Water at the centre

WaterCentre@KTH
– a summary of 2017-2020

www.kth.se/water

If water knows no boundary, so must we”

David Nilsson
Director, WaterCentre@KTH

Photo: Fredrik Persson

Splash!

Everything started with water, and water connects everything we do. Water is needed for food production and ecosystems, for energy production and industry, human consumption, culture, leisure and much more.

This fascinating substance creates a complex web where issues, sectors and life-forms are intimately linked. But our blue gold is under pressure as the demand for water increases rapidly. We must find ways of managing this precious resource in new ways, across political borders and regions, across sectors and knowledge disciplines.

If water knows no boundary, so must we. This is the reason the WaterCentre@KTH exists. The centre started in 2017 with the aim to promote research collaboration around water, across organisational and disciplinary boundaries. Today, water-related research is carried out at all schools at KTH and our work at the Centre reflects this. We have had experts in applied thermodynamics work with historians, structural engineers management experts and planners.

We have engaged students, professors and administrators and we have reached far outside the university realm, working with politicians, entrepreneurs, companies, real estate actors, media, citizens, artists and many others. It has been a fantastic journey. In this report we want to share some of our experiences with you.

Get wet!

David Nilsson
Director, WaterCentre@KTH

Water challenges in everyday life

Water is an essential part of all our everyday life. As we go about our day, it is often easy to forget just how much we rely on water to live a good life.

In our own homes, we will use water on a daily basis for drinking, cooking, cleaning our dishes, showering and washing our clothes. Then there is water which makes up the products we use. Did you know that 132 litres of water are used to produce just one cup of coffee?

At the same time, more and more countries are experiencing water stress due to multiple challenges. Even Sweden has in recent years seen long periods of water scarcity and drought, adversely affecting drinking water supplies, agriculture, forestry and tourism. When we turn to the sea, today more than 85 million people live in the Baltic Sea catchment area. However, their activities are causing serious eutrophication problems which are related to water pollution and impact marine ecosystems. Scaling up to the global level, more than 2 billion people still lack access to safely managed drinking water. Moreover, United Nations have warned that by 2030, water scarcity could give rise to 700 million people being displaced.

There is no doubt that water is one of the defining challenges for the future, locally as well as globally. This is why we can't afford a wait and see attitude. This is why we have moved to action at KTH.

2 billion

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700 million

By 2030water scarcity could give rise to 700 million people being displaced.

1 of 3

1 of 3 Swedish municipalities experienced shortage of drinking water supply during the 2018 drought.

KTH WATER CENTRE

The WaterCentre@KTH started in 2017 with an initial investment from the KTH President's office of 10 million SEK.

Today our portfolio of 14 project totals 128 million for KTH and partners.

We have organised around 40 physical events, from pub evenings to lunch meetings to conferences and application writing workshops.

Photos: Josefin Backman and David Nilsson

KTH water centre – a meeting point

Where is the liveliest place at a Swedish home party? Well, the kitchen of course! That is where you find the most interesting and fun conversations, the best mix of the guests, and plenty of snacks! We think of the WaterCentre in the same way. This is where you meet people whose paths you normally do not cross. This is where you get drawn into lively discussions, exchange ideas, and make new, sometimes unexpected, friends.

How do we do this? It all starts with people. If you can get the right people into the room, and create an atmosphere of trust, then you are half way there. Add an intriguing and pressing challenge, like restoring water quality, or stopping decay of critical infrastructure, or how to feed the world's population. Shake and stir!

Illustration: Ane Mattson

Our future is in the sea

71% of the Earth's surface is covered by water. And yet the economic activity in our oceans amounts to a mere 3% of the total gross world product. This is about to change, and the Kristineberg Marine Research and Innovation Centre is at the forefront of the research necessary to make it happen.

Fredrik Gröndahl
Associate Professor, Kristineberg Centre and KTH

Photo: Roine Karlsson

Our oceans have long been considered the domain of shipping, fishing, and offshore oil and gas. But new activities are emerging that are reshaping and diversifying our marine activities into what has been dubbed the "Blue Economy". The UN has proclaimed a Decade of Ocean Science for Sustainable Development, starting in 2021, to support efforts to reverse the cycle of decline in ocean health and support ocean science. It is in this context that KTH makes a contribution to sustainable ocean management.

Associate professor Fredrik Gröndahl is the research coordinator at the Kristineberg Marine Research and Innovation Centre where KTH and its six partner organizations provide a national arena for experimental marine research. Fredrik is a passionate proponent of the sustainable use of our marine habitats. "The Blue economy will be our biggest engine for sustainable economic growth in the decades to come, and vast sums of money are now being invested into maritime research. The reason is simple: in order to feed the world's growing population we need to look towards the sea. We can sustainably produce very nutritious and protein-rich food on our blue fields, without depleting them. I believe that 'sea farming' will become a common profession in the future."

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Today, Swedish aquaculture is relatively small-scale, but there's great potential for growth. "We have a very long coastline and our waters are quite nutrient rich, which makes them ideal for sustainable sea farming", says Fredrik. While many types of food can be cultivated at sea, he has a particular soft spot for algae: "Algae grow very quickly and apart from being a food source, they can be used for all kinds of things like new materials, chemicals and energy. Algae farming is also climate-smart since it doesn't need irrigation or fertilizing. And just as importantly, it doesn't take up any valuable arable land."

Read more about the research: kristinebergcenter.com

Photo: Eduardo Infantes

Small scale solutions with large social impact

Fresh ways of looking at our water supply systems is not just about technology. A focus on actors and society is crucial for creating possibilities for radically different solutions that are more in tune with today's challenges. The common denominator for these new ideas: small scale.

Dr Timos Karpouzoglou is a research coordinator at the WaterCentre. In his work at KTH he conducts research on the many relationships between water innovation and social processes in Sweden and internationally.

"Today's water systems are based on a centuries-old logic for water distribution and wastewater management. This logic implies highly centralized planning of water services that are now facing several challenges such as rapid urbanization, water scarcity, pollution, and climate change. Our current and often outdated systems are simply not able to handle all the conflicting demands. And since they are operating on a large scale, they can be hard and costly to change. It's a failing logic in many parts of the world, including Sweden".

Timos finds that there is a lot of unexplored potential around small-scale solutions with more diverse user involvement in planning water services. This implies embracing solutions that are based on a different logic. Ongoing research suggests that these solutions can be less costly and better adapted to local conditions, hence delivering higher social impact.

Timos Karpouzoglou
Research coordinator,
KTH WaterCentre

"A good example is SEQWENS, a cross KTH research project, led by the WaterCentre, where we assess the possibilities for property owners to reduce their energy consumption by installing on-property heat recovery technologies for recovering heat from wastewater", says Timos.

The users in this project quickly realised their own vital role as producers of important services,

helping in their own way to meet climate goals in the property sector. "Another example of these new small-scale systems is a recent development in Aspvik, in the Municipality of Värmdö. Many Värmdö residents tend to not have access to the municipal water and sewage network, which in many cases is a cause of great frustration. So, rather than waiting for the municipality to decide on the issue, the Aspvik residents, with the help of a local entrepreneur got every single household to invest in organizing, digging and laying the pipes and other needed infrastructure."

"Our current systems are simply not able to handle the new demands. And they are so large that they are very hard and costly to change."

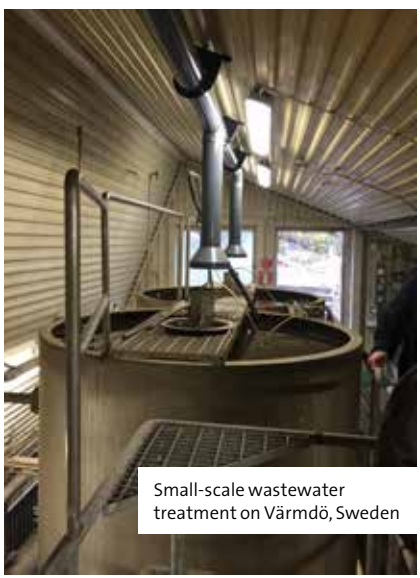
Research in rapidly-urbanizing regions in India, Kenya and Uganda also suggest that small-scale local innovations can contribute to system-level change in a way that is more equitable than traditional large-scale infrastructure solutions.

In many parts of the world, what we define as 'formal water regimes' represent only part of the water supply picture. So called 'informal water regimes' are fulfilling very important functions, particularly in low-income and climatically vulnerable neighborhoods. It is therefore interesting to look at the relationships between formal vs informal and large vs small. Other KTH projects that Timos has been involved in have looked at the interaction between formal and informal water regimes through conflict and cooperation.

"The WaterCentre plays an important role in linking the research with the stakeholders", says Timos. "As a technical university, KTH has brought in new water innovations from emerging fields such as nanotechnology, material science and ICT. But to ensure that it's not only about the tech and performance, we need to look at these new small-scale solutions in terms of social impact to see what new pathways we can create".

Read more at:
www.kth.se/water/research/decentralised

Interviewing water consumers in Nairobi, Kenya



Small-scale wastewater treatment on Värmdö, Sweden

Photos: Timos Karpouzoglou

A rapid response to COVID-19

One of the fundamental goals of KTH is to be useful to society. And at the onset of the COVID-19 pandemic, an opportunity presented itself to put the research platform at the WaterCentre@KTH to good use in helping tackle the challenge of tracking the coronavirus in Stockholm.

The spread of the novel coronavirus in Stockholm is being monitored via wastewater samples from treatment plants by a research group at KTH, in cooperation with SciLifeLab, Stockholm's Water and Wastewater authority and Värmdö municipality. At the beginning of September, Zeynep Cetecioglu Gurol, associate professor at the department of Chemical Engineering at KTH and in charge of the project, shared these reflections with us.

"I was home sick and read a paper from a Dutch research group who had started tracking the coronavirus in wastewater. And when I woke up the day after, a colleague of mine had sent me an e-mail asking if we couldn't do this as well. After that we kind of jumped at the chance, and before long we had a whole group of people volunteering to work on this challenge. None of us had the right background or any real experience in the subject, but we had the right platform in the form of the WaterCentre. It gave us a flying start."

Zeynep and her colleagues have now developed protocols for preparing the samples and measuring the amount of COVID-19 RNA in them to be able to link the readings to estimates of how many in the population are infected. "We quickly got a really nice curve and we will be publishing our results in the weeks to come. We need more time to evaluate our findings, but I can already tell you that in July we could no longer detect any viruses in the wastewater from the three plants we received samples from. We then focused on monitoring a potential second wave and during week 35, the level of coronavirus RNA detected returned to much higher levels."

The idea to use wastewater monitoring as a low-cost early-warning system has now spread and sparked cooperation between researchers across Europe. "We have collaborated with research groups from the Netherlands for method optimization, as well as groups in Italy and Spain for sample collection", says Zeynep.

Read more about the project: kth.se/water/research/covid-1.979048

"None of us had the right background or any real experience of the subject, but we had the right platform in the form of the WaterCentre."

Zeynep Cetecioglu Gurol
Associate professor, Chemical Engineering at KTH

Photo: Fredrik Persson

The variety of KTH water research in cooperation with partners

PELAGO innovation for sustainable coastal development

Sweden's coastline is a staggering 48,000 km when all islands are included. This brings fantastic opportunities and quality of life. But also challenges, like depletion of groundwater, disturbance of sensitive ecosystems and difficult geo-physical conditions for infrastructure. In PELAGO we have partnered with Värmdö municipality, the largest private land owner Skärgårdsstiftelsen and the consultancy firm Ecoloop to develop a new innovation model. Together, we create solutions in coastal areas around for example rainwater harvesting, circular water use and on-site sanitation facilities.

Read more on : www.pelago.nu/

Young water scientists who wants to save the world

Every year Stockholm Junior Water Prize is awarded by Stockholm International Water Institute (SIWI) to high school students from across the world. KTH has partnered with SIWI to help these imaginative young scientists to take one step further and put their ideas into practice. Finalists from 35 countries have visited KTH and learnt about innovation management and entrepreneurship from our start-up coaches and senior researchers. With these young and creative people there is hope for a wiser water future.

Check out the video and photo story on: www.kth.se/blogs/water/2019/08/

A membrane-free approach to water filtration

Photo: Joydeep Dutta

Capacitive deionization (CDI) is an intelligent approach for the design of energy efficient water filtration technologies. Water filters using CDI essentially work by harnessing a source of energy to remove ions of salt from water.

One amongst several promising applications of CDI is in water desalination. The low energy demand involved in CDI compared to traditional desalination methods, means that small-mobile water filtration units can be easily developed and utilized in remote areas using solar power. The CDI technology is today commercialised through a KTH start-up company called Stockholm Water Technology AB.

Company webpage: stockholmwater.com/

Turning wastewater into a resource

Lack of fresh water is a growing problem in many parts of the world. At the experimental treatment plant Hammarby Sjöstadsverk new techniques are developed that will make it possible to turn treated wastewater into nutrients, energy and water.

The facility is co-owned by KTH and IVL Swedish Environmental Research Institute. It is used for both long-term national and international research programs/projects and consultancy, testing and development for the industry and other partners.

Read more on: sjostad.ivl.se

Managing arsenic and flouride in drinking water

Several regions in the world face problems of elevated concentrations of arsenic and fluoride in groundwater. Both these contaminants are found naturally in the ground and pose serious health problems including dental, skeletal fluorosis and cancer.

Researchers at KTH are working in Bangladesh, Bolivia, and Tanzania to provide solutions in collaboration with local entrepreneurs, communities and scientists, as well as with global actors like UNICEF and Sida. We combine scientific approaches including cutting-edge geospatial analysis, scientifically validating indigenous knowledge and use of local material for ensuring access to safe water.

Our scientifically robust sediment colour tool helps drillers to find safe water aquifers. Currently we are developing a digital tool as well as low-cost treatment methods for safe water.

Read more on: www.kth.se/water/research/decentralised

The art of smarter water infrastructure management

Managing municipal infrastructure for water and sewage can be a balancing act. Should you spend a lot of money on inspections and maintenance or simply wait until something brakes and then repair it? And what happens if it breaks, when millions of people depend on these services every day? A new research project aims to give infrastructure owners better decision support strategies.

Mistra InfraMaint is a research programme where researchers and municipalities together develop tools for decision support, better processes and smarter municipal organization. Roya Meydani is a doctoral student at KTH within the programme. Together with Stockholm Water and Waste Company (SVOA) she is working on a decision model for planning maintenance based on actual, measurable data. The aim is to not just assess the condition of this vital infrastructure, taking into account the uncertainties in the measurements.

"We need to look at economic, social and environmental consequences collectively and come to a decision that works for all stakeholders"

It is also to evaluate the consequences of different decisions.

"As a maintenance manager, you are presented with a lot of options, and your decisions have a direct effect on the health and prosperity of entire communities. Because when the water and wastewater infrastructure crashes, society as we know it comes to a stop", says Roya. "My model will be able to help decide which option to choose. And not only from a strictly functional perspective. We need to look at economic, social and environmental consequences collectively and come to a decision that works for all stakeholders. The issue

Roya Meydani
Doctoral student at KTH
within Mistra InfraMaint

is not a lack of data. In Stockholm, we have gathered data since 1986 from more than 8000 sensors. The problem is that we don't have the means to use the data. Today we don't really know how it should be incorporated into a condition assessment tool, as a basis for decisions. This needs further work and perhaps technologies such as machine learning could help here".

Tommy Giertz is a Strategic Analyst at SVOA and cooperates with Roya on the project: "There's this thought that maintenance is about discovering faults before they occur, and that this will help you plan replacements and repairs more accurately and increase our efficiency. But this requires more than just new technology. We need a new way of thinking and to convince management to allocate more money into searching for faults. And that requires a change of mindsets".

Read more about the project: mistrainframaint.se

Tommy Giertz
Strategic Analyst at SVOA

Photo: Daniel Roos

WaterCentre in a nutshell

The Centre started in 2017 thanks to an initial investment by the KTH President of 10 million SEK. Today our portfolio of 14 project totals 128 million for KTH and partners. The Centre is hosted by the School of Architecture and Built Environment but operates across all five schools at KTH.

In 2020 there were 22 staff directly involved in the operations, corresponding to about 8 full time staff. Of course we reach out to many more people through our research, collaboration and communication, both within and outside our university.

Our Board consists of six members, representing three schools at KTH and one member from the City of Stockholm, a strategic partner of KTH.

To meet the water challenges in new and unexpected ways we have strived for recombination of knowledge areas. During 2017-2020 we focused our efforts in four cross-cutting thematic cluster areas:

- Digitalisation
- Decentralised solutions
- Circular water management
- Marine science and innovation

The thematic areas have been coordinated by our Cluster Leaders, all excellent researchers at KTH found in diverse areas such as environmental sciences, chemical engineering, applied physics and computer science.

Since its founding as Teknologiska Institutet in 1827, KTH has always been keen on making a real difference in society. Our biggest impact is probably the many thousands of engineers we have educated over the years. But we are always looking for new ways to contribute to better knowledge and a more sustainable society. Working close to partners in society, and jointly taking on the challenges of today and tomorrow, remains important for us. This ambition is at the very heart of WaterCentre@KTH, now and in the years to come.

Read more on: www.kth.se/water

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A sea of opportunities

In this report we have shared some highlights of how we at KTH, along with our partners, have worked to achieve water collaboration and innovative research over the past four years.

It has been rewarding, innovative and fun. Yet, this was just a small part of the journey. Water has always been an essential part of our teaching, research and societal collaboration at KTH. Water engineering was introduced as a subject already in 1858 at our predecessor Teknologiska Institutet in Stockholm. As we look to the future, there are many challenges, but also opportunities. KTH will continue being an active water player, locally and globally.

To succeed we need to work in partnership with others. Come and join us in the water!

Annika Stensson Trigell
Vice President for research

Visit us:
kth.se/water