

SeaLevel Newsletter

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Welcome to the SPP-1889 SeaLevel Newsletter!

Despite the prolonged, hot summer in Germany, it has been an equally busy, active and dynamic period for the SPP SeaLevel community, with new results, workshops and conferences, fieldwork surveys and various other activities.

In this issue learn about: a modern approach to unravel long-term characteristics of North Sea storm floods by studying salt-marsh development and anthropogenic pollution and combining stratigraphy and climate modelling; about the new version of STAR retracker and how it improves the quality of altimetry-derived sea surface heights in coastal areas; the new findings from the latest expedition in 79 North Glacier in Greenland, ever being reached by ship only since 2016!

Moreover, find out about the ecosystem services approach in sustainable corporate groundwater management as a learning, communication and cooperation tool for stakeholders; the outcomes of experts meeting on groundwater salinisation at north western coastal Germany, including its

OGreen79: An expedition with R/V *Polarstern* to the 79 North Glacier

Janin Schaffer, Alfred Wegener Institute, Helmholtz Centre for Polar and Marine Research

In our recent study (Mayer *et al.*, 2018), published in Nature Communications, we show that an increased ocean heat flux is responsible for the observed thinning at Nioghalvfjærdsfjorden Glacier (also referred to as 79 North Glacier). But what are the processes driving oceanic heat to the marine-terminating glaciers in Northeast Greenland? In the project OGreen79 we aim to assess the mechanisms transporting heat from Fram Strait across the continental shelf off Northeast Greenland to the 79 North Glacier. For this purpose, we run

INSIDE THIS ISSUE

Welcome to the 3rd SeaLevel Newsletter.....	1
Expedition with R/V <i>Polarstern</i> to the 79 North Glacier... 1	
Mainstreaming ecosystem services in sustainable corporate groundwater management	2
Recent SPP publications	3
Unravelling long-term characteristics of North Sea storm floods combining stratigraphy and climate modelling	4
Improving Altimetry derived Sea Surface Heights.....	5
First Expert Meeting on Groundwater Salinisation.....	6
Training course for Indonesian scientists from BIG at GFZ Potsdam.....	6
Other past events and awards.....	7
Future Events related to sea-level research.....	9

drivers, future scenarios and how to increase resilience; about our SPP experts on tide gauge and altimetry data transferring knowledge and providing training to Indonesian scientists, and many more recent events, collaborations, achievements and new SPP publications!

Feel free to get in touch if you wish to subscribe to the Newsletter or have any comments or questions about the SPP SeaLevel.

Enjoy reading and thank you for your interest in the SeaLevel program!



Fig. 1: R/V *Polarstern* at the coast in NE Greenland in July 2018 (©Wilken-Jon von Appen).

high-resolution sea ice-ocean models, but we also installed moorings in the relevant gateways between the 79 North Glacier and Fram Strait to measure current speeds, temperatures, and salinities.

Before 2016, no ship has ever reached the calving front of the 79 North Glacier due to an extensive perennial fast-ice cover. Only recently the ice cover breaks up in summer more regularly. In August 2016, we reached the glacier with the icebreaker R/V *Polarstern* for the first time. We were fascinated by the beautiful scenery, but also by the data we collected. We observed waters warmer than 1°C to flush into the subglacial cavity beneath the 80 km long glacier tongue with speeds up to 40 cm/s. Such a strong inflow of warm water can be expected to cause high melt rates at the glacier base.

To gain a better understanding of the variability and origin of the oceanic heat we installed an ensemble of moorings. Current meters and instruments to measure temperature and salinity are attached to a mooring line anchored to the seafloor and can record data over several years. However, to download the data, we needed to recover the moorings! While we recovered most moorings successfully in late summer 2017, there were still 8 moorings in the water that we planned to recover this year as part of the R/V *Polarstern* expedition PS114. The fast-ice cover only started slowly to break up when we reached the area and unfortunately lots of fast ice blocked the way toward the glacier. Still, we managed to recover 7 of these 8 moorings, which is a great success!

SALTSA: Mainstreaming ecosystem services in sustainable corporate groundwater management

Leena Karrasch, University of Oldenburg

Many ecosystems are threatened by overuse and, in particularly, groundwater-dependent ecosystems are seriously affected by societies due to land conversion or drainage of wetlands, infrastructure development, and pollution of groundwater resources. A gap exists on the implementation of an ecosystem services approach in management and decision-making strategies to make groundwater management

The measurements will help us to gain a better understanding of the relevant processes governing the heat supply toward the 79 North Glacier which is draining the Northeast Greenland Ice Stream. Any changes in the heat flux may further increase melting at the glacier base and destabilize the glacier tongue in the near future. In turn, an increased mass loss from the Northeast Greenland Ice Stream would contribute significantly to sea level rise.



Fig. 2: Fast-ice in front of the calving front of the 79 North Glacier (©Janin Schaffer).



Fig. 3: A released mooring floating in the water before getting on deck (©Carina Engicht).

References: Mayer, C. , J. Schaffer, T. Hattermann, D. Floricioiu, L. Krieger, P.A. Dodd, T. Kanzow, C. Licciulli, and C. Schannwell (2018), Large ice loss variability at Nioghalvfjærdsfjorden Glacier, Northeast-Greenland, *Nature Communications*, 9 (1), doi:10.1038/s41467-018-05180-x.

more sustainable, although the awareness and knowledge of groundwater-dependent ecosystem services is raising.

In her Master's thesis, Elisa Eva Schroettke carried out a case study to answer the question, how an ecosystem services approach can be implemented on a local scale in groundwater management of a water supply company to foster

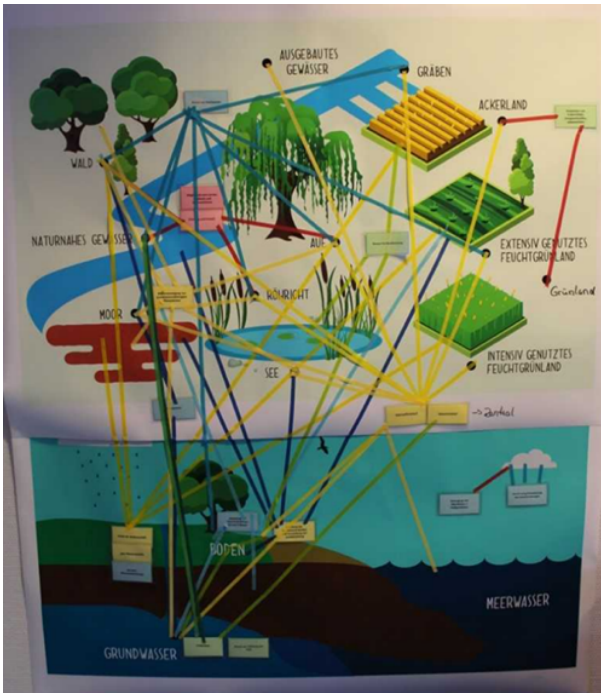


Fig. 4: The workshop participants linked groundwater-dependent ecosystem services with connected ecosystems.

sustainability. A workshop has been organized to examine the relationships of groundwater-dependent ecosystem services and ecosystems based on the institution's knowledge (Fig. 4). Additionally, it has been examined how an ecosystem services approach can be a successful tool within corporate groundwater management to enhance adaptive capacity of the institution as well as resilience of socio-ecological systems.

The results of the workshop show that an ecosystem services approach in corporate

sustainable groundwater management is promising for stakeholder participation processes as a learning, communication and cooperation tool (Fig. 5). The participants concluded that shared interests on ecosystem services enables the identification of strategic collaborations between different stakeholders, such as water managers, nature conservationists, local politicians and farmers. The introduced ecosystem services approach is seen as a potential part of the institution's sustainability framework. It helps to embed their groundwater protection measures into the socio-ecological system and to understand interlinkages between human activities and demand and supply of ecosystem services.

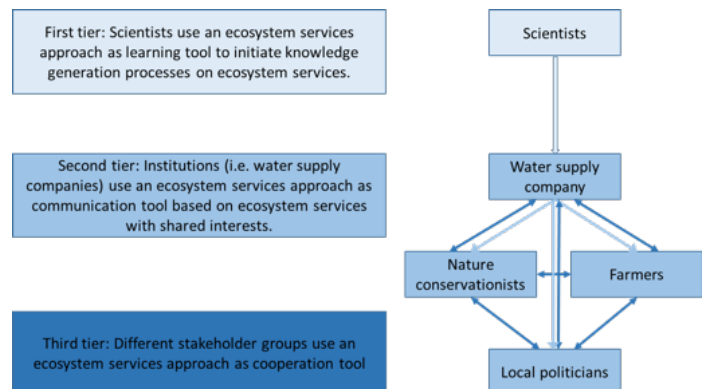


Fig. 5: Network building based on shared interests on ecosystem services. First, awareness of ecosystem services is raised. In a second step, the institution identifies affected stakeholder groups and use an ecosystem services approach as communication tool. In a third step, the stakeholder groups initiate a communication and cooperation processes on supply and demand of ecosystem services to support sustainable groundwater management.

Recent SPP SeaLevel Publications:

SEASCApe Baltic project: Hinkel, J., J.C.J.H. Aerts, S. Brown, J.A. Jiménez, D. Lincke, R.J. Nicholls, P. Scussolini, A. Sanchez-Arcilla, A. Vafeidis, and K.A. Addo (2018), The ability of societies to adapt to twenty-first century sea-level rise, *Nature Climate Change*, 8, 570-578, doi:10.1038/s41558-018-0176-z.

Merkens, J., and A.T. Vafeidis (2018), Using Information of Settlement Patterns to Improve the Spatial Distribution of Population in Coastal Impact Assessments, *Sustainability*, 10(9), 3170, doi:10.3390/su10093170.

OGreen79 project: Mayer, C., J. Schaffer, T. Hattermann, D. Floricioiu, L. Krieger, P.A. Dodd, T. Kanzow, C. Licciulli, and C. Schannwell (2018), Large ice loss variability at Nioghalvfjærdsfjorden Glacier, Northeast-Greenland, *Nature Communications*, 9 (1), doi:10.1038/s41467-018-05180-x.

OMCG project: Fenoglio L., S. Dinardo, B. Uebbing, C. Buchhaupt, J. Kusche, M. Becker (2018). Calibrating Cryosat-2 and Sentinel-3A sea surface heights along the German coast, IAG Proceeding, Springer, in review.

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SEASTORM: Unravelling long-term characteristics of North Sea storm floods combining stratigraphy and climate modelling

D. Bunzel¹, A. Lang², K. Müller-Navarra¹, G. Schmiedl¹, U. Mikolajewicz², S. Lindhorst¹, Y. Milker¹, C. Betzler¹, J. Jungclaus²

¹CEN - Institute of Geology, Uni HH, ²MPI Meteorology Hamburg

The SEASTORM project (Unravelling the signals of sea level and storminess of the past millennium; southern North Sea) combines proxy-data from coastal environments with results from modelling experiments. We have successfully established a comprehensive stratigraphic framework for active salt-marsh sediment successions of the south-eastern North Sea area. Further, modelling experiments have been employed to study the variability and associated large-scale climate forcing mechanisms of severe storm surges on different time scales.

To evaluate the salt-marsh development in the south-eastern North Sea coastal region during the past 150 years, sediment successions from four different active salt-marsh systems along a N-S transect of the coast have been analysed. The reconstruction of depositional changes requires a robust chronology, which then allows the correlation with other records. However, salt-marsh sediments from the highly dynamic North Sea coast often lack a unique stratigraphy, due to the different influences of natural processes, such as storm surges, and human activities, causing a reworking and redeposition of sediments.

Commonly, age-models for the past decades to centuries in coastal environments are mainly based on radionuclides, such as ²¹⁰Pb, ¹³⁷Cs, and ²⁴¹Am. Since these dating techniques are highly time-consuming, due to the long measurement time, we explored the application of other geochemical data series as time markers and used the intercorrelation between different successions for additional age control. Since zirconium (Zr) is known to be enriched in coarser sediments, while rubidium (Rb) is concentrated in the clay fraction, we specifically focus on the ln(Zr/Rb) ratios for relative changes in the sediment, assuming that similar changes occur at different sites at the same regions. Furthermore, high concentrations of the human-induced contaminant mercury (Hg) in the sediment were used to identify the time period of maximum

industrial pollution between AD 1960-1970. Our integrated approach in combining radionuclides, pollution markers, and geochemical proxy records provides a robust regional stratigraphic framework for salt-marsh deposits. This will allow to investigate coastal responses to changes in sea-level, storm surges, and human impacts in the frame of this project.

Furthermore, modelling experiments suggest that the recurrence interval of severe storm floods varies on different time scales, but their long-term variations do not show significant oscillatory modes and are decoupled from the background sea-level variations.

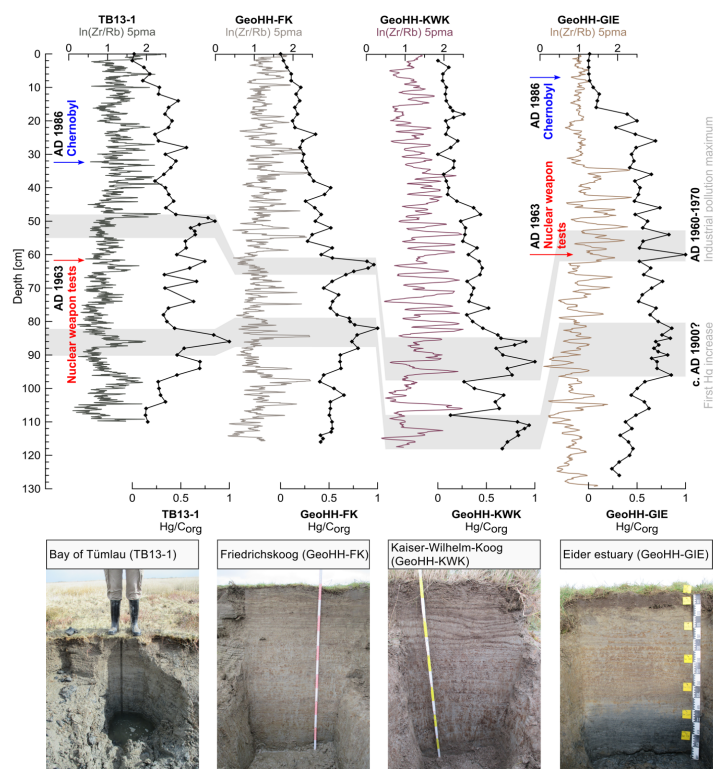


Fig. 6: Stratigraphic framework and correlation between the different salt-marsh profiles based on anthropogenic pollution markers and artificial radionuclides, such as mercury (Hg; grey), ¹³⁷Caesium (¹³⁷Cs; blue) and ²⁴¹Americium (²⁴¹Am; red), together with variations of the ln(Zr/Rb) ratios and the associated sediment successions of the different salt-marshes. 5pma denotes the 5-point moving average.

OMCG: Improving Altimetry derived Sea Surface Heights

Uebbing, B.¹, L. Fenoglio¹, J. Kusche¹, M. Willen², M. Horwath²; ¹University of Bonn, ²TU Dresden

Since 1993 it is possible to observe global sea level change with centimetre accuracy from various satellite radar altimetry missions. The altimetry instrument allows to derive sea surface heights (SSH) above a known reference surface and ultimately, sea level rise with 0.1 mm/year accuracy. In 2010, the Cryosat-2 (CS2) mission was launched which enables us to assess re-processing (“retracking”) approaches performed on PLRM mode against the more accurate SAR mode.

As part of the OMCG project, we had developed the Spatio-Temporal Altimetry Retracker (STAR, Roscher et al, 2017) which significantly enhanced the quality of the SSH in coastal areas. We further improved our STAR method and assessed the quality against high accuracy CS2-SAR data retracked with the SAMOSA+ coastal retracker (ESA’s GPOD service). In addition, we compared to other state of the art coastal retrackers, such as TALES (Fenoglio et al., 2018). With our new STAR version (V2) we estimate highly accurate PLRM-SSHs (Fig. 7) of similar quality as the GPOD-SAR SSHs, especially in coastal areas (Fig. 8). Our method can easily be transferred to other altimetry missions, thus providing significantly improved SSHs for past and contemporary missions.

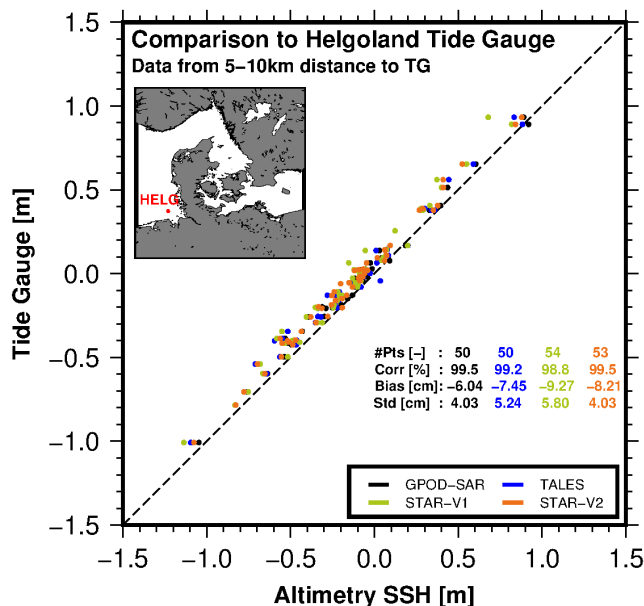


Fig. 7: Comparison of SSH from tide gauge collocated with GPS and CS2 coastal altimetry SAR-SAMOSA+ and PLRM-TALES and -STAR data.

References

- Fenoglio L., S. Dinardo, B. Uebbing, C. Buchhaupt, J. Kusche, M. Becker (2018). Calibrating Cryosat-2 and Sentinel-3A sea surface heights along the German coast, IAG Proceeding, Springer, in review
- Roscher, R., Uebbing, B., Kusche, J. (2017) STAR: Spatio-temporal altimeter waveform retracking using sparse representation and conditional random fields. Remote Sensing of Environment, 201, pp.148–164, doi.org/10.1016/j.rse.2017.07.024.

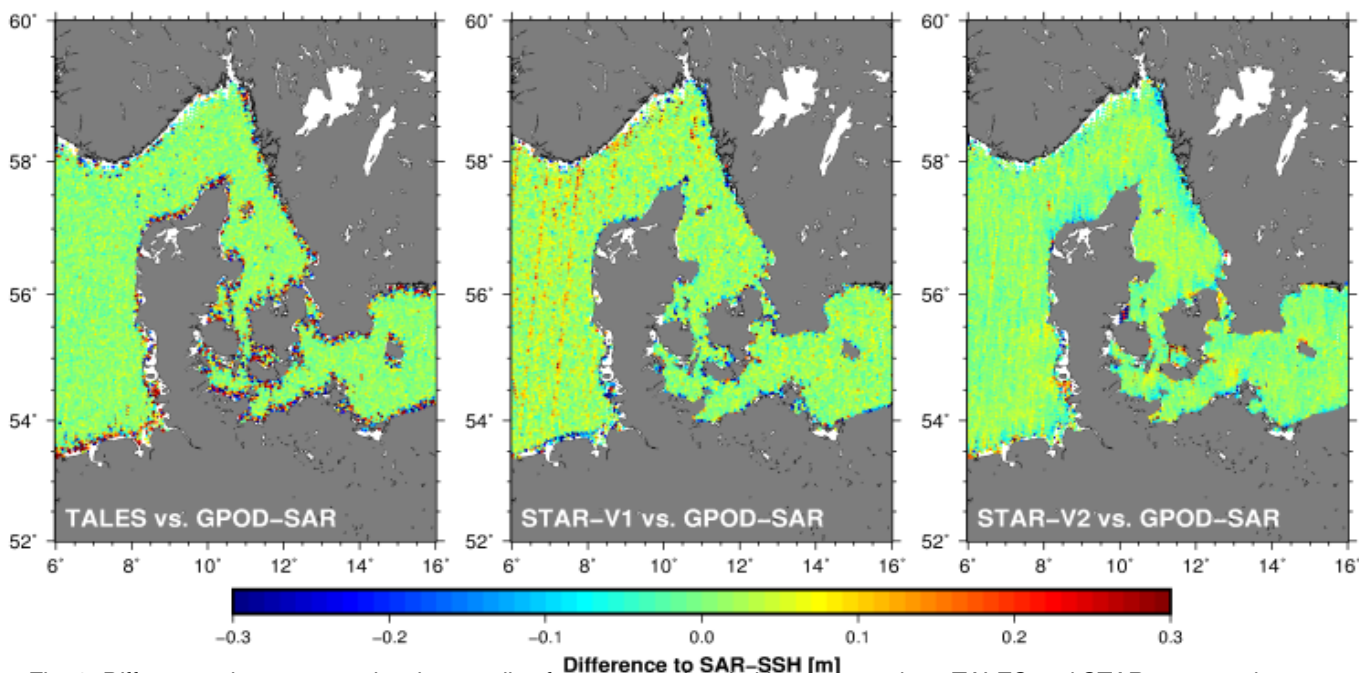


Fig. 8: Differences between sea level anomalies from conventional altimetry retrackers TALES and STAR compared to GPOD-SAR altimetry.

SALTSA: First Expert Meeting on Groundwater Salinisation

Leena Karrasch, Wencke Schubert, Janek Greskowiak, Gudrun Massmann, Bernd Siebenhüner, University of Oldenburg

In June 2018, the project SALTSA organised the first expert workshop on groundwater salinisation in Oldenburg. The consortium invited all experts that have been interviewed since the project started in 2017.

The purpose of this workshop was to kickstart an interactive discussion where the project team and 14 experts discussed the main drivers of groundwater salinisation and possible actions to deal with related problems in the coastal area of north western Germany.

The project team presented and explained the intermediate SALTSA project results and basic information from both strands, density dependent groundwater flow modelling and semi-structured interviews.

Throughout the workshop, participants were asked to think critically about the challenges facing groundwater salinisation in the project area. They had the opportunity to identify and evaluate drivers of groundwater salinisation within the project area, such as sea level rise, river dredging, water extraction rates or salt domes.

Additionally, physical framing conditions for the development of future scenarios have been co-designed with the participants. The scenarios will consider sea level rise, shifts in brackish-water zones of Ems and Weser estuaries, groundwater recharge and extraction rates as well as different groundwater levels.

In the end, the participants explored measures to deal with and increase the resilience to groundwater salinisation. Possible solutions are for example designation of water retention areas, adjustment of water extraction rates and sensible groundwater management.



Fig. 9: The participants of the Expert Meeting Groundwater Salinisation.

CoRSEA: Training course for Indonesian scientists from BIG at GFZ Potsdam

Julia Illigner¹, Tilo Schöne¹, ¹Helmholtz Centre Potsdam, German Research Centre for Geosciences (GFZ)

Between 25.06.2018 and 10.07.2018 three Indonesian scientists of BIG (Badan Informasi Geospasial) visited the GFZ in Potsdam for a sea-level training. BIG is a governmental agency and among other duties is responsible for the installation and operation of tide gauges in Indonesia.

After the tsunami in 2004, GFZ installed 10 tide gauges in Indonesia in the frame of GITEWS (German Indonesian Tsunami Early Warning System) and established a close cooperation





Fig. 9 and 10: Impressions from the training course at GFZ Potsdam.

with BIG. Although the tsunami project is finished by now, the cooperation remained. The close relationship paved the way to install 3 additional GFZ-tide-gauges for research of sea-level rise and subsidence which are now used in the CoRSEA SPP project

Since 2007, BIG installed 138 tide gauges all over Indonesia, and supports the tide gauges installed by GFZ and the University of Hawaii Sea Level Center. The topics of the training ranged from the installation of hardware and maintenance concepts, data transmission and tide gauge data quality control to tidal analysis and -modelling for tidal prediction.

With GFZ's in-house software package (ADS), which allows remote access via a web service,

Other Past Events:

3rd International EU COST-OceanGov Symposium (Ocean Governance for Sustainability: Challenges, Options and the Role of Science)

The 3rd International Symposium of the EU COST Action Ocean Governance for Sustainability: Challenges, Options and the Role of Science (chaired by Prof. Dr. Anna-Katharina Hornidge, EMERSA project), took place in Aveiro, Portugal in June. The symposium was attended by five thematic working groups of the network, and kicked off with two keynote addresses, i.e. regarding Portugal's new ocean governance model with a focus on developing

we trained analysing, modelling and prediction of tidal data and also altimetry data processing. Therefore, the main part of the training has been filled with its introduction and usage. During the two weeks, we analysed tide gauge time series from different tide gauges in Indonesia, in particular gauges from our regions of interest (Jakarta: cooperation with SPP-EMERSA and SPP-TRANSOCAP; Semarang: cooperation with SPP-TRANSOCAP; Jepara and Makassar: cooperation with SPP-SEASchange). Additionally, the training included a brief introduction in superconducting gravimetry and Satellite Laser Ranging.

Beside the lessons at GFZ we had a particularly informative and interesting visit at the "Bundesamt für Seeschifffahrt und Hydrographie" (BSH) (Dr. Müller-Navarra and colleagues of the group "Gezeiten, Wasserstandsvorhersage und Sturmflutwarndienst") in Hamburg. Especially Hamburg with its tidal range of roughly 4 meter and a wind induced water rise or fall of additional 4 meter is a challenge for precise prediction, which is crucial for shipping. The expertise of decades of precise water level prediction has been impressive to all of us and will help to improve the methods used at BIG as well as in GFZ.

After the visit of BSH we had time to present Hamburg's flood protection to our guests, about which we had visited and learned about earlier this year during our last SPP and ECS Meetings.



Fig. 11: The EU-Cost OceanGov Symposium was held in Aveiro, Portugal between 11-13 June 2018.

state marine innovation laboratories, and a talk delivered by Prof. Dr. Nilufer Oral (Istanbul Bilgi University, and Member of the UN International Law Commission) on the challenges of



Fig. 12: Impression from the „Land-Sea Interactions“ Working Group at the OceanGov Meeting.

establishing a global framework for conservation and sustainable use for oceanic Areas Beyond National Jurisdiction (ABNJ).

A special side-event, also hosted by A-K Hornidge (EMERSA), presented a recent publication in *Marine Policy* entitled “Un-gendering the ocean: Why women matter in ocean governance for sustainability”, which was followed by a lively debate among many of the symposium participants, particularly touching on the politics and practices of identity formation,

Well done to Lisa Bott (TRANSOCAP project) for best oral presentation at the ISLR18 Conference for Early Career Researchers!

The INQUA-PAGES Conference for Early-Career Researchers (ECRs) on “Impacts of sea-level rise from past to present (ISLR18)” aimed to facilitate scientific exchange between ECRs from a broad range of disciplines working with sea-level change. Our young scientist Lisa Michéle Bott from the TRANSOCAP project participated at the meeting and gave a talk on “Collective adaptation strategies towards floods and subsidence – the cases of Central Java & Jakarta, Indonesia” at the “Mitigation, adaptation and Coastal Impacts” session, winning the first prize as the best oral presentation of the conference. Well done Lisa!

Our colleague Alessio Rovere, Principal Investigator of the SEASchange project also participated at the meeting.

“The conference in total was very inspiring, highly international and was strongly physical science dominated. However, I was surprised to be the only speaker with a social science background. Thus, the focus of my presentation

knowledge production in the marine sciences, together with the interplay of differentiated forms of spatial and institutional access.

Moreover, Rapti Siriwardane (EMERSA project) will be leading a publication entitled “Bridging the marine-terrestrial divide: Epistemic translations along the coast”, also drawing from the EMERSA project insights derived from the Philippines and Indonesia within the context of riverine/freshwater and seashore/saltwater dyking. The joint publication – together with members from crosscutting working groups – aims at identifying and tracing a number of terrestrialising mindsets or paradigms within the context of coastal management. The paper will draw upon several thematic case studies. Apart from the design of shoreline defense mechanisms, the authors also intend on exploring knowledge flows/‘translations’ within the following contexts: spatial planning, disaster risk reduction practices (particularly urban flooding), and differentiated tenurial systems of reclaimed offshore land as opposed to coastal/grounded space.

Fig. 13: Lisa Bott was awarded for best oral presentation at the ISLR18 Conference for Early Career Researchers, in Utrecht.



was on providing information from the “human perspective” that could be interesting and relevant to physical science researchers and to show where social and natural science sea-level change researchers could collaborate. In this regard, the experience of collaborating with the SPP SeaLevel CORSEA project (Tilo Schöne and Julia Illigner) was very helpful.”, says Lisa.

The conference also included a day field excursion to the Rhine delta and Holland coastal plain, gaining experience on hand coring. “Very

interesting. I personally learned a lot more about sea level research, different methods, approaches, measurement technical and coastal processes. Background knowledge which for me as a geographer working with social science

methods is very helpful to put my results and research into context.”, Lisa notices. The INQUA-PAGES ISLR18 Conference was held between 26-29 August 2018 in Utrecht, the Netherlands

Future Events related to sea-level research:

CoastGIS 2018 Symposium, 27-29 September 2018, Westfjords, Iceland

ENSO Conference 2018, 16-18 October 2018, Guayaquil, Ecuador

JONSMOD conference on “Latest modelling techniques for shallow seas”, 17-19 October, 2018, Florence, Italy

The Baltic Sea Region- A Science Powerhouse, 26 November 2018, Brussels, Belgium

OTGA Training Course: Ocean Data Management for Researchers, 3-7 December 2018, Oostende, Belgium

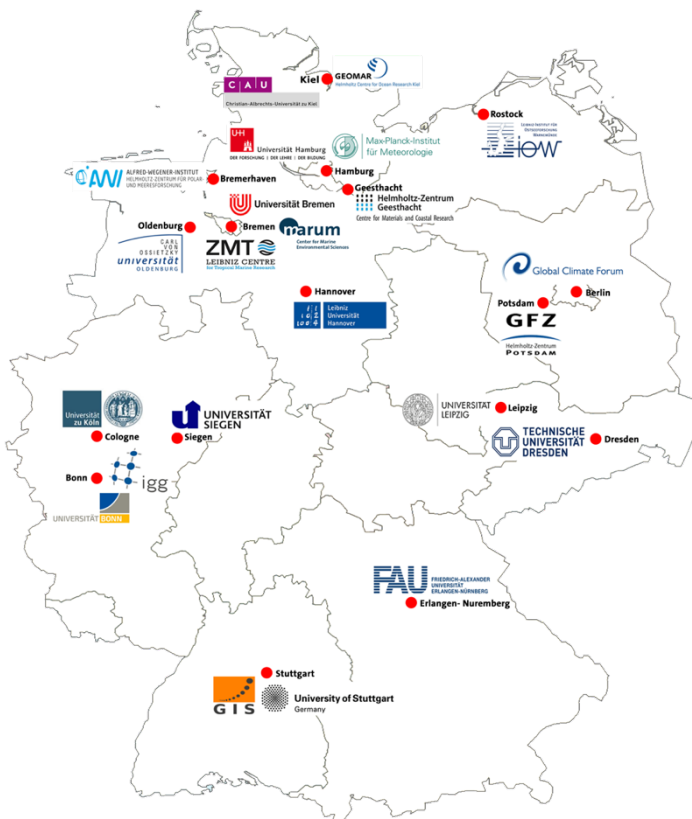
“Sea Level Change and Coastal Impacts and Flooding” Session at AGU Fall Meeting 2018, 26-29 August 2018, 10-14 December 2018, Washington, D.C., USA

Scenarios Forum 2019: Forum on Scenarios for Climate and Societal Futures, 11-13 March 2019, Denver, Colorado

European Space Agency Living Planet Symposium 2019, 13-19 May 2019, Milan, Italy

3rd International Conference on Coastal Cities and their Sustainable Future, 11-13 September 2019, Rome, Italy

The SPP SeaLevel Members



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