected in tanks for further treatment. Residual rinse water at the bottom of the evaporation basin accumulates more and more chrome so that it can ultimately be returned directly to the chrome bath in the electroplating facility.

This method reduces the volume of this particularly problematic wastewater by more than 90 percent. The small remaining amounts of wastewater containing chrome (about one batch per week) do not come from regular brass electroplating but from other cleaning processes in the electroplating facility and the wastewater area, and from the backflushing of ion exchangers and filtration systems. They also come from the section (one cubic meter per week) where electroplating is done by hand to fill special orders and finish customized items.

#### 2. UV oxidation

Organic chemical additives are indispensable for the nickel plating process. However, they decay after a time and form degradation products that interfere with the reaction process and thereby shorten the operating time of nickel baths. These undesirable degradation products

can be dealt with using a UV oxidation system. Hydrogen peroxide is added to the nickel bath, which is then irradiated with UV light from a close distance. Highly reactive hydroxyl radicals form as a result and decompose the interfering organic ingredients, thereby eliminating them. As soon as their concentrations fall below a predetermined value, fresh organic additives are added and the electrolyte bath can go back into operation. This process, which, by the way, does not consume water, ensures the consistent quality of the nickel bath and thus a high-quality nickel coating.

#### 3. The filtration system for perfluorinated surfactants

A particular challenge is posed by the cleaning of wastewater from the electroplating process that is contaminated with perfluorinated surfactants (PFCs). Used in Teflon coatings and fire-extinguishing foam, these chemicals have a number of varied applications, but also possess highly undesirable characteristics. Once released into the environment, they do not degrade and therefore accumulate in biological food chains where their effect is toxic. Thus it is important to see that these chemical compounds are kept away from the environment as completely as possible.



Wetting agents are essential in electroplating processes to make sure vapors and spray mists that are toxic for employees do not rise from the hot baths, and also to make plastic components wettable. The only proper wetting agents are substances that are so resistant that they cannot be affected even by highly aggressive chemicals such as chromic acid. In this regard, perfluorinated surfactants have proven to be ideal because of their high level of stability. But because they are carried over into rinsing baths, they also enter the wastewater streams of the electroplating system. If countermeasures are not taken during the wastewater treatment process, these chemicals flow into the municipal wastewater treatment plant together with other industrial and domestic wastewater, and rain and surface water. Only a small portion is retained in the sludge there; the greater share flows through the treatment plant cycle and is discharged into rivers, from where it spreads into the plant and animal world. It is the persistence of this class of substances that makes them a serious and permanent problem.

Hansgrohe has installed additional steps in the treatment of wastewater from electroplating to prevent perfluorinated surfactants (PFCs) from reaching the environment. The company relies on a filtration system that is based on the principle of ion exchange to largely eliminate (by more than 90 percent) the PFCs used. This operates between the chamber filter press and the gravel filter system in the treatment process (green box in the diagram below).





Legislators have also responded to the problem posed by perfluorinated compounds and have severely limited the use of PFOS (perfluorooctane sulfanate), long applied in electroplating methods. The chemical industry now offers substitute compounds for electroplating such as the partially fluorinated surfactant H4PFOS, thought to be more easily degradable than PFOS.

To date, however, there are no research studies available on the degradability, toxicity and environmental impact of H4PFOS. But based on experience so far with perfluorinated compounds, Hansgrohe does assume that H4PFOS can also cause problems for the environment and human life. The PFC filter system has therefore been kept in operation. This ensures that the partially fluorinated surfactant substitute H4PFOS is also reliably eliminated from wastewater. Even if it is still unclear how hazardous this replacement chemical is, Hansgrohe is keeping its preventive measures in place. Hansgrohe has developed an innovative rapid photometric test for PFCs to monitor the cleansing capacity of the PFC filter system. Compared to conventional analysis with HPLC/ MS (high-performance liquid chromatography / mass spectrometry), it provides results in just a few minutes, and is even cheaper. It determines precisely when the cleaning capacity of ion exchangers or the active carbon filter decreases. This monitoring is important for changing filters on time and being able to rely on PFC removal from wastewater at all times.

#### Remaining challenges

An electroplating process that does not produce wastewater is still a dream for the future. The presentation at this year's Hansgrohe Water Symposium by Frank Schlegel, managing partner of H2O GmbH (see page 86), shows that we are nevertheless approaching this goal. Hansgrohe's current treatment of the wastewater generated in electroplating processes is the result of years of optimization. In recent years, both the amount of water used for rinsing has been greatly reduced through improved rinse technology, and the amount of wastewater generated overall has decreased through the recirculation of rinse water.

It is the declared intention of Hansgrohe SE to continue this trend and to further improve our production methods. The vacuum evaporation technology developed by H2O GmbH is an innovative approach. A major challenge in using Vacudest technology to treat wastewater from metal electroplating processes is whether the materials used in this technology are resistant to the highly aggressive substances in concentrated wastewater. Additionally, the evaluation of the vacuum process must include the energy balance. Hansgrohe's own goals for sustainability foresee a reduction in carbon dioxide emissions of 20 percent by 2015. We will need to clarify whether the energy needed to evaporate large amounts of wastewater is consistent with our climate and energy consumption goals.

In any case, Hansgrohe SE will carefully examine which wastewater streams can undergo vacuum evaporation and to what extent this method can be used to recycle water. At the same time, we are currently investigating whether rinse water can be reused after targeted filtration – perhaps for processing stages that make lower demands on the quality of rinse water (such as rack strippers). To pursue this idea, we can rely on many years of experience in our business. The concept is based on exactly the same system of cascades utilized in the Hansgrohe Pontos system to treat and reuse gray water in households.

## Water Helps Our Climate: Heating with Water and Ice

#### DANIEL ALBIEZ

Heating with solar, geothermal and ambient heat saves large amounts of oil and natural gas and is therefore environmentally friendly. It would be ideal if we could collect and store summer heat and use it in winter. Architect Daniel Albiez has spent a long time working on the development of this novel technology. In his workshop, he explained how ice storage systems can help us move in this direction.



As an architect, I was commissioned in 2006 to undertake the energy retrofit and expansion of a hotel. This endeavor meant that room capacity nearly doubled, the kitchen was enlarged from 70 to 300 square meters, and 30 new rooms and two conference and event rooms were added. As the cost of utilities in the original building had been disproportionately high, we started looking for a heating and cooling system with minimal operating costs and came across the SolarEis storage system by Isocal.

The SolarEis storage system is based on well-known principles. As with many other heating systems, heat is supplied by a conventional heat pump. The difference is that the heat pump of the SolarEis storage system does not extract its energy from the ground or ambient air alone, but also from the additional energy that is released when water turns to ice. How does this amazing yet simple system work, and what advantages does it offer?

Everyone knows that days in our latitudes are characterized by a constant and natural change from warmer to cooler temperatures caused by the change from day to night. This is also seasonal; warm weather in summer is followed by cold weather in winter. But we have hardly made use of these changes so far. Cool nighttime temperatures could be used to regulate room temperatures on hot summer days. And the abundant amount of heat and solar energy summer brings us could serve as a source of energy for heating in winter. The challenge we face is to harness these alternating temperatures so that they can be used to heat and cool buildings. Today's heating systems do not take advantage of summer warmth, while on the other hand the energy used for room heating in winter disappears into thin air and is irretrievably lost. By using a long-term heat storage unit, the SolarEis storage system succeeds in linking winter and summer temperatures in a controlled way and thus providing year-round heating and air conditioning.

#### How SolarEis works

Here I will explain how the heat of summer can be stored to provide heating in winter and the cold of winter stored to cool buildings in summer. The same principle can be used in a day and night cycle; the need for cooling in summer is especially high in hotels and public buildings.

Conventional heat pump systems extract heat from the ground or air which is ultimately regenerated by the sun. The heat in the ground and the air is passive and therefore cannot be influenced in a conventional heat pump system. What is new about the SolarEis system is its large water tank, which is buried in the ground and functions as a heat storage unit. The tank is not insulated and can absorb warmth directly from the earth, and with the help of a

heat pump it can also absorb warmth from the sun's rays and ambient air as well. When heat is extracted from the tank to keep a building warm, the temperature of the water drops and the resulting coldness is used for cooling whenever necessary. In contrast to other heating systems that store energy at high temperatures, the SolarEis storage unit works at ambient temperatures and therefore does not need insulation.

To give you a better idea of the size of the tanks needed: a single-family home usually requires a 10,000-liter tank, basically a simple rainwater tank (Figure 1). Energy can be extracted from this water-filled tank by means of heat exchange until the water cools down to zero degrees Celsius. If more energy is extracted, the water begins to freeze (Figure 2). When cold water (zero degrees Celsius) turns into ice, a surprisingly large amount of energy is released, corresponding to the amount of energy released when hot water at 80 degrees Celsius cools down to zero degrees Celsius. This energy, called crystallization energy, is harbored in the transition of water to ice, even though the temperature remains at zero degrees Celsius. So we still have an enormous reservoir of energy available after all the energy has been extracted from the water in its liquid form, and the water has cooled down to zero degrees.



Tank for a singe-family home (Fig. 1)



A layer of ice forms around the refrigerant pipe in the storage unit (Fig. 2)

Figure 3 clearly shows the various phases. By making use of the crystallization energy that is released when liquid water turns into ice crystals, we can extract 93 kilojoules per liter from the tank without causing any further cooling in the unit. This is the principle of latent heat storage.



#### When water turns to ice, 93 kilojoules of energy are released per liter of water (Fig. 3)

#### Heat management

Where exactly does the SolarEis storage system get its energy from? First, it constantly absorbs heat directly from the warm ground soil (8 to 10 degrees Celsius) surrounding it, at all times, even in winter. To optimize contact between the cement wall of the tank and the soil, the space between the tank and the earth is not filled with sand but with soil from the surroundings that is as cohesive (meaning thermally conductive) as possible.

Second, a spiral of closely positioned refrigerant pipes is placed in the water tank (Figure 4). A circulation pump connects it to the solar/air collectors on the roof of the building. These black panels (Figure 5), also known as solar swimming pool panels, contain a heat transfer fluid that absorbs heat from the sun's rays and ambient air and transmits it to the storage unit.



Refrigerant pipes are installed in the water tank (Fig. 4)

Solar/air collectors (Fig. 5)

Why does the SolarEis storage system use simple solar/air collectors instead of sophisticated vacuum solar panels? In favorable conditions with lots of sun, the latter can attain temperatures of 50 degrees Celsius and higher, but in contrast, solar/air collectors absorb energy

from both solar radiation and ambient air. Operating temperatures are generally much lower, but they supply the storage unit with energy 24 hours a day, even under overcast conditions and at night.

Heat exchange is regulated by an intelligent central control unit that complements the underground SolarEis storage unit and the swimming pool panels on the roof. Because of the system's low temperature level and its capacity to store heat with no loss, an average of 65 percent of a building's annual heating needs is supplied from ambient heat alone – without any need for additional energy from other sources.

#### The role of ice

When does water become ice in the system, and why can we use this for heating? During most of the year, ambient temperatures are high enough to provide for sufficient heating through the solar/air collectors on the roof. In summer, excess heat gradually increases the temperature of the underground tank to about 20 degrees Celsius. Heating energy is extracted from the tank whenever the solar/air collectors cannot provide enough heat due to a drop in ambient temperatures. Since the tank continues to absorb heat from the surrounding soil in fall and even in winter, the temperature of the water cools down rather slowly. Our experience shows that it takes two to three months for water to reach the freezing point.

Assuming that the heating season starts in late August, there is enough energy stored in the tank and absorbed from the surroundings to provide heating until November or December. Only then does the water gradually cool down to zero degrees Celsius. Ice starts to form in the tank in January or February. This freezing process releases crystallization energy, and again we have a huge amount of energy for heating at our disposal – enough to last until the end of the heating season. So to be exact, we are not using ice to heat during this period, but rather the energy released by the transformation of water into ice.

At first it might be surprising to find out that a solid container such as a cement tank does not crack when ice forms inside it, in the way a forgotten bottle of water inside the freezer does. But the explanation is actually quite simple. Water in a bottle freezes from the outside in, until it has a liquid core. When even this core freezes and expands, the bottle bursts. Ice forms in the ice storage unit in exactly the opposite way. An evenly shaped circular layer of ice forms around the cold refrigerant pipe from the inside out (Figure 6). Even when all the water in the storage tank freezes, there is still a gap of approximately 1.5 centimeters between the ice and the tank's wall, which is kept warm by the surrounding earth, which as I mentioned before, has a temperature of 8 to 10 degrees Celsius.



Ice envelopes the refrigerant pipes of the ice storage tank at the Stuttgart City Archives (Fig. 6)

#### **Environmental benefits**

How does the SolarEis storage system hold up as far as cost and environmental aspects are concerned? The initial cost of a gas-fired condensing boiler for heating and hot water is considerably less expensive. Operating costs however are a completely different story. The operating costs of a SolarEis system are about 67 percent lower, so that an initial investment can be recouped within just a few years. The greatest disadvantages of gas-fired condensing boilers are their reliance on non-renewable natural gas and their CO<sub>2</sub>, emissions, which contribute to climate change. By contrast, heat pumps are climate neutral (as long as the electricity they use comes from renewable sources).

In what way is the Isocal System with its SolarEis storage unit different from a conventional geothermal heat exchanger? First, there is no need for expensive well drilling that requires special permits, and there is no risk of groundwater contamination. Second, the SolarEis system is simple and robust and can even be installed in groundwater source protection zones. Last but not least, the SolarEis system's year-round storage of heat makes it 50 percent more energy efficient. And as far as cooling is concerned (see the following section), efficiency is 99 percent, as cooling is a free byproduct of the heating system.

Further cost advantages are possible if the SolarEis storage unit doubles as a rainwater storage tank. During the summer, there is hardly any need for water in the tank so most of its capacity can be used to collect rainwater for flushing toilets, for washers and for water-ing plants. It is also possible to use the system and still have room on the roof to generate photovoltaic power at the same time. The solar/air collectors do not necessarily have to be installed on the sunny side of the roof, as most of the heat they extract comes from ambient air. Another option is to alternate photovoltaic panels with the solar/air collectors.

#### Cooling with the SolarEis system

In the future, the need for cooling in buildings will continue to increase as summer temperatures rise. This is particularly true for public buildings and office buildings, but hotels and restaurants also require cooling for rooms as well as storerooms. The Isocal system can preserve the winter's cold for the summer months, just as our ancestors used to store snow and ice from glaciers in caves. Once the water in the SolarEis storage unit is frozen, a reversal of the winter heating process makes ice-cold water available for refrigerators and storage rooms for three or four months – at no cost whatsoever. The larger the storage unit is, the higher its cooling potential.

It is often overlooked that well-insulated residential dwellings do not cool down much at night, and therefore require additional cooling in summer. Although sunshades and blinds keep out some of the heat, many houses still require cooling, especially if summers become hotter. The SolarEis storage unit can be useful in this situation by supplying a floor heating system with cool water at 19 or 20 degrees Celsius, thereby lowering room temperatures two or three degrees without additional cooling. And by the way, ice does not need to be in the storage tank to achieve this effect.

The size of the SolarEis storage unit depends on the heating and especially on the cooling needs of a building. In the case of a single-family dwelling that requires only heating and no cooling, the storage unit should be large enough for crystallization energy to provide only back-up heating. There is no technical need for the storage unit to be so large that an excessive amount of ice forms. For large buildings that require a lot of cooling in summer, however, it certainly makes sense to install a larger tank as the ice which forms in winter is needed to cut cooling costs in summer.

For example, the Stuttgart City Archives installed an underground tank with a capacity of 400,000 liters. In summer, the building has a store of 400 cubic meters of ice at its disposal for cooling purposes (Figure 6). A general guideline for southern Germany is that approximately 2,000 hours of heating are needed in winter and 1,000 hours of cooling in summer. This ratio is completely different in warmer regions, where cooling is more important; here too, the SolarEis system can be a very intelligent solution.

Figure 6 shows that a thick layer of ice forms around the refrigerant pipes. Initially, it was not clear whether pipes covered by a thick layer of ice could still extract a sufficient amount of energy from their surroundings. But in fact, the enlargement of the surface area caused by the formation of ice compensates for the insulating effect of the ice; in other words, the



Performance profile of an Isocal SolarEis storage system (Fig. 7)

amount of heat extracted through the ice-covered pipes is just as great as the amount extracted when the pipes are surrounded by water.

#### The SolarEis system in the course of a year

The upper chart in Figure 7 shows the temperature pattern of an average year. The red line stands for ambient temperature and the blue line is the temperature in the SolarEis storage unit. The heating season begins at the left of the chart with an ambient temperature of 17 or 18 degrees Celsius. When the blue line drops, it means that energy for heating is being withdrawn from the storage unit (red areas in the middle chart). When it goes up, the solar/air collectors are transmitting ambient heat to the storage unit (green areas). This example shows that ambient heat is transmitted to the storage tank, even in winter. The storage tank cools down to zero degrees Celsius by the end of the year as the heat load increases and ice begins to form. A few warm days in March are enough to defrost the storage unit and drive the temperature up to over zero degrees. By mid-May, temperatures in the storage unit are back to 20 degrees Celsius. There are only a few days in January in which the storage unit is no longer able to provide energy for heating (lower chart), and it is only now that auxiliary heating is used. Figure 8 shows when most of the energy for heating is needed. More than one-third of the heat (35 percent) is used when temperatures are just above zero degrees Celsius, in late autumn and early winter, and then again just before the onset of spring. Although more heating is needed when temperatures drop to minus 5 or minus 10 degrees Celsius, this happens only on very few days (6 percent), and carries little weight in the annual heating profile. If we look at the 70 or so SolarEis systems of different sizes that are in operation, we can see that the energy extracted from ambient heat meets more than 65 percent of annual heating needs, without any need for additional energy from other sources.



Most heating is needed when temperatures are between zero and 5 degrees Celsius (Fig. 8)

Eighty-five percent of the heat needed comes from solar, geothermal and ambient heat, and ice crystallization (Fig. 9)

The pie chart in Figure 9 shows the energy sources for heating a commercial building with a SolarEis system. Most of the energy needed (85 percent) is supplied by solar, geothermal and ambient heat, and ice crystallization. Only 6 percent of the energy used for heating comes from an external source. So when is additional external energy (gas or electricity) needed?

Let's assume that the water in the tank is completely frozen and energy cannot be extracted from the surroundings because outside temperatures are still at minus 3 degrees Celsius. In principle, systems are designed to prevent this from happening, but to be on the safe side, an external heat source is there too, either an electric heater or a gas-fired condensing boiler. For hotels, it always makes sense to supplement the system with a boiler because of peak demand for hot water, as hotel guests tend to take showers at more or less the same time in the morning. In a single-family dwelling, an electric immersion heater is enough to melt the ice in the tank in case the water freezes. In the commercial building mentioned above, 6 percent of the energy used for heating was sourced externally during the period of time recorded.

But we must bear in mind that heat pump systems also need electricity. On average, a SolarEis system needs one kilowatt-hour of electricity to generate about three kilowatt-hours of heat. If the electricity is generated from renewable energy sources, the entire system is climate neutral. Complete independence from external energy sources can be achieved if the electricity for the heat pumps is generated by the building's own photovoltaic cells.

#### The Stuttgart City Archives building

Our projects show that the system can be installed in buildings of all sizes. One example is the reconstruction of the Stuttgart City Archives. We were able to install a SolarEis system there in spite of huge economic and environmental (water protection area) obstacles. The storage capacity of the tank is 400,000 liters. Figures 10 and 11 give an idea of its enormous size.



The underground storage tank at the Stuttgart City Archives building before refrigerant pipes were installed. (Fig. 10)

Installation of the refrigerant pipes at the Stuttgart City Archives (Fig. 11)

There are a variety of ways to combine this system with other heat sources. Waste heat from computers and kitchens can also be integrated into a heat management system. And single-family homes like the newly constructed house shown in Figure 12 are also well-suited for this technology.



Single-family house equipped with a SolarEis storage unit (Fig. 12)

#### Outlook

I believe that the principle of the SolarEis storage unit has a promising future, especially in larger housing complexes. In Harburg, a district in Hamburg, 483 apartments belonging to the Railway Workers' Building Association are currently being connected to a SolarEis storage unit which boasts a capacity of 1,500,000 liters. The system can be expanded at will – the larger the tank, the more flexible its potential uses. In theory it is also possible to use SolarEis systems in a district heating network as a year-round reservoir for heating and cooling. A homeowners' association in the town of Fischerbach in Baden Württemberg plans to build 26 single-family homes, for instance, that will be supplied with central heating through a ring main heating system.

Basically, the SolarEis system offers an all-round solution for an ancient heating problem. It allows us to harness and store heat over long periods of time, year-round, from summer to winter. It saves energy, is environmentally compatible and makes an important contribution to the energy transition in Germany.











## CHAPTER 4 Tea ceremony

Water – not as a food or commodity but as a source of spiritual inspiration – is central to religious and spiritual practices around the world. The Japanese tea ceremony is a particularly intense experience, and participants gratefully looked back on the mindful and peaceful introduction by Zen master Ulrich Haas (Sôshiki Seizen) at this year's Hansgrohe Water Symposium.

## The Way of Tea: The Japanese Tea Ceremony

#### ULRICH HAAS

Zen master and director of the branch of the Urasenke Foundation in Freiburg Vörstetten Ulrich Haas (Sôshiki Seizen) introduced participants at his workshop to the Way of Tea by carrying out a Japanese tea ceremony. A space imbued with tranquility and mindfulness became part of the Hansgrohe Water Symposium. The guiding principles of the Way of Tea – harmony, respect, purity, and tranquility – reflected the concept of the symposium to approach water from both a scientific point of view and a spiritual perspective.





"In my own hands I hold a bowl of tea; I see all of nature represented in its green color. Closing my eyes I find green mountains and pure water within my own heart. Silently, sitting alone, drinking tea, I feel these become part of me. Sharing this bowl of tea with others, they, too, become one with it and nature. That we can find a lasting tranquility in our own selves in the company with each other is the paradox that is the Way of Tea." Dr. Soshitsu Sen, Urasenke Grand Tea Master XV

The Way of Tea, chado, with its most common ritual, chanoyu (tea ceremony, literally meaning "hot water for tea"), is a Zen discipline and path to enlightenment. It evolved over hundreds of years in Japan, stemming from the wish to transcend the mundane and be in harmony with one's own nature. The Way of Tea brings together aspects of art, ethics, philosophy and religion. But practical things play a fundamental role too in the correct handling of everyday utensils and the mastering of social etiquette. By learning to perceive the character of each utensil, the practitioner achieves an openness and heightened awareness of his surroundings. It is precisely the simple pleasure offered by a bowl of tea that makes the four principles of the Way of Tea come alive: wa, kei, sei and jaku.

# わ

WA

Wa means harmony, the feeling of being in accord with nature and other people. At a tea gathering, there is harmony between host and guest, guest and guest, mood and season, the food served and the tea utensils used. Awareness and

sensitivity to the changing rhythms of the seasons, and harmony with these changes pervades the Way of Tea. The host carefully selects the tea utensils, the flowers, and the hanging scroll according to the season. He or she uses a portable wood coal stove in summer and a sunken hearth in winter. Even the weather and its unpredictable and variable nature is an integral part of the tea ceremony; it is never shut out or considered unpleasant. Harmony with nature leads to a deep understanding of the evanescence of all things and the unchanging in the changing.



Kei means respect. Respect results from a natural feeling of gratitude and is extended to people as well as the tea utensils used and to our entire daily lives.

The etiquette observed in a tearoom helps us to apply the principles of kei in everyday life. To the uninitiated, the etiquette of the tearoom may at first seem very unfamiliar and formal, but this only serves to convey the principle of kei. The hospitality of the host, the consideration of the guests for each other and the careful handling of the tea utensils clearly exemplify this form of respect.



SEI

Sei means purity, cleanliness and order, in both the physical and spiritual sense. These qualities are essential parts of the study of Zen and of tea. When the host cleans the tea utensils, he or she is simultaneously purifying heart and mind

through total concentration on this task. Before guests enter the teahouse, they walk down a garden path and wash their hands and rinse their mouths at a low stone water basin to cleanse themselves outside the teahouse of the dust of the everyday world. Sei means simplicity, the elimination of all unnecessary elements. The design of the garden path and the architecture of the teahouse reflect this kind of simplicity. After the tea gathering, when the guests have departed, the host sits alone for a while in the tearoom, allowing time to reflect before cleaning the teahouse and the utensils and putting everything away. Finally, the room is as it was before – empty.



### R JAKU

Jaku means tranquility. Through the constant practice of wa, kei and sei, a person is prepared for the complete stillness and silence of jaku. However, jaku means not only ordinary physical silence or the lack of noise; what is meant is the

mental state of inner tranquility, in which even movement, the physical act required by the tea ceremony, is carried out with a free mind. This is how the dynamic force of the most inner self flows into the Way of Tea. It is this spiritual force that gives the tea gathering its deep significance.

#### Zen and the Way of Tea

The philosophy of the Way of Tea developed from a synthesis of traditions in the East Asian cultural sphere and its religious philosophies. Japanese Master Rikyū (1522-1591) summarized the Way of Tea in four basic principles: harmony, respect, purity and tranquility. The constant practice of these four principles inside and outside the tearoom leads to increased awareness and a deep inner peace.

Harmony, respect, purity and tranquility come together in the Way of Tea. The harmony in the preparation of tea unites the host and the guests, and transcends the strife of everyday life. Elaborate religious ceremonies become meaningless when compared to the dignity of the Way of Tea and the respect it fosters in each person for each other person, and for the common goal. It does not satisfy any form of human ambition; no ostentatious display of personal wealth that might arouse envy takes place. The tea ceremony begins quietly, proceeds simply in an atmosphere of social harmony, mutual respect and spiritual purity, and ends silently. The silence in the tearoom reflects the serenity of the participants' thoughts. The silence makes it possible for participants to connect to their inner selves during the course of the ceremony. The Way of Tea is a never-ending human endeavor to know oneself. Step by step, we come closer to ourselves until we bring together body and mind, until we achieve unity with all that surrounds us, with the Whole.

But the Way of Tea – like other Zen disciplines – has no tangible goal. Once we decide to study the preparation of tea, we set off on the Way of Tea. There is no end to our studies; there is no end to the Way; the Way has no goal. The pursuit of enlightenment is not an active quest, but the acceptance of and trust in the nature of the universe. Only in this manner can the revival of body and mind take place. When we open our senses and free our minds, the Way of Tea becomes the path to our inner selves.



#### The Way of Tea in the West

Even now, the Way of Tea is still one the most important Zen disciplines in Japan. Although many aspects of daily life in Japan today lack balance and focus, people nevertheless still carry within them the need for tranquility. Not only in Japan, but also far away, people with a simple teapot can set off on the Way of Tea. In times of mounting crisis and environmental awareness, people around the world are discovering a way in the seemingly unfamiliar tea ceremony to gain a new understanding of themselves and nature. What appears to be a remote practice can prove to be something close at hand and needed.

People who set off to discover the Way of Tea learn to concentrate on essential things in their everyday lives. In the manner in which the host hands the guest a bowl, and how it is accepted by the guest, the principles of wa, kei, sei and jaku counter disorder and confusion with harmony, egoism and self-righteousness with respect, ugliness and sordidness with purity, and hate and disturbance with tranquility.














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#### What Water Needs

Exploring how we deal with water from a new and unusual perspective, the fifth Hansgrohe Water Symposium in 2012 focused on the fundamental dependency of human civilization on global circulation systems, without which there would be no life on Earth. Today we are only beginning to understand the role of water in these systems, and how we can conserve and protect them and the phenomenon of life on our planet. Rather than asking how people could take even more advantage of water's unique properties, the inevitable question at the symposium became: What does water need?

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