Funded by
DFG Deutsche Forschungsgemeinschaft
German Research Foundation

Königshafen Submarine Groundwater Discharge Network (KiSNet)

Mallast, U.[1], Waska, H. [2], Moosdorf, N.[3,4]

[1] *Helmholtz Centre for Environmental Research (UFZ)* [2] *University of Oldenburg* [3] *Leibniz Centre for Tropical Marine Research (ZMT)* [4] *University of Kiel*

1. The Challenge

Submarine groundwater discharge (SGD) as a pathway for water and chemical constituents between land and ocean is a rather young topic. For a long time it has been neglected by the scientific community and coastal managers. However, it has increasingly attracted attention since the turn of the millennium (Fig. 1). Yet, SGD is mostly investigated either by terrestrial or marine disciplines although a broader, interdisciplinary approach would benefit SGD research. Moreover, so far reported SGD flux data at local to regional scales are a) hardly comparable: To our best knowledge, only a few, mostly isolated studies directly compared available SGD methods in a quantitative fashion. Furthermore, flux data contain large uncertainties, either because they were up-scaled from local discrete (point) measurements to regional scales or because they were derived from of regional or even global budgets/models despite the known high spatial and temporal variability.

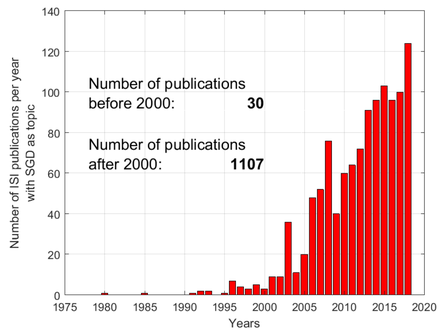

Fig. 1 Number of publications concerning SGD listed in ISI Web of Science per year. The total number of shown publications is 1137 (www.webofknowledge.com – accessed on 13.03.2019).

2. The Aims

In order to pave the way for a more standardized and interdisciplinary SGD research that would reduce inherited measurement/ extrapolation uncertainties, the Königshafen Submarine Groundwater Discharge Network (KiSNet) seeks to contribute through three concrete aims:

1. forming an interdisciplinary group of SGD experts to initiate and intensify collaborative ties across disciplines
2. improving individual methodologies by ground-truthing through interdisciplinary intercomparison, which includes a focus on spatial and temporal variability, and
3. providing a method catalogue which outlines optimal combinations for qualitative and quantitative SGD investigations that may serve as basis for future standardized SGD research.

3. The KiSNet-work

The core of the network that started on 01. February 2020 consists of 20 persons from 9 different institutions. Its strength however is the diversity of the disciplinary background of all network members paired with their SGD expertise, long-term experience, their commitment and the fact that the network already proved to be work-effective during previous DFG roundtables and joint publications/conferences even across disciplines.

The already existing network expertise will be complemented by leading scientists in the field of SGD. These scientists likewise embody the idea of interdisciplinarity to contribute and further develop the SGD topic. All will be invited to the planned meetings/experiments to discuss ideas and discuss results and further procedures. Since the network idea is prevailing, we are open for further scientists who would like to join our network and contribute to our aims and the experiment with promising and new methods.

To reach the abovementioned aims, the network will be established around an intercomparison experiment (see section 4). Before and after the experiment, we will conduct a “kick-off” and a “result-meeting” respectively. Both serve to foster the already existing network created during previous DFG roundtables, and to allow for further interdisciplinary expansion.

4. The Experiment

To reach these aims, the network is established around an intercomparison experiment that uses an unprecedented width of qualitative and quantitative methods to characterize SGD at one spot and at the same time.

Qualitative large scale mapping: **Thermal infrared remote sensing** (UAV-based), terrestrial (e.g. geoelectrics, ground-penetrating radar) and marine **geophysics** (e.g. multibeam echo sounder, ERT)

Qualitative small scale mapping: **Biological indicators** such as macrobenthos (all taxa of plants, invertebrates, small fish, and algae) including their spatial abundance/distribution per taxa and **socio-scientific approaches** to identify stakeholder knowledge on SGD

Quantitative small scale methods: **seepage meters** directly measure SGD fluxes, **temperature rods** use heat as tracer and yield an integrated vertical (advective) flux, **natural tracers** (e.g. radium, radon, dissolved silica, methane, dissolved inorganic and organic carbon, water isotopes, etc.

Quantitative large scale methods: **Water column sampling using natural tracers** (radium, radon) at the outlet of the Königshafen bay will be carried out with high resolution during several tidal cycles, a **numerical groundwater flow model** integrates data obtained by qualitative (e.g. geophysics) and quantitative methods (seepage meter, natural tracers), a **transport model** will be applied to interpret and quantitatively analyse the measured pore water concentration profiles for the estimation of elemental fluxes (see natural tracers), a **numerical ocean model** will simulate the hydrodynamics within the Königshafen bay during high and low tides and thus helps to interpret the spatiotemporal distribution of natural tracers within the water column.

5. The Site

- Intertidal bay with only one outlet and no surface inflow (Fig. 2)
- Pre-knowledge exists from various fields such as morphological development and sedimentology, benthic biogeochemistry, distribution of biota and their relation to submarine groundwater discharge
- Several monitoring devices (observation wells, meteorological station, tidal station) exist and data are accessible
- A branch office of the Alfred-Wegner-Institute is located in the proximity (< 3 km) of Königshafen whose infrastructure and equipment (e.g. vessel Mya II for pursuing natural tracer measurements – see above) we will be able to use during the intercomparison experiment

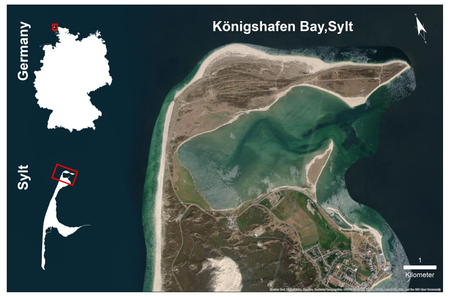

Fig. 2 Overview of the bay of Königshafen on Sylt, Germany, in which the tidal structures and the outlet are clearly visible

6. The Outcome

First, a method intercomparison experiment and meetings before and after the experiment will bring together young and experienced scientists from all SGD-relevant marine and terrestrial disciplines. Not only will the mixture of disciplines and level of experiences help to broaden SGD knowledge for all network members, it will also confront the next generation of SGD researchers with an interdisciplinary view of SGD. To distribute the gained knowledge including the interdisciplinary view, the network seeks to establish a close link and active exchange with national initiatives (e.g. DFG Research Training Group “Baltic TRANSCOAST”, MWK research project “BIME”). Through the aforementioned exchange and link to existing initiatives, the network will set the foundation for future interdisciplinary SGD research. Second, the method intercomparison experiment will create data sets that are unique in their interdisciplinary nature. The data sets and resulting analysis will be published in international peer-reviewed and open-access journals.

CONTACTS:

Ulf Mallast
Helmholtz Centre for Environmental Research (UFZ)
Department Catchment Hydrology
ulf.mallast@ufz.de

Hannelore Waska
Institute for Chemistry and Biology of the Marine Environment (ICBM)
University of Oldenburg
hannelore.waska@uol.de

Nils Moosdorf
Leibniz Centre for Tropical Marine Research (ZMT)
nils.moosdorf@leibniz-zmt.de