



"The moment I looked down a microscope I knew". A closer look at Joan Rose, the 2016 Stockholm Water Prize Laureate.

► INTERVIEW: PAGE 9



Combined efforts along the pharmaceutical life cycle – production, procurement, consumption and wastewater treatment – are needed to reduce potentially harmful impact on our waterbodies. ► ANALYSIS: PAGE 13

STOCKHOLM

WATERFRONT

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THE MODERN RAIN DANCE

Cloudseeding is gaining ground in water-scarce regions

FOCUS

Craft beer brewers embrace reverse osmosis

THE LAST WORD

"A once in a lifetime event"

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Photo: Thomas Henriksson



IT'S NOT THE WATER, IT'S US

Water scarcity is an often-used phrase in water-and development circles. It is not seldom used in the same sentence

as drought, or climate change. Even though we in the water world know better, it risks creating a picture of a world where there is not enough water to go around. But there is. We know that the amount of freshwater, although finite, is not the most serious problem for the next few generations. The real challenge is the increasing demand and the way we use water. To support growing economies and populations, we need plenty of water. The other challenge is governance. Properly managed and transparently distributed, the water that exists can support us all. Therefore, I believe that we need to talk more about how we use water.

For an interesting perspective on access and demand, read this issue's cover story about cloudseeding, The modern rain dance, and Anton Earle's comment.

In this issue we also carry an interview with the 2016 Stockholm Water

Prize laureate, Joan Rose. Professor Rose has also written the Opinion piece, on page 10.

More craft beer brewers have embraced reverse osmosis. Together with other efforts, it has potentially large effects. Read more on page 12.

This issue's Analysis is about pharmaceuticals that enter our water bodies, and what can be done, by combining efforts along the pharmaceutical life cycle, to minimize potential risks.

As we are sending this issue to print, World Water Week is drawing close. We hope to meet many of you in Stockholm. For those who cannot be with us in person, use the many opportunities to follow the discussions and events online. Start by going to www.worldwaterweek.org and carry on from there.

Happy reading!

Torgny Holmgren
Executive Director
Stockholm International Water Institute

STOCKHOLM WATERFRONT

Stockholm WaterFront is a quarterly magazine that aims to inform the global water debate and be a source of knowledge and inspiration for professionals worldwide with an interest in water issues. Stockholm Water Front mixes popular science articles with news reporting and carries analyses by some of the world's most knowledgeable water writers. It is published in print and digitally by Stockholm International Water Institute, and is free of charge.

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BRIEFING

WATER GOAL IN FOCUS AT AFRICA WATER WEEK

At the recent Africa Water Week, held in Dar es Salaam, the President of the African Minister's Council on Water (AMCOW) called on African governments to commit their own resources to achieving SDG 6 on Water and Sanitation. He noted that

if this goal is not achieved the attainment of the other SDGs is put at risk.

Africa Water Week assembles the water community of the continent. Increasingly the event is a melting pot of different sectors all linked by a common factor – dependence on a

water wise world. Energy, health, agriculture, trade and manufacturing will not develop without water security, while social development is impossible without equal access to water and sanitation services for all.

2030 WRG AND KENYA JOIN HANDS TO CLOSE GAP BETWEEN SUPPLY AND DEMAND

The 2030 Water Resources Group (2030 WRG) and Kenya say they will join forces to close the gap between supply and demand in the water-stressed East African nation.

Without urgent action, the gap between global water supply and demand is projected to reach 40 per cent by the year 2030. In Kenya, taking a “business-as-usual” approach to managing its water resources will result in an almost 30% gap between water supply and the water required. The partnership between 2030 WRG and Kenya will include expanding access to finance for efficient irrigation; catalyzing partnerships in water stressed catchments; and replicating best practices in urban and industrial water efficiency.

www.2030wrg.org

100 MOST INFLUENTIAL PEOPLE

Sunita Narain has been named one of the world's 100 most influential people by TIME Magazine. In 2005, the New Delhi-based Centre for Science and En-

vironment, under her leadership was awarded Stockholm Water Prize.

www.time.com/collection/2016-time-100



GLOBAL ASSESSMENT OF TRANSBOUNDARY RIVER BASINS SHOW SEVERAL RISKS

The most comprehensive assessment of the world's 286 transboundary river basins identifies hotspots at risk from a variety of issues, with risks in some regions projected to increase.

The Transboundary Waters Assessment Programme (TWAP) created a baseline assessment of all the transboundary water resources on earth. Several organizations, including SIWI, contributed to the assessment, the first of its kind in scope and ambition.

The assessment found that the threat to freshwater biodiversity is global. Extinction risks are moderate to very high in 70 per cent of the area of transboundary river basins. It further found that the construction of dams and water diversions is in progress or planned in many transboundary river basins, often without adequate international water cooperation instruments. The final report states that risks are projected to increase in the next 15-30 years, particularly in four hotspot regions: the Middle East, Central Asia, the Ganges-Brahmaputra-Meghna basin, and the Orange and Limpopo basins in Southern Africa.

twap-rivers.org

SIWI, AGWA SET CRITERIA FOR WATER CLIMATE BOND STANDARD

The world's first certified green bond under the Water Climate Bonds Standard has been issued by the San Francisco Public Utilities Commission (SFPUC). The criteria for the Standard was developed by two working groups led by John Matthews from the Alliance for Global Water Adaptation (AGWA) – a network hosted and chaired by SIWI.

The Water Climate Bonds Standard is a screening tool for investors that specifies the criteria that must be met for bonds to be labelled as ‘green’ or earmarked for funding water-related, resilient, and low carbon initiatives. These criteria represent the first phase of a two-phase process.

The first phase of work concentrated on the clear articulation of resilience and greenhouse gas impacts of water investments, embedded in a matrix of economic and ecological systems. The standard reflects an abrupt shift in how many issuers and investors have seen climate change – less a distant, abstract issue, to something that influences their investment and sustainability strategy.

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SEPTEMBER

Last day to nominate your water hero for Stockholm Water prize 2017
www.siwi.org/prizes/stockholm-waterprize/nominate

TV SCIENCE PROFILE NEW JURY CHAIR OF STOCKHOLM JUNIOR WATER PRIZE

SWEDISH BROADCASTING'S POPULAR SCIENCE PERSONALITY VICTORIA DYRING HAS BEEN APPOINTED NEW JURY CHAIR OF THE STOCKHOLM JUNIOR WATER PRIZE FOR THE PERIOD 2017 TO 2019.

Victoria Dyring has been appointed by the Stockholm Water Foundation as new jury chair of the Stockholm Jun-

ior Water Prize for the period 2017 to 2019.

Victoria Dyring is the host of the prime time popular science show "Vetenskapens värld", and has a long career as a host of popular science shows for both children, youth and adult audiences.

"Stockholm Junior Water Prize attracts the best young water minds in the world. I have been im-

pressed by Victoria's commitment to spread science to



youth, and I am certain she will be a very successful jury chair and ambassador for the Prize", says SIWI's Executive Director Torgny Holmgren.

Victoria Dyring will be taking over as jury chair after Fredrik Moberg, who has been the jury chair of the Stockholm Junior Water Prize for five years and whose term ends after the 2016 prize ceremony

SIWI RECEIVES EXCELLENCE AWARD FROM GOVERNMENT OF BOTSWANA

SIWI's four-year partnership with Botswana's Department of Water Affairs, spanning from capacity building to the development of a water pricing strategy, has been awarded with a certificate of excellence by the country's government.

In Botswana's capital Gaborone, the Minister of Minerals Energy and Water

Resources, Mr Kitso Mokaila recently officiated at an annual national event called the Water Pitso (Setswana for consultation) where national water agencies account for their performance to stakeholders and incorporate their views into annual work plans.

At the Water Pitso Minister Mokaila awarded SIWI with a certificate of excellence recognizing a four-year partnership SIWI has with the Department of Water Affairs.

In last year's Pitso, the Minister acknowledged SIWI as a key partner of the

Botswana water sector that had made an immense contribution to capacity development.

Botswana is a semi-arid country set to experience increasing scarcity. The national currency, the Pula, means rain - showing the significance that citizens place on water resources. In Gaborone, where the Pitso was held, water restrictions have had to be instituted because of water shortages.

IN MEMORIAM: SVEN ERIK JÖRGENSEN



The 2004 Stockholm Water Prize Laureate Sven-Erik Jörgensen, professor emeritus

in environmental chemistry at the University of Copenhagen, passed away on 5 March 2016.

Professor Jörgensen shared Stockholm Water Prize with Professor William J. Mitsch, The Ohio State University, Columbus, USA. They got

the award "for their pioneering development and global dissemination of ecological models of lakes and wetlands, widely applied as effective tools in sustainable water resource management".

In 1975 Sven-Erik Jörgensen founded the highly recognized journal *Ecological Modelling* and acted as its Editor-in-Chief. In 1978 he founded the International Society of Ecological Modelling and acted as its president as well. He edited or authored more than 70 books, among

them 1986 "*Fundamentals of Ecological Modelling*" (fourth edition 2011) and 2012 "*Introduction to Systems Ecology*". His books have been translated into Chinese, Russian and other languages. Sven-Erik Jörgensen published more than 350 scientific papers and he was a member of the European Academy of Sciences.

Professor Jörgensen's international outreach is impressive with over 70 courses on ecosystem modelling held in more than 30 countries. He

inspired many young scientists and engineers, particularly in developing countries, emphasizing the need for interdisciplinary approaches to water resource problems.

Sven-Erik Jörgensen was a strong supporter of SIWI and World Water Week in Stockholm and contributed in an inspiring way with good advice and ideas. All his friends related to the Stockholm activities are deeply saddened by the news of Sven-Erik Jörgensen's passing, and he will be sorely missed."

THE MODERN RAIN DANCE: CLOUD SEEDING



TEXT | TOM FREYBERG PHOTO | UAE RESEARCH PROGRAM FOR RAIN ENHANCEMENT SCIENCE

WEATHER WAS A PHENOMENON WE THOUGHT WE COULD NEVER CONTROL. UNTIL NOW. CLOUD SEEDING IS A GROWING BUSINESS IN THE WORLD'S DRY AND WELL-OFF REGIONS.

For centuries mankind has looked to the skies in the hope for rain to quench people's thirst, the lands and alleviate drought. During the dry months Native American tribes used to perform rain dances, wearing jewelled head-dresses and special clothing to invoke the clouds and bring rain to an entire community. In ancient China, shamans – believed to be in contact with spirits that control rainfall and flooding – would perform sacrificial rain dance ceremonies during droughts.

Fast forward thousands of years and rather than having to dance, pray or sing for water, humans found a way to engineer rain to where it was needed. Known more broadly as weather modification, the process of cloud seeding or rain enhancement involves dispersing material – salts or silver iodide crystals – into clouds to encourage rainfall. Surprisingly, the process was actually discovered by accident.

It started with a bang. According to the Texas Weather Modification Association (TWMA), it was during the 1861-1865 Civil War that an engineer called Edward Powers observed that it often rained where major battles had taken place. At the time clouds seemed to be invigorated whenever smoke, dust and

other particulates from conflict were put into the air.

Since then, from 1891 in Texas various experiments took place, with strategically placed dynamite, through to ground based generators to disperse agents such as silver iodide. More recently, aircrafts have been kitted out to release hygroscopic and glaciogenic materials, including dry ice.

Cloud seeding then became so popular in Texas in the 1950s and 1960s that legislation was introduced requiring any activity to require a license issued by the state's water agency.

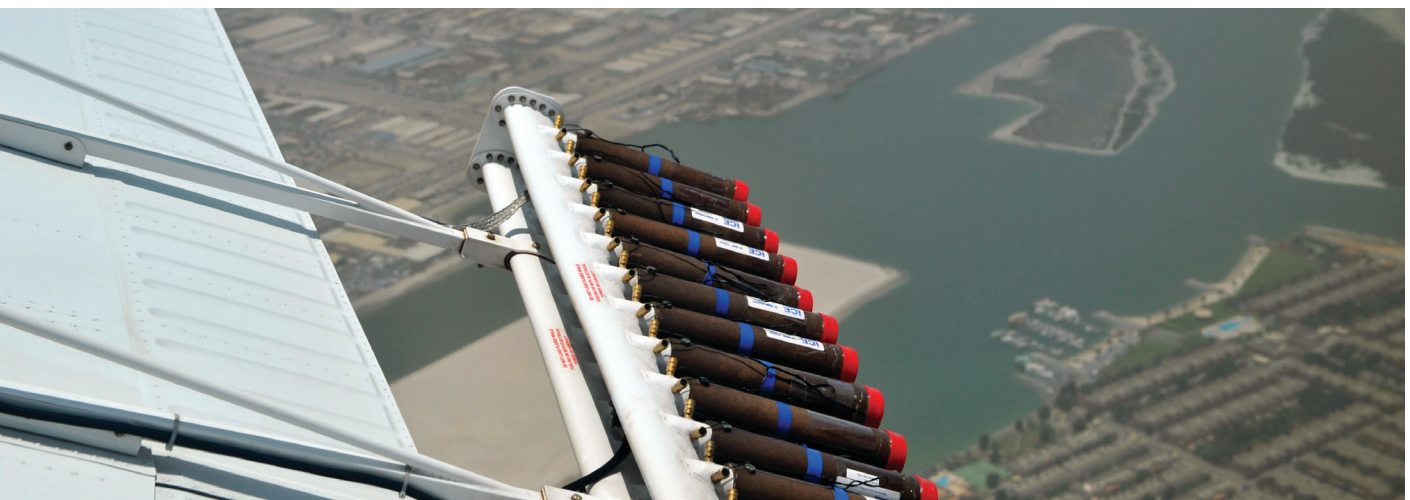
TWMA says that since 2004, targeted areas saw an increase of 13 per cent in total rainfall. That may not initially sound like a huge difference yet the association claims for every dollar invested into weather modification pro- ●●●

The process

- Radar and satellite data, together with meteorological observations are used to help time cloud seeding activities
- Selected materials are dispersed into the atmosphere by flying aircraft at an altitude of 5,000 feet above the cloud base
- Silver iodide (Israel) or sodium chloride (UAE) accelerate the creation of ice particles in the cloud. Previously, small drops of rain at the bottom of clouds would not be heavy enough to fall as rain. When turned to ice crystals through seeding, they fall to earth as rain, due to their added weight

Results

- In Israel, water company Mekorot believes its cloud seeding efforts increase rainfall on average between 10-15 per cent, generating between 30-40 million cubic metres per annum. Estimates suggest this costs the company USD 1.5 million per year.
- In the UAE, although cloud seeding is in much earlier development, authorities have higher expectations and believe it can enhance rainfall by as much as 30-35 per cent. Early tests in the Al Quaa region showed monthly rainfall at 136mm after seeding but 29.9mm previously. Costs are estimated at USD 1 per cubic metre of water delivered.
- In Texas, TWMA says targeted cloud seeded areas have seen an increase of 13 per cent in rainfall. USD 1 invested into cloud seeding has an estimated return on investment of USD 19 based on saving irrigation costs.



●●● grams, the return is roughly USD 19 with the potential state-wide impact upwards to USD 38. This is based on an analysis done in conjunction with the Texas A&M Agrilife Extension Center. The returns were calculated based on “reducing the need to irrigate”, according to TWMA.

Israeli Innovation. Meanwhile, at the same time during the 1960s Israel carried out three cloud seeding experiments, followed by extended seeding programmes in the north of the country from 1975.

During the winter months between November and April, the country was seeding clouds with silver iodide in an effort to increase the amount of water

that falls into the Sea of Galilee and its surrounding watershed.

Israel’s national water company, Mekorot, believes such efforts have increased rainfall on average between 10-15 per cent - generating additional water of between 30-40 million cubic meters per annum into the sea “at a very low cost”.

“By the 1960s, Israel had put a lot of resources into testing rain-cloud seeding and developed world-renowned expertise in how and when to seed,” said author and businessman Seth Sigel, in his book, *Let there be water: Israel’s solution for a water-starved world*. “It is believed that cloud seeding may add as much as 18 per cent to the rainfall over the Sea of Galilee watershed and about

10 per cent to what falls on the lake itself. The technique may be adding as much as ten billion gallons of water a year to the lake. At a cost of only USD 1.5 million for the annual Mekorot cloud-seeding operation, this is very inexpensive water.”

Fiddling with nature. Today estimates from the World Meteorological Organization suggest there are over 80 cloud seeding projects taking place around the world, in more than 52 countries. Cloud seeding has turned into a big business. Take the project list of Weather Modification Inc. – one of the world’s largest private aerial cloud seeding companies. From Indonesia, to Burkina Faso and Saudi Arabia, not



to mention the 30+ projects in North America – it's clear other countries are looking to the skies as a solution to increasing water scarcity.

However, the activity of fiddling with weather patterns and intercepting water on route to where nature intended it to go, has attracted its fair amount of criticism over the years.

Three researchers – Prof. Zev Levin, Prof. Noam Halfon and Prof. Pinhas Alpert – from Tel Aviv University's Department of Geophysics and Planetary Sciences wrote a paper entitled 'Reassessment of rain enhancement experiments and operations in Israel including synoptic considerations'. Featured in an Elsevier journal called

Atmospheric Research, the work analyzed 50 years of data on cloud seeding in Israel but said that the resulting increase in rainfall was down to changing weather patterns. It concluded that: "Re-analysis of the cloud seeding experiment and operations in Israel shows that seeding has not produced the expected enhancement in rainfall."

According to the researchers, when comparing the seeded area with an "unseeded adjacent area to the south" it showed "no difference with even slightly higher values in the unseeded area". "This suggests that seeding had little or no effect on total precipitation on the ground", the paper said.

Efforts in the Emirates. Later to

the game, the United Arab Emirates (UAE) is also trying its hand at cloud seeding. Last year the UAE Research Program for Rain Enhancement Science was launched. Overseen by the National Centre for Meteorology and Seismology (NCMS), to date more than 110 cloud seeding test flights have been launched. It is hoped water supplies, with the majority currently supplied by desalination, could be boosted by 5 per cent. Results published to date are positive. In April 2013 monthly rainfall in the Al Quaa region of Abu Dhabi was recorded at 136mm following cloud seeding. This compared to a monthly average of 29.9mm between 2003 and 2014 without rain enhancement, according to NCMS. ●●●

●●● Speaking to WaterFront, Alya Al Mazroui, programme manager for the UAE Research Program for Rain Enhancement Science (UAEREP) says cloud seeding costs USD 1 per cubic metre of water produced, which she says is “cost effective” when compared to desalination. She believes cloud seeding can enhance rainfall by 30-35 per cent. “We are now in an arid region: we have average below 100mm annual rainfall rate with a big pressure on our total annual water use in the country. Add to this our current water recharge rate is low. We are looking for a more sustainable approach – we are addressing water security issues through the programme.”

Omar Al Yazeedi, director of research, development & training department at the NCMS adds: “The goal here is to increase the rain – no matter where it is of course it will be beneficial for animals, for agriculture, for recharging the water in aquifers and for the benefit of people.”

Others remain skeptical of the work, questioning how the enhanced rain will be collected and used. After all, unless seeded clouds rain over crops or water reservoirs, what use is the additional water if it's lost in the desert?

“Cloud seeding is usually for agriculture,” says David Lloyd Owen, managing director of independent consultancy, Envisager. “For the UAE to encourage agriculture in its area would be rather indulgent and probably pretty expensive. For piped water, there is the challenge of gathering the rain and getting it to the pipes. Catchment systems need to be able to gather water through groundwater and deserts tend to be poor in this respect. So, this is something of a challenge here.”

As part of the UAE research programme, a grant of USD 5 million is

offered over a three-year period to be shared by up to five winning proposals. Earlier this year three scientists from Japan, the UAE and Germany shared the funding:

- Masataka Murakami, visiting professor from the Institute for Space-Earth Environmental Research, Nagoya University (Japan), for his work on precipitation enhancement in arid and semi-arid regions
- Linda Zou, professor of chemical and environmental engineering from the Masdar Institute of Science and Technology (UAE), for her work on using nanotechnology to accelerate water condensation
- Volker Wulfmeyer, managing director, professor, and chair of physics and Meteorology at the Institute of Physics and Meteorology in the University of Hohenheim (Germany), for his work on cloud seeding optimization.

“It is hoped water supplies, with the majority currently supplied by desalination, could be boosted by 5 per cent”

Since Edward Austin's early observation during the American civil war of conflict-induced rain, cloud seeding methods continue to evolve to this day. Some will continue to argue that we should not be meddling with nature. Others

believe if the technology is available, we should take advantage of it and deliver rainwater to where it is most needed. The weather and rainfall by their very natures are unpredictable. Recent investment from the Middle East into cloud seeding research should help to keep the momentum up. Yet getting additional rainwater through to residents' taps comes with its own unique challenges. ●

Tom Freyberg is chief editor of Water & Wastewater International (WWI) magazine

SUPPLY AND DEMAND

TEXT | ANTON EARLE

The empirical evidence that cloud seeding efforts can produce more rainfall is mounting, with gains reported of 13 to 35 per cent in various parts of the world. This sounds like good news and certainly is for the direct beneficiaries of such increases – typically farmers relying on rainfed agriculture.

But have we stopped to consider the wider implications of relying on such a supply-side approach?

In almost every water-scarce part of the world which has exploited water resources to supply agricultural, municipal or industrial needs at scale, the pattern has been repeated. An increase in the supply of water is rapidly accommodated by the population being served, where use of water increases with little regard for efficiency; rapidly leading again to a situation of scarcity.

Water efficiency can potentially have a large impact at the level of a municipality or across a sector such as agriculture, progressively and sustainably reducing water used while still making social and economic development possible.

Make no mistake – an increase in available water supply will always play an important role in ensuring water security, especially in developing countries where there is a backlog in the development of this infrastructure. However any increase in supply which is not accompanied by a concomitant process of improving water use efficiency (value added per unit of water consumed) is likely to be futile in the medium term, with water scarcity returning once the newly supplied water becomes fully allocated.

Hence a short “health warning” should accompany any proposal to increase supply (cloud seeding included): Your supply solution should not be consumed in excess and should form part of a comprehensive programme aimed at reducing demand and improving water-use efficiency. Failure to heed this warning may result in you facing water scarcity again sooner than you think.

Anton Earle is Director of SIWI's Africa Regional Centre in Pretoria, South Africa



“THE MOMENT I LOOKED DOWN A MICROSCOPE I KNEW”

TEXT | VICTORIA ENGSTRAND-NEACSU PHOTO | MICHIGAN STATE UNIVERSITY

THE 2016 STOCKHOLM WATER PRIZE LAUREATE HAS ONE FOOT IN MICROBIOLOGY AND THE OTHER IN PUBLIC HEALTH. COMBINING THE TWO SATISFIES HER CURIOSITY AND OFFERS HER AN OPPORTUNITY TO MAKE A DIFFERENCE FOR PEOPLE ON A GLOBAL SCALE.

On a dark morning in February, Professor Joan B. Rose got an unexpected phone call.

“When I got the call about Stockholm Water Prize, I was speechless. People who know me wouldn’t believe that. You have a lot of emotions when you hear that you’ve won such a prestigious prize. The prize is known the world over, and it calls attention to the most important issues around water in the 21st century, and, for me, that is water quality.”

What motivates you?

When I was younger I wanted to just do good work. I loved working in the water pollution field. It was exciting to go out and take a water sample and bring it back and look for these critical microorganisms. And I have always been motivated by the principles of public health. How do we prevent disease? There were new and emerging pathogens that caused disease and there still are. Infrastructure is crumbling in many parts of the developed regions of the world and in other places the population unserved by sewage treatment is in the millions. We need to develop a global water curriculum to educate the next generation of problem solvers. The need is enormous.

What was your dream when you were growing up?

I was always motivated as a kid to explore the world and especially the natural world and to pursue my love of science. Of course, I had a chemistry set and ant farm and all of that, but I think, more than that, my dad always said, “Follow your passion,” and my mom always said, “Don’t worry about going where no one’s gone before.” Because I work at the interface between public health and engineering, and at the time I started, the world of engineering had a lot of males in the profession, and I think that can be daunting.

I think the way I was encouraged, I didn’t feel that was a door that was closed to me. As soon as I got into college and was thinking about the whole idea of science and health and what kind of scientist; there’s so many options. I took my first class in microbiology, and I was hooked. To think that there’s a whole world that we can’t see out there, churning, doing things, running the biogeochemical cycles of the Earth, transmitting diseases globally. This was intriguing to me, and to combine that love of microbiology with my interest in public health, really made me feel like I could do good with my science. That was really helping people, focusing on something that people really cared about.

Working in different fields, how do identify yourself?

I am a water scientist, scholar and teacher who works at the interface of public health and engineering. I like to say I spend much of time doing community engaged research. There are key issues when you do this type of work. ●●●

••• You have to think about the specific priorities for the community, and cost, but what is also important is the timeliness of the results, communication of those results in consultation with numerous partners. We need more of this type of work.

What difference has your work made?

Water quality is so complex and I have always wanted to use the newest techniques and methods to study viruses and parasites in my own backyard so to speak. I have been so fortunate to be able to work in Florida – for example in the Keys – and in the Great Lakes – for example along Lake Michigan – with utilities, water districts, beach managers, and teams focused on restoration. And as soon as I found pathogens in the water, enteric viruses or Giardia or Cryptosporidium parasites, it became important information and moved the political will towards doing something, investing in sewage treatment, creating new policies.

But for me personally what has really made the difference is being connected to my international colleagues in health-related water microbiology. I attended my first conference in 1984 and this group of people have become friends and colleagues, we share our tools, data, struggles and successes, they are honest and do passionate science. Creating platforms where we can share knowledge globally really makes a difference.

I think I've been very fortunate to be able to work at the international level and to work with dedicated professionals in the water business. I first went to Singapore 16 years ago, and their idea of transforming that city state to a sustainable system with "New Water" was just a blueprint on a table in a trailer at a wastewater plant. I know that, even as an individual, there's only so much you can do, but you can be part of a collective group that is going to be able to transform access to safe water a focus on improving water quality. I think the testing that goes on globally, the water quality testing

OPINION

THERE IS NO SHORTCUT TO BETTER WATER QUALITY

TEXT | JOAN B. ROSE PHOTO | ISTOCK | GRAPH JOAN B. ROSE



WATER QUALITY IS DEGRADING AROUND THE WORLD, AFFECTING THE HEALTH OF A GROWING GLOBAL POPULATION. WE NEED TO ENCOURAGE EFFORTS TO SHARE VITAL INFORMATION THAT CAN HELP TURN THIS TIDE, WRITES JOAN ROSE IN THIS OPINION.

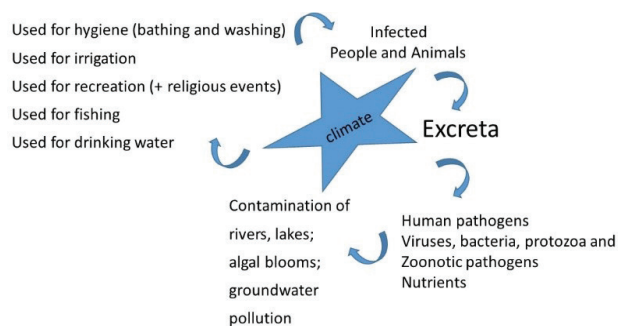
I am worried, very worried about the degradation of water quality around the world and the impact this will have on our health. The global population has reached 7 billion, with more than 50 per cent living within 150 km of a coastline, major lake or river system. Half of the world lacks any wastewater infrastructure, and where it exists, it is often (i.e. the US) in desperate need of restoration. Beyond humans, the numbers of cattle, sheep, pigs and chickens are estimated at 1.4, 1, 0.9 and 21 billion, respectively. On average, animals generate 61.7 and humans 10.1 million metric tonnes of excreta per day. (FAOSTAT www.fao.org/docrep).

Much of this faecal waste eventually enters a waterway and even if treated generally does not control the microorganisms or nutrients of concern. This impacts the designated uses including for recreating and drinking. While what we do on the land (waste generation, treatment and disposal) is the source of these pathogens,

climate drives the transport of the pollution from the sources to the waters of the world.

The severity of water quality problems are exacerbated by climate both during droughts and extreme flood events. Climate change will aggravate regional and global water scarcity by as much as 15 to 40 per cent, which will mean that sewage-dominated waterways and unplanned reuse will increase. Waterborne disease outbreaks tied to large precipitation events will continue to plague communities across the world.

I am part of the Global Water Pathogens Project (GWPP, www.waterpathogens.org) whose aim is to improve sustainable access to and uptake of sanitation by updating knowledge on water pathogens in a state-of-the-art reference on water-related disease risks and intervention measures. The GWPP has nine teams, and currently 110+ authors around



"I have always been motivated by the principles of public health"



the world committed to providing information for improving public health and decreasing the global disease burden associated with faecal contamination of water and the environment.

The data we are now generating are available for us to produce global and country-specific maps on pathogen risks associated with fecal pollution. This information suggests that we need to address explicitly which sanitation technology is really effective for reduction of groups of pathogens important to public health, whether it be viruses, bacteria, protozoists or helminths and at what scale high coverage (or compliance) can be achieved. Otherwise investments may not show the desired impact, risking the bio-health of the planet and the ecosystem services that our aquatic resources provide.

In the US we are also looking at innovative technologies to move from conventional sewage treatment systems to resource recovery facilities, where water and nutrients will be extracted for reuse and energy will be produced. Yet most of these systems have yet to be evaluated in terms of the desirable water quality. This we must do.

The challenge for those involved in sanitation and wastewater treatment will be to build capacity and provide the data necessary to move the political will. Because it is this knowledge, informed by geospatial data, which will feed directly into the risk framework and support evidence-based decision-making. Using quantitative microbial risk assessment will allow for science and policy integration to guide where, how and when to wisely invest in both innovative and general sanitation technologies to protect water quality and health.

With the diagnostic tools and risk frameworks

and our understanding of water quality, is so important to achieving safe water.

What do you hope to focus on in the future?

I want to expand what I've been doing my whole career, and that is expand water diagnostics, the testing of water and the understanding of water pollution. I'd like to see this at a large scale. I think knowledge is power, and we're trying to make these big decisions about providing services, water services, and in particular on the wastewater side, focusing on sewage and sewage treatment. We've let that lag across the world.

The future is about resource recovery, so moving from sewage treatment to a wastewater system that recovers water, recovers nutrients, recovers energy. That's going to be the future, but we can never lose our primary goal, and that is that wastewater treatment is about protection of public health. That is removal of contaminants of concern, and that's going to be my effort in the future. ●

currently at our disposal, we can use the data collected around the world on pathogens in sewage and the techniques for their removal to build a better and safer blue economy. By investing in water quality we can enhance industrial activities and tourism, upgrade the uses of our waterways for water supply, recreation and agriculture and, most importantly, improve both lives and livelihoods through health and jobs.

I recommend that we utilize this knowledge and continue to invest in:

- networks between public health institutions, universities, water providers and managers
- risk analysis frameworks to integrate science and policy and promote the translation of science into action around sewage (re)sources
- global pollution maps for pathogen and country specific impacts
- advanced technology for water diagnostics to improve resolution of the evidence needed for decision-making.
- a 21st century water curriculum for future water scientists, technicians, managers and engineers

If we do, our energy and hard work can go toward the solutions to meet our aspirations and we will not need to worry as much about the Blue Planet that our grandchildren will live in. ●

2016 Stockholm Water Prize Founders

Bacardi • Borealis & Borouge • Europeiska ERV • HP Kemira • Poul Due Jensen Foundation • Ragn-Sells Scandinavian Airlines (SAS) • Snecma/Safran • Water Environment Federation (WEF) • Xylem • Ålandsbanken Supporter • Grand Hôtel

CRAFT BREWERS EMBRACE REVERSE OSMOSIS

TEXT & PHOTO | RANDALL HACKLEY

CRAFT BREWERS CONCERNED WITH THE QUALITY OF WATER, WHICH MAKES UP MORE THAN 90 PER CENT OF THEIR BEER, ARE INCREASINGLY GOING HIGH-TECH AND EMBRACING REVERSE OSMOSIS.

Reverse osmosis (RO) makes the water purer, the quality of the incoming supply better and taste of the product more consistent at a time when consumers are buying craft beers like never before – it is the fastest-growing sector in the British and US beer market. The heightened demand for craft beers is also why, over the last year, two RO-using craft breweries have been snapped up by the world’s biggest brewers. SABMiller bought the London craft brewer Meantime and AB InBev acquired Camden Town Brewery of London.

London has had a love affair with craft beers, with more than 80 brewers now operating in the British capital.

The craft beer phenomenon is just as heated in the US, where craft beer now makes up 12 per cent of overall industry sales. Reverse osmosis technology strips water to its elemental components. Brewers then rebuild the main ingredient in beer with a customized mineral profile for a more distinct taste. This means brewers who start with reverse osmosis can construct water profiles to compliment specific kinds of beers. That could not be done if using tap water from municipal sources, well water with high nitrate levels from agricultural runoff or groundwater heavy in minerals that do not go well with certain craft beers.

“We see this trend to clean up intake water and then remineralizing to meet a profile and RO is an extremely reliable method to achieve that outcome,” said Snehal Desai, global business director for Dow Water.

“In the case of bottled water, adding minerals is essential to provide the taste that consumers seek because pure RO water is tasteless,” he said. “In the case of a brewery, soft drink manufacturer or coffee company, they may know that a particular mineral profile will interact best with the yeast, soda concentrate or coffee grind.”

Using RO in craft beer production maintains a consistent and high level of water purity yet is energy-intensive, employing a filtration method to remove particles and harmful bacteria from water and cut the hardness of water found in chalk streams and southern England.

In California, enduring a fifth year of record drought, more energy was needed to treat water after Escondido craft brewer Stone discovered that drought had changed its incoming water quality. ●

Beer in numbers

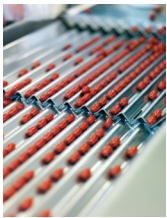
- The number of operating craft breweries grew 15 per cent in the US last year to about 4,200
- Reverse osmosis systems can remove almost all minerals and salts from the raw water supply and about 95 per cent of arsenic and other contaminants.
- With gains in technology, brewers can now make craft beers even from treated wastewater



JOINT EFFORT WAY FORWARD TO LIMIT PHARMACEUTICALS' DAMAGING EFFECT ON ENVIRONMENT

TEXT | JOHAN KARLSSON & NICOLAI SCHAAF PHOTO | ISTOCK

PHARMACEUTICALS ARE IMPORTANT TO OUR SOCIETY, BUT RISK IMPACTING THE ENVIRONMENT NEGATIVELY IF RELEASED INTO SHARED WATERBODIES. JOINT ACTION IS KEY TO LIMITING THE DAMAGE, WRITE JOHAN KARLSSON AND NICOLAI SCHAAF IN THIS ANALYSIS.



Pharmaceutical products are essential for our society, and their use is likely to increase due to a growing, ageing population. But in high concentrations, pharmaceuticals will impact the recipient waterbody. Combining efforts along the pharmaceutical life cycle – production, procurement, consumption, and wastewater treatment, will be key for sustainable development.

SIWI's Swedish Water House has led a two-year long consultative process with the aim to find the best and most effective ways to limit unnecessary release of pharmaceuticals into water. Many of the political and technical tools needed are already in place, both on a national and European level, but are poorly implemented. Someone has to take the lead and Sweden is seen as a premiere candidate.

The so-called cluster group included actors from the entire pharmaceutical lifecycle, including the industry, academia, regional and national procurement, pharmacy, and wastewater treatment plants.

Pharmaceuticals find their way into the water mainly from wastewater treatment plants, animal husbandry, and manufacturing. Use of pharmaceuticals in animal husbandry is an entirely separate challenge, hence the group focused their efforts on human use of pharmaceuticals. On the surface it appears that the solution to the problem ought to be quite straightforward – implement more effective wastewater treatment technology. This would take care of residues flushed down the toilet and unintended release from manufacturing processes. Unfortunately, and not surprisingly, things are not that simple.

Why is that so? Well, implementing advanced treatment technology is expensive and energy-consuming. The significant investments required is a deterrent even in rich countries like Sweden. Most of the manufacturing processes take place in low-income countries where additional costs to the production could blunt the competitive edge and mean less or no business at all. That said, a lot is being done by the industry to limit unintended release of pharmaceuticals in their manufacturing processes.

The most potent and potentially harmful negative effect that could arise when pharmaceuticals get into the environment is development of antibiotic resistance in pathogens. Research done in India and China has shown that microbes living in areas heavily polluted by broad-spectrum antibiotics have developed multi-resistance. The uncontrolled use of the anti-inflammatory agent diclofenac in Indian cattle has decimated the vulture populations to the verge of extinction. Research conducted in Sweden has shown that relatively modest release of residues from contraceptive hormones and anti-depressants have had negative reproductive and behavioural effects on fish.

The way forward for maximum and sustainable effects lies in cooperation, the cluster group concluded. Efforts made along the entire pharmaceutical lifecycle is essential. Limit effluents from production, optimize total consumption, raise awareness about environmental risks associated with certain pharmaceuticals, develop new business opportunities for the industry for green pharma, implement state-of-the-art wastewater treatment at sensitive waterbodies – all without compromising patient safety – are some of the recommendations that came out of the consultations. Now, the group is trying to find a “testbed” to implement all the recommendations. ●

“A once-in-a-lifetime event at worst? Far from it... unpredictability is becoming the new normal”

TEXT | ALEX KIRBY PHOTO BBC

Realists say that climate is what we expect, but weather is what we get. For generations now the British have expected cold winters and hot summers, but we've learned to resign ourselves to disappointment. Sixty years ago or so the winters were often so bitter that you would wake with a thick layer of ice coating the inside of the bedroom window. Summers really were marked by blistering heat. Today, though, much of the UK spends much of each year in tepid nondescript gloom, as the seasons lose their distinct edge. Weeks on end of rain and wind should come as no surprise.

The problem is that we are still surprised by what we think are unfamiliar weather patterns, even when they affect us increasingly often. In October 2000 the small town where I live in southern England was badly flooded: a month's worth of rain fell in a single day. That autumn, September to November, was the wettest on record in England, Wales and Northern Ireland: the wettest, in fact, for 330 years. A once-in-a-lifetime event at worst? Far from it. There was severe flooding, though not as bad as in 2000, in and around the town again in August 2015.

Much of the United Kingdom is having to learn to live with more savage weather, not only floods but storms and high winds as well. In February 2014 the main railway line from London to the West of England was washed away by a storm at a point where it runs just metres from the English Channel. It remained closed for weeks, prompting one frustrated traveller to say it was a foolish place to have built a railway anyway. But it wasn't. When the line was laid, more than 150 years ago, Channel storms of that ferocity were almost unknown there. The folly, if any, lies with those of us who now fail to recognize how fast and fundamentally weather patterns are changing, and how unpredictability really is becoming the new normal.

Mercifully few lives have been claimed recently in the UK by extreme weather, though one death is one too many. But this is a rich, resilient and



developed country, where people can expect prompt warnings of danger ahead, and where rescue and other emergency services will do their utmost to save those in peril. Most of the time, for most of us, even today's sometimes untameable weather need not be a matter of life or death.

There's only one atmosphere, and the extreme weather and rising temperatures which are increasingly the norm in this self-contained set of islands in the North Atlantic are increasingly common across the world. But their effects there can be much more malign: droughts, typhoons, failing crops as monsoons falter, and dwindling hopes of ending abject poverty, let alone finding the way to really sustainable living. We're all in the same boat. ●

Alex Kirby reported the environment for BBC News, and is a founder editor of Climate News Network.

CALENDAR

**11-14 SEPTEMBER
MELIÀ SITGES, SPAIN**

1st International Conference on Sustainable Water Processing

The conference allows the dissemination and discussion of cutting edge research in water process engineering, sustainability and energy efficiency. The scope will include theoretical and applied research, technological and industrial development.

sustainablewaterprocessing.com



**12 OCTOBER
LONDON, UK**

Financial Times Water Summit

The FT Water Summit gathers senior practitioners from demand-side corporate's together with policy-makers, suppliers and the financial community to talk about the new and innovative approaches to improving water security for multiple uses including: human and industrial consumption, irrigation, energy generation and navigation. Wastewater treatment and management, efficient use and reuse of water are fundamental themes to achieve water security.

<https://live.ft.com/Events/2016/FT-Water-Summit>

**17-20 OCTOBER
QUITO, ECUADOR**

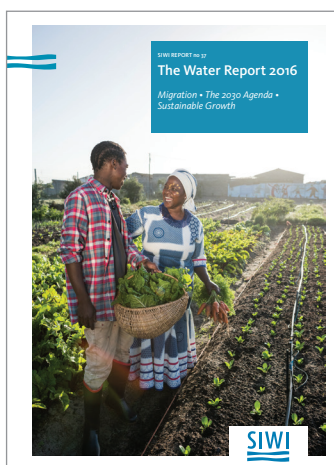
Habitat III

Habitat III is the United Nations Conference on Housing and Sustainable Urban Development. The conference aims to reinvigorate the global commitment to sustainable urbanization, to focus on the implementation of a New Urban Agenda, building on the Habitat Agenda of Istanbul in 1996.

www.habitat3.org



NEW SIWI PUBLICATIONS



THE WATER REPORT

The Water Report follows and analyzes current and long-term issues that are central to building a water-wise world. The Water Report 2016 discusses Water and

Migration, Water in the 2030 Agenda and the Paris Agreement, as well as Water for Sustainable Growth.



WORKING PAPER: WATER PRICING

This paper discusses use of these instruments towards achieving complex goals, often including social and environmental components. Case studies from

All publications can be found online at www.siw.org/publications

Australia and South Africa highlight that the development of a policy regime to achieve multiple goals tends to be a multi-stage process.

STOCKHOLM

WATERFRONT

Look out for the next WaterFront in October. If at World Water Week in Stockholm, don't forget to pick up your copy of WaterFront Daily!

20
1997-2016

SIWI STOCKHOLM
JUNIOR
WATER PRIZE

In a matter of weeks, 52 young innovators from 29 countries will compete in the international final of the prestigious Stockholm Junior Water Prize. The competition brings together imaginative and ambitious young minds from all over the world, encouraging their continued interest in water and sustainability issues. H.R.H. Crown Princess Victoria of Sweden is the Patron of the prize.

This year marks the 20th jubilee of the competition. Xylem, a leading global water technology company committed to “solving water” by creating innovative solutions to meet the world’s water needs, has been a global sponsor of the competition from the beginning.

To help celebrate the jubilee, SIWI and Xylem have partnered to further support these talented young people and their ideas. More information will surface during the Week, but you – the global water community – will have a very important part to play.

#WaterTank
Coming this
World Water Week.



OUR WATER,
OUR CLIMATE,
LET'S TAKE
ACTION.

Water is infinitely renewable but the amount of water on earth is fixed.

At Xylem, we help our customers implement sustainable solutions to their water challenges. We design and manufacture the world’s most advanced technologies to move water, treat water and test water in sustainable ways. Our 12,500-strong global team is dedicated to expanding access to clean, safe water today and renewing this valuable resource for future generations.

We look to a future where global water issues do not exist. And everyday, we get one step closer.

Let's solve water.



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Let's Solve Water