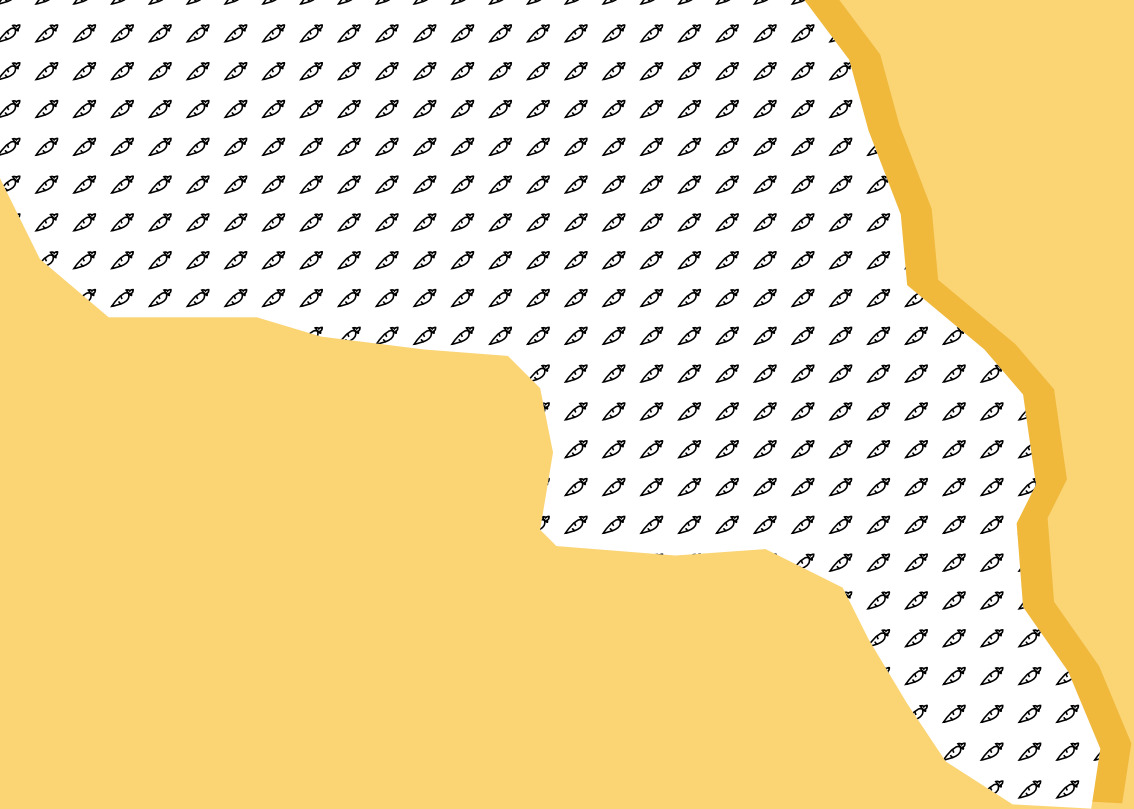
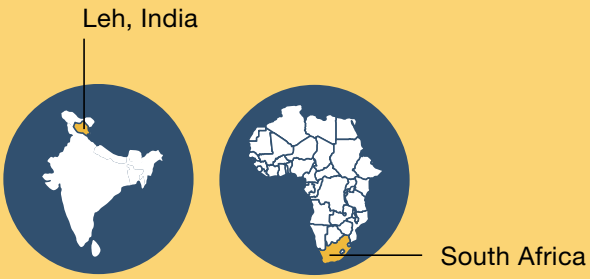


Link
www.cee.ed.tum.de/en/sww/home/ www.nexus.wasser.tum.de

A Long-Term **Ménage à Trois**

Connecting water, energy and food to save the world – that's the mission undertaken by an international research initiative focusing on the Water-Energy-Food (WEF) Nexus. Its researchers are developing alternative solutions to the consumption of natural resources in large and small cities and their surroundings around the world.



Gesamter Artikel (PDF, DE): www.tum.de/faszination-forschung-30

Langfristige Ménage-à-trois

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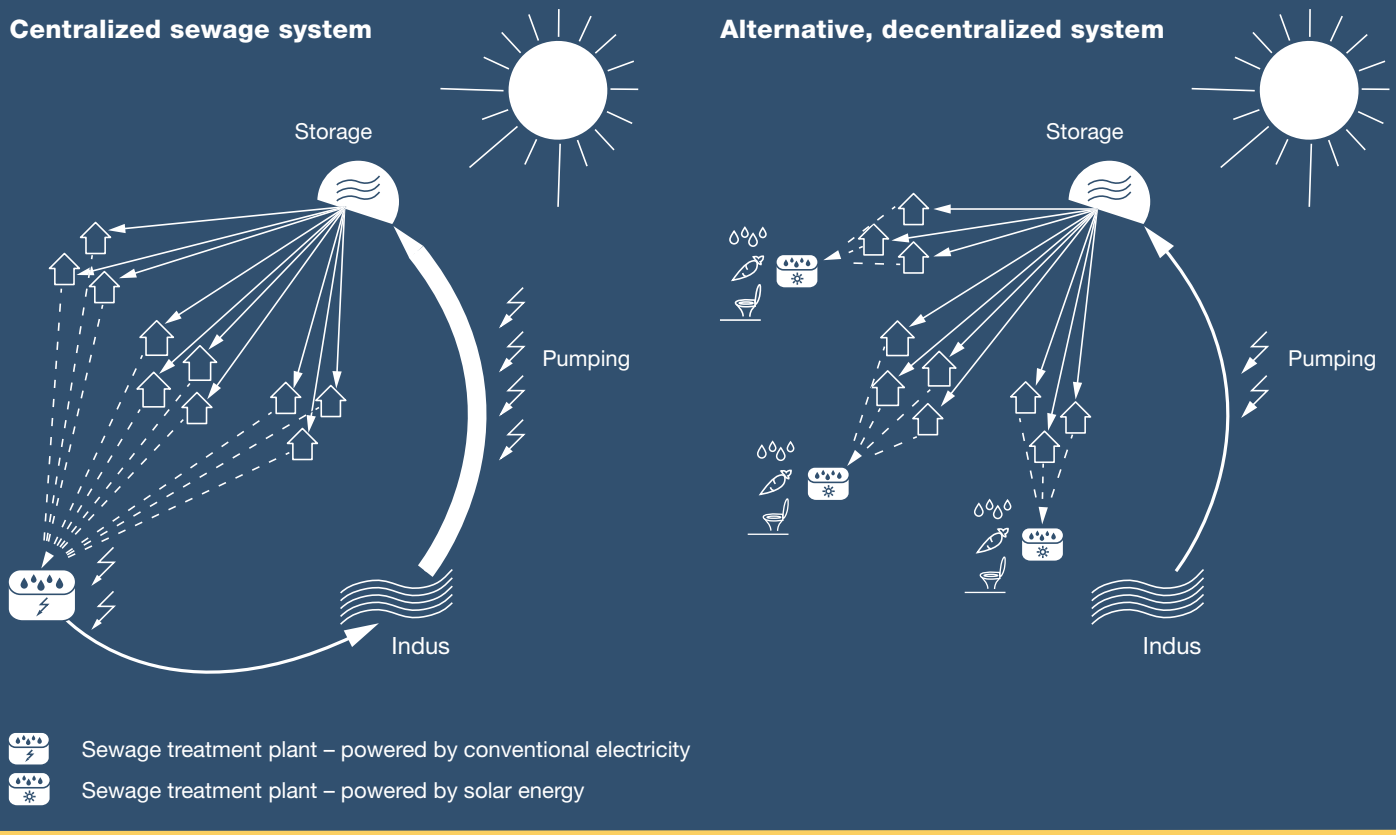
Wasser, Energie und Nahrung: An alternativen Lösungen für den Verbrauch dieser Ressourcen in großen und kleinen Städten forschen Prof. Jörg Drewes und Dr. Daphne Keilmann-Gondhalekar. Etwa für die kleine Stadt Leh im indischen Himalaya, die an Wassermangel leidet. Hier entwickeln sie ein dezentrales System zur Wasserwiederverwendung, das die Stadt unabhängiger von externen und weit entfernten Wasserquellen machen könnte. □

Graphics: ediundsepp



A concept for a decentralized wastewater system developed with the residents of the city of Leh. The water is reused locally, such as to cultivate vegetables or flush toilets. This type of system would reduce demand for fresh water, cut the waste stream, save energy and help to grow food locally.

A morning shower followed by brushing your teeth, turning on the radio and making a coffee. Sound familiar? This morning routine, which many of us take for granted, is actually a significant organizational effort – especially in major cities. Particular complications include the rising demand for natural resources like water, energy and food, which is caused in part by a further complication: the consequences of climate change. In Los Angeles, for example, high temperatures drive up energy consumption due to increased use of air-conditioning systems in buildings. Glacial melting in the Swiss Alps is reducing water supplies, meaning that water has to be sourced from elsewhere. These are just two of many examples of the impacts of climate change. Against this backdrop, it is essential that we bring our consumption of resources down to a sustainable level.

But how can we achieve this? While this ultimately means consuming less, we can also promote integrated planning of three closely connected sectors: water, energy and food. Agriculture and energy production facilities both require water. Transporting water and food also requires energy. Integrating plans for supplying these resources can generate synergies. Or, to put it differently: if water, energy and food were engaged in a ménage à trois, they would be equal partners who support and rely on each other – and communicate effectively to maintain a functioning and optimal relationship.

However, consideration of the interrelationships between these resources has barely penetrated teaching and research, and practice even less so. “We need a circular perspective rather than a linear one,” underscores Prof. Jörg Drewes, who heads the Chair of Urban Water Systems Engineering at TUM. Since 2017, the Chair has been home to the Urban Water-Energy-Food Nexus research group, led by Dr. Daphne Keilmann-Gondhalekar. Together, they initiated the Nexus@TUM research and teaching agenda in 2021.

"We need a circular perspective on water, energy and food rather than a linear one."

Jörg E. Drewes

Using a small city in the Himalayas as a model for sustainable resource management

Drewes, Keilmann-Gondhalekar and their team have already completed several pilot projects, including in India and Niger, but also in Bavaria. Their interest is in regions where natural resources are scarce and there is a need for novel solutions usually not yet financed by the public purse. One example is Leh, a city in the Indian Himalayas, surrounded by desert. Over recent decades, the city has experienced exponential growth, driven by tourism, and is now grappling with limited water resources. Drewes, Keilmann-Gondhalekar and their team have been working in the area for over a decade. Conventional concepts developed and financed externally – such as a time-consuming, expensive plan to install a pipeline to pump water to Leh – have not yet yielded the desired results. The Nexus researchers have recorded and measured demand for water and spoken with many local residents. They agree that, rather than transporting water to the city from elsewhere, a better option would be to capture, treat and reuse the wastewater generated in Leh. Every hotel, guesthouse and household could feed their used water into a decentralized system so that it could be used, for example, to irrigate fields and serve as fertilizer. This type of system would reduce demand for fresh water, cut the waste stream, save energy and help to grow food locally. It would also give the city greater independence than having to rely on (and pay for) water to be transported from elsewhere. "This example shows the need for new concepts that are developed, implemented and financed together with local people," comments Dr. Keilmann-Gondhalekar.

Leh has also afforded Keilmann-Gondhalekar another vital insight: "We need new computational models to calculate potential demand," she says. "The most affordable solution in the short term is usually not the most affordable in the long term." For instance, it may cost more to build a decentralized water system than a centralized one. Conventional calculation methods, however, usually fail to take into account the sharply rising value of water. Consequently, the researchers have turned to multi-criteria decision-making analysis. This is a decision-making method that affords equal weight to various criteria that are not easy to compare or quantify. ▷

Graphics: ediundsepp (source: TUM)

"The Indian city of Leh is an example showing the need for new concepts that are developed, implemented and financed together with local people."

Daphne Keilmann-Gondhalekar

Time to turn words into action

In South Africa, Drewes' team is currently developing concepts for informal settlements – more commonly known as slums. In these areas, electricity, water and adequate sanitary facilities are all in short supply, with local people unable to establish farming fields and produce food. Streams and rivers are contaminated with waste, which leads to health problems. These problems are linked and can exacerbate each other in a downward spiral.

In this project, like in their other research, the scientists gather information and record demand for water, energy and food, while students write papers on potential solutions – such as using renewable energy sources like wind, solar and biomass, producing biogas from waste, and capturing rainwater. "The latter is something we don't even do in a modern city like Munich," says Drewes. "There are plenty of ideas and we already have some solutions but, unfortunately, we aren't implementing them." Keilmann-Gondhalekar adds: "We urgently need to act." This is why Nexus@TUM goes far beyond examining technical aspects. It aims to motivate people, create acceptance, highlight transformation pathways, win the support of various stakeholders (including governments), teach environmental engineers the importance of Nexus approaches – and much more besides. Consequently, Nexus@TUM also relies on input from researchers in the social and political sciences. "Our research is made meaningful by adopting an interdisciplinary approach. Implementation will only succeed if we work together with local people in a long-term, transdisciplinary approach that is built on trust," says Drewes. ■ *Gitta Rohling*

Get involved!

Nexus@TUM welcomes researchers from all disciplines. For more information, visit: www.nexus.wasser.tum.de

Picture credit: Astrid Eckert/TUM; Graphics: ediundsepp

Prof. Jörg E. Drewes

has led the Chair of Urban Water Systems Engineering at TUM, along with the associated research center, since 2013. Before taking up his position at TUM, he was a Full Professor at the Colorado School of Mines, USA and Director of Research at the NSF Engineering Research Center on Reinventing the Nation's Urban Water Infrastructure. He is a member of the German Advisory Council on Global Change (WBGU) and Co-Chair of the Drinking Water Commission at the German Federal Ministry of Health.

Dr. Daphne Keilmann-Gondhalekar

is an urban planner and leader of the Nexus research group at the Chair of Urban Water Systems Engineering at TUM, concentrating on integrated urban planning, the urban Water-Energy-Food Nexus and multi-stakeholder processes. She received her doctorate from the University of Tokyo and was a Postdoctoral Associate at the Massachusetts Institute of Technology (MIT).