

HELMHOLTZ



# Geo.X

Status Report 2016 – 2018

Research Network for  
Geosciences in Berlin and Potsdam

Mid-term Review 2019

# **Geo.X Status Report**

Research Network for Geosciences in Berlin and Potsdam

Mid-Term-Review 2019

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## 1 Executive Summary

The Geo.X Research Network integrates and clusters geoscientific expertise in the metropolitan area of Berlin and Potsdam. Geo.X stands for cutting-edge research at the intersection of geoscience with other disciplines, where universities and extramural research institutions commit themselves to close cooperation in the areas of research, education, sharing joint infrastructure, internationalization, and knowledge transfer. The network spans the entire range of geoscientific disciplines across all spatial and temporal dimensions and capitalizes on the synergies and specific competence of its partnering institutions. This includes the high level of diversity of educational programs at our universities, expertise in integrated knowledge transfer and transformation into society provided by the Museum für Naturkunde and the IASS, as well as mentoring expertise and access to state-of-the-art research infrastructure provided by the Centers of the Helmholtz Association. The nine partners have committed to joint research in defined fields and developed shared governance and communication structures to exploit the full potential of the network.

Here we report on progress resulting from Geo.X actions achieved at the 40% mark of the project. We outline changes to the project in response to comments by the international committee of reviewers, summarize success, and, finally, we take a look ahead to the next three years and beyond.

The *Geo.X Young Academy* has been newly established with the cross-cutting topic *Geo.Data Science*. As the first generation of the Geo.X Young Academy, we have attracted a cohort of promising young researchers, who have designed their research projects and developed their own course curriculum; they are also represented in the highest operational management level for strategic decisions on Geo.X. The Young Academy includes a training program covering advanced data science, and initiatives for career development and scientific co-operation. As a result, some of our Young Academy alumni have already obtained high-level positions in academia and industry.

*Career development* plays a significant role in Geo.X. The network offers resources for all of the early career scientists of the Geo.X partners and provides a platform for communication and participation for all members. A longitudinal study is tracking career development of researchers in the Geo.X network and identifies obstacles to individual careers inside and outside of science.

*Seed funding initiatives* were established to stimulate cutting-edge, often across-discipline research within the Geo.X community, providing support for developing applications to competitive research funding calls. To cultivate the Geo.X brand and to encourage new partnerships within the network, travel grants enable exchange with German and international research groups as well as conference visits. Additionally, Geo.X working groups are developing *common data handling initiatives and measures for infrastructure sharing* within the network to bundle the strengths of the individual partners which will, in perspective, be supported by a Geo.Data Clearing House which is currently being set up by the Geo.X head office.

Over the next three years, the stimulation of innovative projects and their coordination will be further developed into a nationally and internationally visible node of the regional geoscience research community. Our stable network with dynamic interactions between institutional partner's projects is the foundation for reacting to opportunities and needs from inside and outside the network. Geo.X is positioning itself to be the cornerstone of future large-scale research initiatives, such as the Helmholtz Information & Data platform, national research data initiatives (NFDI) and national, EU and international initiatives for Earth System science, including the German initiative for Earth System Sciences (DESA).

## 2 Update on the research approach and the organizational structure

Research within Geo.X is based on the mutually complementary and internationally renowned geoscientific profiles of the Geo.X partner institutions. Their expertise spans the entire range of Earth sciences disciplines, ranging from planetary science, space-borne Earth observing systems, through atmospheric studies, to material sciences, Earth surface dynamics and the deep biosphere. Geo.X started the co-operation between six partner institutions in 2010; these include the universities Freie Universität Berlin (FU), Technische Universität Berlin (TU), Humboldt-Universität zu Berlin (HU), and



Figure 1: The five Geo.X research fields. (Planetary) Geodynamics and Geo-Bio Interactions were added in 2012 and 2017

Universität Potsdam (UP), the Helmholtz Centre Potsdam - German Research Centre for Geosciences (GFZ), and the Museum für Naturkunde (MfN). Over the years work has focused on three jointly chosen key research fields. Since then, Geo.X has grown to nine collaborating partners covering five research fields (Figure 1) and published high-profile science in all research fields (a list of selected joint projects and top joint publications can be found in Appendix 8.1. The new partners who joined after 2010 are the Helmholtz Centre for Polar and Marine Research – Alfred Wegener Institute (AWI), the German Aerospace Center (DLR) and the Institute for Advanced Sustainability Studies (IASS).

### **Geo.Data Science**

To cross-fertilize research in the Geo.X research fields, methodological research and technological developments cut across these fields and create new research opportunities and approaches. Geo.Data Science was chosen as the first cross-cutting topic, within which the complementary competence of the Geo.X partners was bundled. This represents a change from the original Geo.X proposal, which did not focus on geoscientific flagship projects. In response to the reviews, Geo.Data Science was adopted as a unifying concept around which a Geo.X young researcher's program could be organized. Since Geo.Data Science is an emerging field for innovative discovery science, it allows access to the five research fields in an interdisciplinary manner. Geo.Data Science combines the methodological fields of mathematics and data science with geoscience research problems. Examples are the real-time assessment of earthquakes, spatiotemporal characteristics of volcanic eruptions or the prediction of flood events with machine learning, multi-scale analysis or high-dimensional statistics (see 4.1). Such projects bring together our diverse Geo.X partners to apply emerging cross-cutting methods to tackle societally relevant geoscientific problems.

### **Geo.X Young Academy**

Another change to the original proposal is the creation of the *Geo.X Young Academy* (rather than the *Geo.X Talent Incubator*). In contrast to the originally envisaged *Talent Incubator*, the Young Academy integrates Ph.D. candidates and postdocs in one topically focused class with a custom-made curriculum. The term *Academy* emphasizes the transfer of specialized knowledge combined with scientific self-reliance and self-organization. Our fellows gain methodical expertise at the interface of

geosciences, mathematics, and computer sciences and are active in their own, custom-tailored curriculum design. With this competence, they are expected to stimulate new scientific constellations in and outside of the Geo.X community and influence future geoscientific research.

To integrate the fellows of the Young Academy into the scientific community, the Young Academy is part of the Geo.X Early Career Scientists Section (ECSS), which sends two members as representatives into the Geo.X steering committee (see Figure 2). The ECSS is an association of all young scientists (Ph.D. candidates and postdocs) working at Geo.X partner institutions. As detailed in 5.3.1 the ECSS exchange scientific or career path-related questions, formulate needs and requirements and communicate these issues via their voice in the steering committee. In contrast to the Young Academy, the ECSS is not focused on a specific topic and open to all interested young scientists.

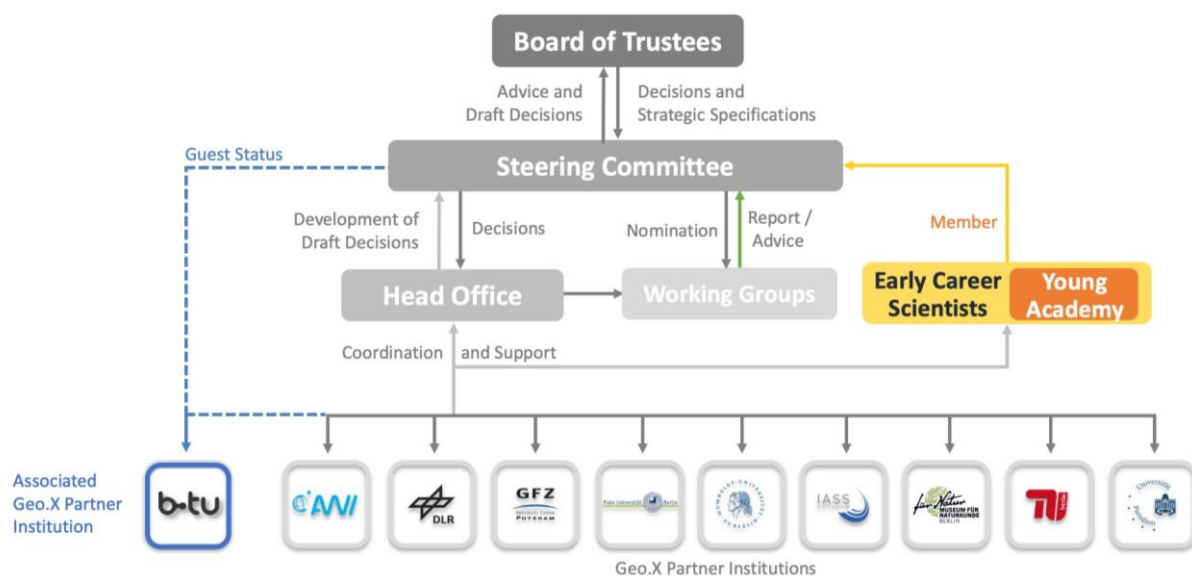


Figure 2: Geo.X's organization has changed with the addition of the Young Academy and the Early Career Scientists, as well as the addition of the BTU as an associated partner

### Seed Funding

In parallel with the establishment of the Young Academy and the cross-cutting topic Geo.Data Science, we systematically strengthen collaboration between the five Geo.X research fields by providing seed funding to support new inter-institutional research projects (see 3.3).

### Geo.X Expansion

In 2016 we revised the Geo.X contract and introduced the *associated partnership* as a new form of cooperation. In 2017 the Brandenburg University of Technology Cottbus-Senftenberg (BTU) became an associate member of the network.

## 4 Geo.X Young Academy

### 4.1 Motivation and concept

The vision of the Geo.X network is to develop innovative concepts and methods that harness the potential of the interdisciplinary data analysis. Thus, we created the Young Academy which has established its reputation as a beacon of Geo.Data Science throughout the entire network.

Geo.Data Science as a Geo.X cross-cutting topic acts as the link between the Geo.X key research fields. According to our interdisciplinary mission, *Geo meets X*, Geo.Data Science combines geoscientific domain knowledge with methodological expertise from mathematics and computer sciences. Hence this expertise goes beyond the traditional, computer-science-based interpretation of data science.

Within the Geo.X Young Academy we aim to train a new generation of interdisciplinary scientists in order to define and establish a new quality of cooperation.

#### **Why Geo.Data Science?**

The variety of data sources in geosciences requires novel technology development to manage, analyze, and explore these big data resources. Data Science is one of the core competencies for future scientists, as it allows to collect, process, understand, and visualize valuable information gained from simulations, experiments, open-world sensors, and model-driven research. Data science methods are ubiquitous in geoscientific research, whether in data measured by scientists in labs and field experiments or created by models. By combining such data in interdisciplinary projects, geoscience will gain insights into the system Earth and its relation to human habitat. Geo.Data Science aims at developing novel approaches for advanced data analysis at the intersection of mathematics and computer science with Earth sciences.

### 4.2 Academy organization and fellowship development

#### 4.2.1 Recruiting process

The goal of Geo.X is to promote outstanding young scientists within an interdisciplinary and inter-institutional framework. Therefore, the open call for 15 positions in Geo.Data Science was internationally published addressing Ph.D. candidates and postdocs.

The applicants were asked to describe their interdisciplinary data science research project, highlighting the innovative use of combining mathematical and computer scientific approaches with at least one Geo.X research field (*Natural Hazards and Risks, (Planetary) Geodynamics, Geo Bio Interactions, Natural Resources and Energy Materials, Human Habitat and Sustainability*).

To serve the inter-institutional idea, the candidates had to identify their potential Principal Investigators (PIs) in advance to ensure the co-supervision by at least two Geo.X partners. The resulting supervising tandems allow all partner institutions to participate with their specific expertise and foster the cooperation between university and non-university institutes (see Figure 4).

In total 322 applications were submitted and 41 candidates were invited over the course of three application rounds. The Selection Committee together with the PIs examined and evaluated the applications anonymously and electronically. Key criteria were scientific excellence, multidisciplinary



and inter-institutionality of the future projects. Besides these quality-based criteria, a gender-balanced selection was pursued.

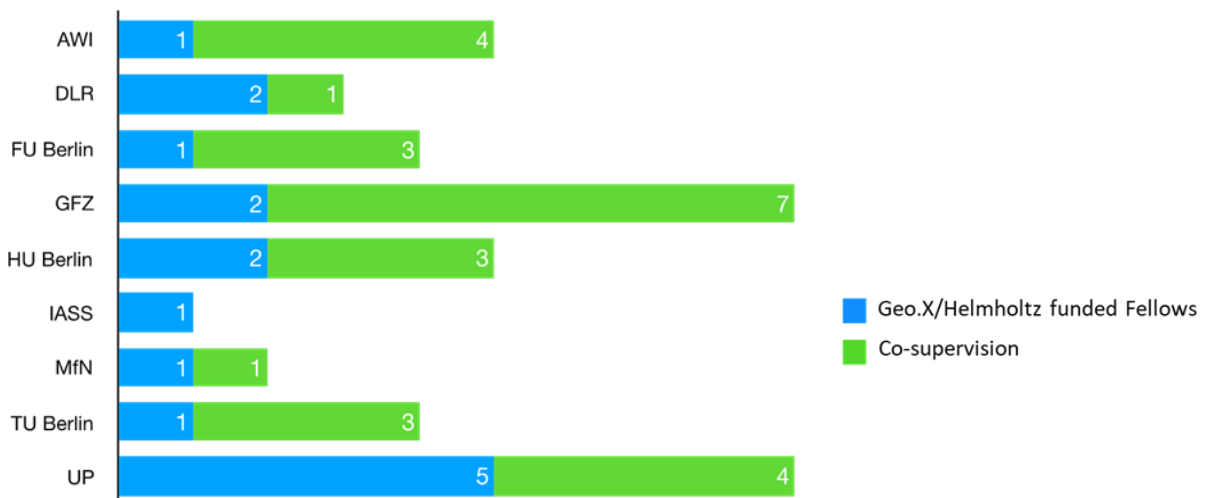


Figure 4: Participation of the partner institutions in the Young Academy

To spread the knowledge from inside the Young Academy into specific research communities we opened the group of paid fellows to other data science-oriented young scientists from the Geo.X network. As fellows they benefit from inter-institutional collaboration, interdisciplinary supervision, specialized training courses, and soft skills training. This enables more young scientists to participate in the Young Academy program, beyond the limited offered positions and at the same time puts them in a multiplier role of communicating the interdisciplinary idea to the general community.

#### 4.2.2 Demographics: Structure and development

The first cohort of the Geo.X Young Academy currently consists of 25 fellows, whereas 15 positions are paid by Geo.X, and ten internal fellows come from the Geo.X partner institutions and have their own funding, where three of them are from the HEIBRiDS cohort.

The various cultural backgrounds (Figure 5) and different career-levels are illustrated in Table 1 and contribute to a fruitful exchange on scientific questions but also in personal career and life choices in the protected environment of their peers. The established dynamic structure of the group also allows to mitigate fluctuations effectively and to integrate new fellows from the very beginning reasonably.

##### HEIBRiDS

HEIBRiDS is the newly established Helmholtz-Einstein International Research School in Data Science. It is a cooperation of different Helmholtz Centers in Berlin and Potsdam with ECDF (Einstein Center Digital Future).

Infobox 1

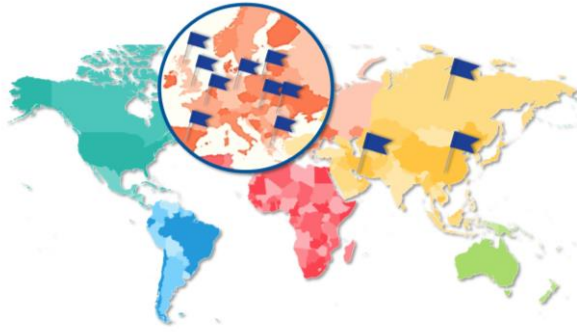


Figure 5: Internationality in the Young Academy

Since 2017, eight fellows have left the Young Academy due to terminated contracts and/or new positions. Their positions have been refilled, according to the time they left and their specific function to the group. Therefore, there was a significant shift in the initially well-balanced gender proportions, also depicted in Table 1, as in particular women have left early for high-ranked positions in academia (*Nature Communications*), industry or the start-up environment, such as *Senozon*.

Table 1: Young Academy diversity

	2017	2018
<b>Number of fellows</b>	<b>25</b>	<b>25</b>
Broken down to ...		
Gender balance (m / f)	14 / 11	16 / 9
Career level (Ph.D. / postdoc)	12 / 13	11 / 14
Nationality (nat. / int.)	10 / 15	11 / 14

The Geo.X Young Academy alumni work closely to the field and methods of Data Science and have indicated to be available for concerns of the Young Academy. To ensure knowledge transfer to the next generation cohort, Geo.X will establish an alumni database/network as a unique pool of Geo.Data Science expertise and experience.

#### 4.3 Training concept for scientific and career development

The Young Academy training program is tailored to the specific requirements of the group, arising at the crucial intersection where individual research interests meet the overarching goal of significantly expanding their Geo.Data Science portfolio. Besides building their scientific skillset, we aim to stimulate collaboration efforts across all institutional and career levels, in the best case leading to new project proposals. In order to prepare a readiness for a successful career in academia or industry, Geo.X provides a career development framework implemented in the whole network to accompany personal career decision making.

## Geo.X Key Research Fields

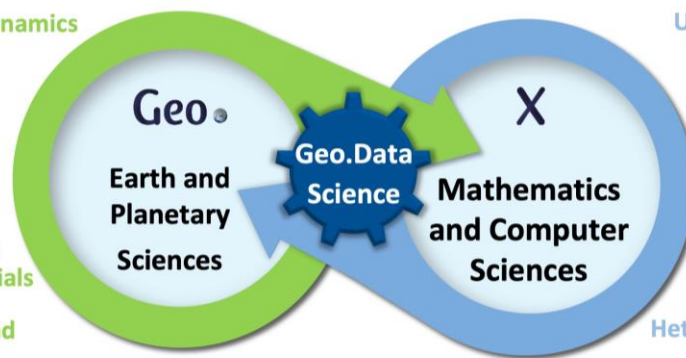
(Planetary) Geodynamics

Natural Hazards  
and Risks

Geo-Bio-  
Interactions

Natural Resources  
and Energy Materials

Human Habitat and  
Sustainability



## Methodological Research Fields

Uncertainty Quantification  
and Multiscale Analysis

Data Profiling and  
Data Integration

Explorative Simulations  
and High-dimensional  
Statistics

Heterogeneous Data Sources  
and Machine Learning

Figure 6: Geo.X Young Academy projects contribute to five geoscientific research field and interact with methodological research areas from mathematics and computer sciences

As concrete training elements, numerous workshops on programming, computer science, and geoscientific methodology have been held for the Young Academy. These particular measures were backed up with general scientific Geo.X events, like the Geo.X Hackathon on *The challenge of +4 data – Visualizing and comparing outputs from landscape evolution models* in March 2018 at TU Berlin. The scientific program is complemented by the Young Academy Autumn School 2018 that was self-organized by a core team of the fellows. It took place in October at the Einstein Center for Digital Future (ECDF) in Berlin. The location also demonstrated the already initiated and further to be established the connection to the HEIBriDS-Program (Infobox 1). The underlying training guideline reflects the general Academy concept to transfer specialized knowledge combined with scientific self-reliance and self-organization. A key event in this development was a Think Tank which is explained in more detail in Infobox 2.

The topics of the Fall Schools aimed to advance machine learning implementations in the programming language Python, like data visualization, code optimization or weather forecasting. The schedule also included tutorials on how to work on Linux servers and HPC clusters, as well as software and code development on the software development platform GitHub. The Fall School 2018 found its highlight in the joint project work of scientific data solutions for geoscientific challenges in a hacking format (4.4.2).

In order to expand the scientific offer, the Young Academy coordination also attempts to curate external offers for the fellows and provide them with the appropriate access. Centrally coordinated conference visits and workshop participation in which many fellows would

### Think Tank

This innovative 2-day format pooled scientific new ideas, needs, and requirements of the group. Team-building exercises and reflection on their role made the fellows aware of their power to influence and eventually design the future Academy program.



Young Academy Think Tank by Geo.X 2018

Infobox 2

usually participate independently leads to the fellows acting as a highly interconnected and unified group at international levels, like European Geosciences Union (EGU) or American Geophysical Union (AGU). In this way, they also act as ambassadors for Geo.X.

Career Development activities are conducted in larger structures, mostly including the whole Geo.X network, e.g., Geo.X Career Day (5.3.2) or addressing the ECSS as a target group (career development workshops). These workshops covered topics like grant proposal writing, appointment to professorship or didactics for higher education.

#### 4.4 Fostering collaborations

The vision of the Young Academy as a pioneer and incubator for immediate collaboration needed an initial phase with continuous impulses from Geo.X to evolve in that direction. However, the fellows currently perceive the Young Academy itself as a suitable platform for tackling their demanding and highly-specific questions in the Geo.Data Science field, which cannot be necessarily answered in their own research groups.

##### 4.4.1 Funding measurements: Young Academy support

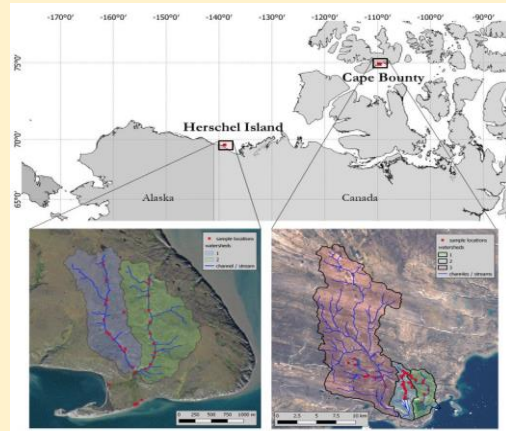
Funding mini-projects from at least two fellows is an incentive to foster collaborations. We offer this funding possibility exclusively to the Young Academy fellows. An application is only possible via their internal website.

A successful application allows the two connected fellows to extend their existing contract for up to four months with their actual institution. The potential collaborations can be built on a common methodology, common research interests or pairing different expertise. The small collaboration project should be evolved from the ongoing Geo.Data Science project and should yield a measurable output, like a joint publication, a joint grant proposal, a comparable outreach medium (e.g. MOOC), a software, etc. All requirements need to be included in the project description of the application, and especially the interdisciplinary approach needs to be clearly outlined. PIs from the Young Academy, who are not involved in the proposed mini-project, evaluate the application.

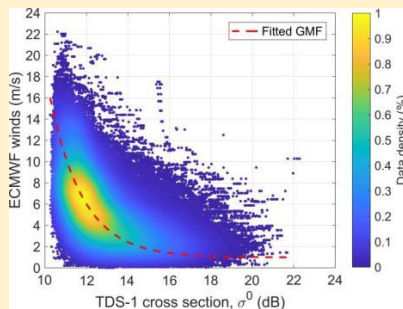
A successful conducted mini-project increases the outreach and allows to add additional value to the results of the fellows' research projects (Infobox 3).

### Mini-project Examples

The first successful application for a mini-project comes from two Ph.D. students from FU and AWI. They will work on "organic matter composition and the optical characteristics of water in Arctic catchments". This collaboration has the potential to establish a permanent collaboration between the working groups at AWI (Permafrost Research section) and the Institute for Space Sciences at Freie Universität Berlin. The mini-project benefits from the cross-over of both applicant's joint networks and pooled expertise of collaborating senior scientists from all involved institutes. The fellows plan to initiate a joint project proposal in the future.



Location of both study areas and sampling locations



TDS-1 derived  $\sigma^0$  collocated with ECMWF wind speed as the training dataset. The fitted GMF of the form  $U_{10} = Ae^{B\sigma^0} + C$  is shown with the red dashed line. Values of A, B, and C, obtained by least squares, are equal to 9042.24, -0.62, and 0.99, respectively.

The same pursue is followed by two Ph.D. students who applied for the mini-project with a proposal on "GNSS Reflectometry Geophysical Model Function: Machine Learning Based TDS-1 Wind Speed Inversion". As preparation for the application they presented their idea to different professional audiences in workshops and conferences, for example, last years' EGU meeting.

Infobox 3

#### 4.4.2 Innovative collaboration catalyst: Geo.X Hackathon

The format of a Hackathon is designed to enhance the collaboration intentions through ad-hoc forming teams working closely together on a solution strategy for a problem or a challenge in a very tight time-frame. Therefore, the hackathon format was applied as a key element within the Geo.X Young Academy School, next to the usual input lectures and hands-on tutorials. The challenge was to test different approaches from the methodological Data Science perspective to given problems in order to find new and innovative results and findings.

All teams showed significant progress and outcome on their challenge considering the short time. The jury identified a winning team, which was granted the opportunity to publish their findings in an Open Access Publication. In case they further evolve their approaches to a large-scale project proposal they are eligible to take a fast track granting of the Geo.X seed funding (5.1).

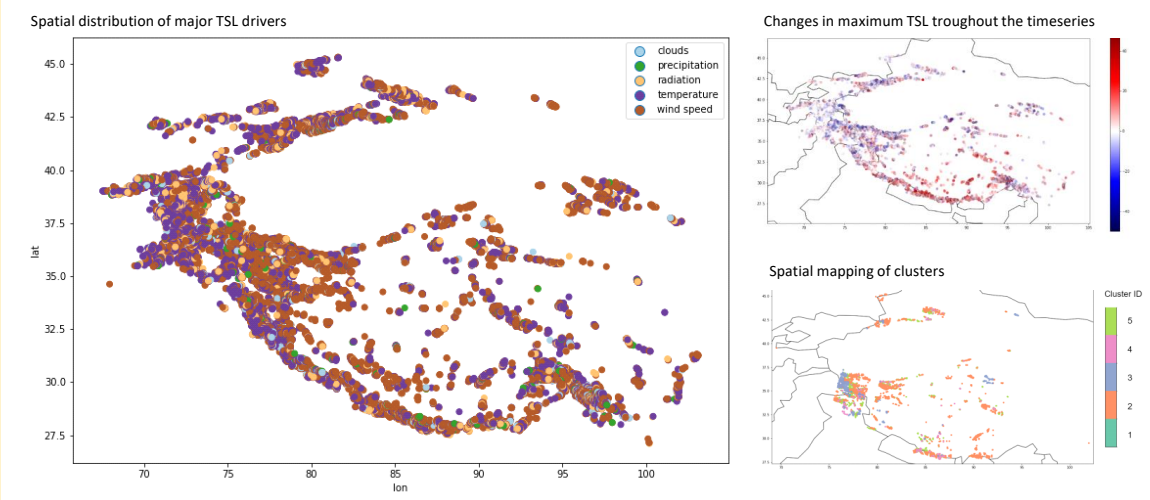
The jury evaluated the presented results according to the following criteria:

- Matching capability to the given question of the challenge,
- Innovative approach,
- Interdisciplinarity and teamwork, and
- Potential for future collaboration and outreach.

The winning team forms a group around a postdoc from HU Berlin, who submitted the challenge *Topoclimatic forcing of glacier changes in High Mountain Asia*, which emerged out of his work in the interdisciplinary Geo.X project [MORSANAT](#) (for further details see Appendix 8.3.)

### Topoclimatic forcing of glacier changes in High Mountain Asia

The task of the winning challenge was to use and test multiple methods to the thoroughly pre-processed comprehensive time series dataset of transient snow line (TSL) altitudes for glaciers in High Mountains Asia, created from optical remote sensing data using the Google Earth Engine. The challenge aimed to identify patterns of correlation between this dataset and datasets that are indicative for the local topographic and climatic regimes to constrain spatial patterns, forcing mechanisms, and sensitivities.



#### Compiled results

Combining trend analysis techniques, clustering of spatial and time series data, and machine learning techniques (e.g. gradient boosting, random forest and extra trees), a variety of insights regarding TSL dynamics and their correlations to potential driving factors were obtained. These include a general trend towards higher TSLs with the most substantial rise during November, a dominance of topographic factors in controlling climate change sensitivities of individual glaciers, and wind speed as well as temperature being the most influential climatic parameters for most glaciers. Patterns of spatial distribution reveal a complex picture of clusters, dispersion, and scatter that require in-depth analysis; However, the spatial distribution of overall change rates exhibits several well-known large-scale patterns such as the 'Karakoram Anomaly' (indicating relatively stable or even advancing glaciers in the Karakoram and western Kunlun mountain ranges) or frequently reported outstandingly negative glacier mass balances in the eastern Nyainqêntanglha Range in southeastern Tibet. These key findings pave the way for further investigations in the individual drivers, for example by applying random forests within the identified clusters or even including more available data into the analytic procedure.

*Infobox 4*

The jury agreed that the presented results demonstrated the team's capability to profitably pool the individual expertise and joined forces of each methodological toolkit encompassing upscaling methods, spatial and time-series analysis, multivariate statistics, machine learning, and satellite image processing.



## 4.5 Scientific output

Additional to the individual publication record of each fellow, the Geo.Data Science class currently prepares a joint review paper on *How machine learning can add value to state-of-the-art Earth Sciences*. The paper will aggregate the classes' expertise and is exemplary for the new levels of collaboration. The review paper strives to give a comprehensive and systematic overview over evolving Data Science methods applied to geoscientific research questions. It aims to cover all relevant fields that are part of the Young Academy. Applying these methods will be underpinned by best practice examples from the fellows' project work to set the direction of future research. The final draft of the publication is planned to be submitted to Earth Science Reviews by April 2019. To further support the fellows' standing within the scientific community Geo.X aims to cover the costs for an Open Access publication of the joint review paper. We assume that with the current cooperation initiatives of mini-projects, the number of joint publications will increase, especially those of joint publications that are also building bridges across a greater variety of more research fields.

The individual publication list of each fellow can be found within the detailed project description of Appendix 8.2.

### Publication records

Since 2016, the publication output of the Young Academy counts 88 publications in numerous journals, not including book or conference contributions. Each fellow has a record of 4-5 publications, with 2-3 in first-authorship. Typical disciplinary journals are, e.g., Climate Dynamics, Earth Surface Dynamics, Geophysical Research Letters and Remote Sensing of the Environment. More overarching and also high-impact journals favored by the fellows are Nature Communications and Global Change Biology, as well as Earth Science Reviews.

*Infobox 5*

## 5 Strengthening the Geo.X community

### 5.1 Research: High-risk projects and seed funding

Before the Young Academy started in 2016, the Geo.X community was invited to apply for high-risk projects that cannot be funded through other programs. The proposals had to have an interdisciplinary approach to Geo.X's general research fields and involve at least three Geo.X partner institutions.

We selected two high-risk projects: *MORSANAT* and *First time ancient DNA analysis of mountain gorillas*. Both projects have made significant progress and have developed very positively since their challenging launch in December 2016. Detailed information on both projects are given in Appendix 8.3. While the MORSANAT project was already described within the Hackathon section 4.4.2 a brief overview of the second project is given in Infobox 6.

#### First time ancient DNA analysis of mountain gorillas:

Linking biotic response to past climatic variations, extensional tectonism, and earth surfaces processes in an African biodiversity hotspot

Rene Dommain, University of Potsdam

Involved Geo.X partner institutions: AWI, GFZ, MfN

This high-risk project aims at investigating the capability of sedimentary ancient DNA techniques for the reconstruction of the local presence of mountain gorillas in the Bwindi Impenetrable Forest (Uganda) during the Late Quaternary and at reconstructing the contemporaneous paleo environmental conditions. This largely exploratory and ambitious project faces several risk factors in the past and now. First of all, only very few researchers have thus far collected sediment cores in the Afrotropical mountain regions due to various logistical and safety challenges. Site access is not guaranteed, largely depending on suitable weather conditions and the absence of safety concerns (i.e. poachers).

This project will ultimately contribute to 1) an advanced understanding of sedimentary DNA preservation in equatorial settings, 2) the use of ancient metagenomic data in biodiversity reconstructions, baseline setting and species conservation and 3) generally to elucidate novel aspects of diversification processes in the hyperdiverse Afrotropics.

Digital images of one of the collected cores used for sedaDNA analysis



Infobox 6

Both projects demonstrate in an extraordinary way the added value through collaboration within the network and therefore served as a blueprint for the set-up of the *Geo.X seed funding program* in 2018.

The *Geo.X seed funding program* is a central tool for strengthening the network and was launched in spring 2018. It is an incentive for the initiation of new collaborative projects and supports young scientists in pursuing their academic career within the Geo.X network. Geo.X follows two paths: (a) *the promotion of collaborative projects* in the initial planning and preparation of proposals for collaborative projects, thus providing incentives for Geo.X scientists to take the lead in coordinated



programs, and (b) *the promotion of early career scientists* at the postdoc stage of their scientific careers. We hold that the funding will have positive effects on networking between the Geo.X partner institutions even in the case of a negative review.

The Geo.X funding instrument *promotion of collaborative projects* supports scientists in the preparation phase of proposals. Applicant scientists must commit to taking the leading/coordinating role within a new project consortium which involves scientists from at least three partner institutions. The proposed projects can be submitted in EU- und ERC-Projects, coordinated programs of the DFG and joint projects from the federal framework programs.

The Geo.X Steering Committee decides on both funding instruments according to criteria for (1) relevance to the Geo.X key topics and cross-cutting issues, (2) the potential of the project to foster collaboration within Geo.X, and (3) interdisciplinary nature of the proposed research approach.

All decisions base on a quorum of at least 2/3 of voting steering committee members, as well as on the principle of abstention in case of institutional or personal bias.

Table 2: Approval rate in both funding lines of Geo.X seed funding

Funding line	Applications	Funded projects
Collaborative projects	5	3
Promotion of young scientists	8	5

The finally supported collaborative projects pursue ambitious scientific goals, which are highly relevant to the Geo.X research fields:

#### Cosmic Sense

DFG Research Unit

UP, GFZ, and TU Berlin.

Status: approved and started in November 2018

The soil moisture content is considered as the key state variable when evaluating the exchange of water between atmosphere, biosphere, and hydrosphere. State-of-the-art observations of soil moisture content are ranging from continuous point-scale measurements via field-scale snapshots to remote sensing products. By using Cosmic-ray neutron sensing (CRNS) the presence of water will be measured by sensing changes in neutron density above the ground. In this way, the project aims to bridge existing gaps between scales and disciplines through additional techniques and sources of information about the soil water storage.

Infobox 7

**ClimXtreme Modul C**

BMBF funding program ClimXtreme

FU Berlin, GFZ, and UP

Status: Submission of the full proposal in January 2019

ClimXtreme focusses on meteorological extreme events producing impacts on the natural and socio-economic system. Such impacts are often not just explained by the local extreme value of the meteorological parameter eventually leading to the impact. Instead, often combinations or sequences of meteorological parameters ("compound events") are important for the severity of the ultimate hazard process.

*Infobox 8*

**Earth Literacy: Supporting Earth and Environmental Education**

(CSA), Horizon2020

UP, GFZ, MfN, and DLR.

Status: Submission of the pre-proposal in March 2019

This project pursues to raise awareness of environmental issues and how political decision-making will influence our environment, since increased support of earth and environmental education seems to be essential. The project seeks to pair the modern interdisciplinary concept of the earth system sciences with issues related to public environmental concerns as well as with a growing market for environmental technologies and sustainable solutions. German teachers from STEM disciplines, the social sciences and economics will convene within the Earth Literacy project to share but also to develop educational programs and strategies in the realm of environmental and sustainability education.

*Infobox 9*

The Geo.X funding instrument *promotion of early career scientists* supports the application of Geo.X scientists in programs of the DFG, EU, Alexander von Humboldt Foundation, Volkswagen Foundation, and BMBF for the Promotion of Young Scientists.

## 5.2 Joint projects, working groups, infrastructure, and initiatives

The joint planning and implementation of projects, as well as the expansion and use of infrastructure for joint projects is an essential aspect in the bundling of geoscientific competence in the region of Berlin and Potsdam.

Within Geo.X, larger collaborative projects with geo-related topics, such as DFG Collaborative Research Centers or DFG Research Training Groups, are usually acquired by an application consortium with several Geo.X partners. For example, the DFG Research Training Group *Natural hazards and risks in a changing world (NatRiskChange)* is a joint coordinated program of the University of Potsdam together

with FU Berlin, TU Berlin, and GFZ. This collaborative project aims to develop and advance methods of analyzing and quantifying natural hazards and risks in a changing world. The Transregional Collaborative Research Center TRR 170 *Late Accretion onto Terrestrial Planets (LATP)* under FU Berlin leadership involves the Geo.X partner institutions GFZ, TU Berlin, and MfN. The TRR seeks to improve our current understanding of the late-accretion history of the Earth, its Moon, and other terrestrial planets from 4.5 to 3.8 billion years ago.

The FU Berlin recently established the Research network for planetary systems and remote sensing: *Planetary system – from genesis to habitability*. This initiative bundles the competences in the field of planetary research at the FU, the TU, the DLR, and the MfN and aims to deepen knowledge on the origin and development of planetary systems and associated habitats on and outside the Earth.

The Geo.X network benefits from collaborative effort, while not all initiatives can be successful. For instance, the application for a Cluster of Excellence, coordinated by the UP, with the four other Geo.X partner institutions AWI, GFZ, MfN, and TU, was not selected for the final round. The reviewers rated the project *Delta-Earth: Dynamics of the Earth's Surface: From Imbalance to System Understanding* as "fundamentally exciting, important and highly ambitious", but expected a more detailed description of the model systems and their interactions. Nevertheless, the letter of decision emphasizes the high level of competence of the scientists involved: "The scientists who play a key role in the project are highly qualified, have excellent international networks and are recognized. They can show extensive preparatory work that supports the planned studies. Among them are internationally leading scientists in their respective fields in the earth sciences, environmental sciences, and life sciences". Geo.X will benefit from the momentum, which has enabled the participating institutes to establish the [NEXUS](#) research initiative as well as a strengthened interaction between geosciences and biosciences. The University of Potsdam and the Ministry of Science, Research and Culture in Brandenburg continue to accompany and support the administrative and scientific components of NEXUS.

Further collaborative projects within Geo.X can be found in Appendix 8.1.

The Geo.X working groups represent essential cornerstones of the network. Providing a platform for thematic discussion as well as coordinated internal cooperation, the working groups support the active and living structures of the network. For example, the Geo.X project Geo.Data Clearing House closely cooperates with representatives of the working groups *Joint use of libraries* and *Infrastructure* in order to develop a concept for joint research data management adapted to the needs of the partner institutions. In collaboration with the working group *Infrastructure*, we plan to foster the joint use of laboratories among our partners. As a pilot project, Geo.X has initiated a joint laboratory for high-pressure/high-temperature experiments called *High Pressure Laboratory for Geomaterial Sciences*, which should improve the common usage of this laboratory infrastructure throughout the Geo.X network. Located at GFZ Potsdam, this lab is run jointly by the GFZ and the Mineralogy group of the UP. The technical devices are being managed and maintained by a scientist, whose position is as well financed by and affiliated to both Geo.X partners. During the period 2016-2018, there have been experiments running for eight different research projects, which include collaborations between Geo.X partners (UP and GFZ) as well as international cooperations with researchers from France, Norway, and Canada.

Another example is the cross-institutional consensual coordination of appointment procedures for professorships. Currently, the FU, GFZ, and UP are coordinating the replacements of professorships in the field of Structural Geology. The agreed strategy involves discussions concerning the fields of specialization in Structural Geology and an analysis of the needs and requirements at the individual

institutions and within the network as well as the texts for the job advertisements. Such structured processes are unique in Germany so far.

### 5.3 Joint talent management throughout the network

#### 5.3.1 Early Career Scientists Section

The Geo.X Early Career Scientists Section (ECSS) was officially founded in 2017. The ECSS is the communication and networking platform for all Ph.D. students and postdocs within the Geo.X partner institutions, where everybody is invited to be active and shape the future of the section with his or her ideas. It currently counts 152 members, who actively subscribed to the designated mailing list and receive the information about events, activities and organizational issues. The section is being self-organized and self-governed by the elected ECSS representatives and active members of the ECSS community, i.e., the members are defining their own goals, responsibilities, and terms, which are written down in the ECSS statutes. For community-building, bi-annual meetings (formal and informal) are organized and carried out by the ECSS core team, with an average attendance of 40-60 ECSS members, continuously aiming to increase this number. As a response to the needs and requests of the ECSS community the bi-annual meetings are connected to a career development workshop such as *Publication of Research Data* in November 2017 and *What's next, Doc?* in July 2018. Communication and flow of information throughout the ECSS section is fostered through the provided channels such as the Geo.X webpage, the ECSS mailing list, and several social media groups.

Two official ECSS representatives, one postdoctoral researcher and one Ph.D. candidate, were appointed in November 2017. The two representatives are members of the Geo.X steering committee with full voting rights; both can directly communicate the needs and requests of the ECSS to the steering committee. The representatives are elected for 1.5 years, thus taking part in three consecutive steering committee meetings. The ECSS representatives are supported and mentored by the Geo.X coordinator of the FU Berlin. This ensures a close connection to the Geo.X coordinators and a long-term anchoring within the network. The representatives are also invited to participate and to bring their experience in other Geo.X events such as the Career Day 2018. From the point of view of the Early Career Scientists, Geo.X provides an excellent platform for junior scientists/doctoral candidates which are new to the region.

#### 5.3.2 Network for career development

Within Geo.X, a large number of young scientists do their research within structured programs. In addition to their specific scientific goals, these programs are committed to supporting their young scientists through gender equality measures and career development programs. To meet demands concerning career development and professional growth other than publishing, the coordinators of the structured programs take up the idea of synergy and jointly develop new offers in the framework of Geo.X. By joining forces in this way, we can test new formats which make use of the acquired expertise of a large number of young scientists. The Geo.X Career Day has proven to be a feasible format of communication that brings together expert knowledge of senior scientists with open questions from junior scientists in an efficient, interactive way:

The Geo.X Career Day 2017 *Scientific life balance* focused on exemplifying ways of balancing work and personal life in scientific careers. More than 100 scientists at different career stages promoted the exchange of ideas, which helped to dispel common prejudices concerning academic life. Important questions were: How to arrange work and personal life? How to establish job security? How to stay in academia with children or time-consuming social engagement and volunteering? The participants additionally exchanged their experience on the life of couples in different cities and the management of two careers in one family. Another vital element was the perspective of leaders, senior scientists, and representatives of funding agencies who put their strategies and perspectives up for discussion.

The Career Day 2018 *Career Navigation – Equal Opportunities In and Outside Academia* was about mapping possible career pathways and offered impulses to approach career decision-making in a systematical manner. It addressed more than 80 Ph.D. candidates and postdocs to reflect on their preferences and potentials, and match their skills with external requirements. Experts from science, administration, industry, and politics assisted in discovering and utilizing useful tools for career navigation. We documented our Career Days and their outcome as short video clips on our website: [www.geo-x.net/en/young-scientists/career-development/](http://www.geo-x.net/en/young-scientists/career-development/).

### 5.3.3 Accompanying research

Based on pre-existing theory building and research findings on career development in academia, Geo.X network's accompanying research aims at identifying retaining factors and obstacles in the early careers of young scientists, postdocs in particular, and their gender-differential impact on career prospects. A longitudinal, prospectively designed study shall also reveal factors driving scientists out of academia. Recurring measurements at equidistant points in time allow for analyzing the impact of these career-relevant factors while employing a robust methodology. During the course of our study, four survey events are planned with gaps of six months intervals. Each activity comprises answering an online survey. In combination with a smaller number of more exhaustive interviews, this survey is meant to expose previously unknown causal pathways of mindset formation and development, as well as the implementation of career decisions.

Besides to the impact of gender, the study considers cultural differences as an additional influencing factor, paying tribute to the increasing internationalization of research outside academia.

The derived conclusions enable young academics to gain career-related insights and reflect their plans. PIs and supervisors receive evidence-based feedback on how leadership behavior is connected to career success in science and get support in devising interdisciplinary projects with prevalent risks and chances in mind. The Geo.X network benefits from insights on optimizing future

#### Central research questions:

- How do early career scientists assess their career competencies, their career success, and their career satisfaction?
- How do career-related decisions develop over time, e.g., motivation to stay or leave academia?
- How do executives (PIs) contribute with their leadership behavior to individual career development?
- How do graduate programs contribute to career development in academia?
- To what extent do early career scientists work across disciplines?
- How does interdisciplinary research influence career development in academia?
- How do gender and cultural aspects influence these processes?

Infobox 10

career development measures, input on how to establish conditions in interdisciplinary research projects that are beneficial to individual career progress, as well as feedback on how the balance between structure provided by the Young Academy and self-responsibility of each fellow is perceived.

In 2017 and 2018, nine guided interviews were conducted with both female and male Young Academy fellows on different career levels and subsequently transcribed. The quantitative survey was then designed with an emphasis on issues and topics frequently raised throughout these interviews. In summer of 2018, a total of N=88 young scientists participated in the first measurement time of this online survey. The preliminary evaluation of the first online survey provides indications of positive effects, but also of still existing obstacles that are associated with interdisciplinary research (see Table 3).

*Table 3: Preliminary results of the accompanying research study*

Drivers for career prospects in academia	Obstacles for career prospects in academia
<ul style="list-style-type: none"> <li>• career competencies, strategic career planning and mentoring are positively associated with subjective and objective career success</li> <li>• growing networks and increased quality of research as essential benefits within interdisciplinary projects</li> <li>• Geo.X members within structured programs report higher levels of proactively building scientific and interdisciplinary career competencies</li> </ul>	<ul style="list-style-type: none"> <li>• minor role of mentors in building scientific and interdisciplinary competences</li> <li>• communication or coordination difficulties and missing feedback as most important obstacles within interdisciplinary projects</li> <li>• females report less often to work with a career development plan and assess leadership behaviors less positively</li> </ul>

#### 5.3.4 Innovators Camp

One aspect of supporting young scientists to develop a distinct scientific profile is to provide an incentive to look outside academia and to create an awareness of alternative career paths. The aim is to communicate ideas and opportunities how to make the results of their research available to the economy, the public sector or society (e.g., software or innovative measuring instruments).

In collaboration with the GFZ technology transfer office, Geo.X currently develops a new format addressing young researchers in order to promote a view beyond research. This innovation camp will be arranged as an expert-driven event, which will give young scientists a chance to present their ideas to a jury recruited from the economic sector (industry, SME, start-ups) as well as administration and NGO's.

The target group includes the fellows of the Geo.X Young Academy and interested scientists from the Geo.X Early Career Scientists (ECSS) Section. The group size will range between 10-15 participants to enable individual support for each of the young scientists. The first innovation forum is planned to take place in March 2019.

The central part of this event will be a short presentation, the pitch, given by the young scientists in front of the expert jury. During the presentation, they convey their ideas which part of their research might be of interest for non-academic partners or may even constitute the basis for a career outside



academia. In preparation of their presentation, the fellows will receive a training in pitching which they can immediately integrate into their presentations. After the pitch, the young scientists will get the chance to receive a 1:1 feedback from one of the experts. The individual consultations will be followed by a world café activity where the young scientists will have the chance to discuss general questions with the experts in various discussion panels. As closing remarks, the experts will give general feedback of their impression from this event.

### 5.4 Establishing joint data management

With the implementation of a first version of the Geo.Data Clearing House, the next step of a joint strategy for research data management and research data publication following the FAIR data principles (**F**indable **A**ccessible **I**nteroperable **R**e-usable), will be realized for the Geo.X community. The final goal of this project is to set up a discovery portal for geoscientific research infrastructures and data including their description which is available for the scientific community and the public with or without registration.

In preparation of this project two workshops were arranged dealing with the opportunities in research data management and common use of research infrastructure in the region of Berlin and Potsdam:

Geosciences in Berlin and Potsdam have a broad spectrum of scientific infrastructure available for research and teaching at the university and non-university Geo.X partner institutions. In January 2015, the Geo.X partners organized a workshop at FU Berlin where challenges and chances of a joint utilization of research infrastructure were discussed. The Geo.X partners agreed to expand the flow of information about the common infrastructure and to overcome obstacles for joint use. As a result, the set-up of a discovery portal for geoscientific infrastructure and possible search criteria were discussed.

In November 2017, the Geo.X partners organized a second workshop at FU Berlin discussing opportunities on how research data can be made available to the scientific community. The partners presented their strategies and examples of research data management. The participants agreed that research data should be handled according to the FAIR data principles. GFZ Data Services offers citable data publication based on FAIR standards for all partners in Geo.X. To support this approach several memoranda of understanding have been signed by Geo.X partners in the follow-up of the workshop with the aim to give guidance to their scientists that domain data repositories like GFZ Data Services are the best place to publish data. Along this model, the Geo.X community decided to establish a Geo.Data Clearing House.

### 5.5 Strengthening joint efforts in knowledge transfer and outreach

#### 5.5.1 GeoEducation within Geo.X

Geo.X fosters Earth science education by providing opportunities for knowledge transfer from science to the classroom. In cooperation with the *Jugend forscht* foundation, Geo.X conducts collaborative workshops in Berlin/Brandenburg to depict and highlight the potential of current geoscientific research for a project and seminary teaching in K12 education. Within these workshops, teachers are introduced and invited to educational programs at all Geo.X partners. This allows teachers and students to get in close contact with researchers from the Earth and environmental sciences, to conduct their research

by using state-of-the-art scientific infrastructure, and to learn about career paths in science. In addition to the *Jugend forscht* initiative by Geo.X teacher's workshops on topics such as ocean sciences, sustainable use of raw materials, and others are conducted by the GeoEducation working group in cooperation with the *GeoUnion*, Germany's association of 28 different geoscience societies. These workshops, which are strictly correlated with respective state curricula, are aimed at transferring recent research highlights to teachers via workshops and fostering the social science and economy.

### 5.5.2 Potsdam Summer School

Geo.X is partner of the Potsdam Summer School (PSS). The PSS is a ten-day multi-faceted event, which is being annually held since 2014 in cooperation with Potsdam research institutions (AWI, GFZ, IASS, and Potsdam Institute for Climate Impact Research – PIK)

The themes of the Potsdam Summer School deal with challenges at the interface between society and the environment: *Anthropogenic influence on the Arctic* (2014), *Facing Natural Hazards* (2015), *Dealing with Climate Change Impacts* (2016), *Human Environments in a Changing World* (2017), and *Dynamics and processes at the Earth's surface* (2018).

The interactive format of the Potsdam Summer School includes discussions and group work, while aiming to enable the participants to acquire transdisciplinary knowledge and process understanding. By bringing together talented early-career scientists and young professionals operating in the private sector, governmental agencies and non-governmental organizations from many different parts of the world, the PSS provides an innovative format to discuss frontier (research) questions on future sustainable development.

#### Potsdam Summer School 2018

##### Topic: The Skin of our Planet – The Earth Surface System

370 applications

42 chosen candidates

32 participants from 26 countries

30 speakers



Infobox 11

### 5.5.3 Outreach project TerraP: Plastics in soils

Striving for greater rationality in public and political discussion of scientific topics, Geo.X started a joint science communication project on the topic *TerraP: Plastics in soils* in collaboration with the Helmholtz geoscientific information platform ESKP (Earth System Knowledge Platform). In light of the currently heated discussion about plastics, but insufficient scientifically based knowledge on its role in impacting the terrestrial environment being available, we are collecting *well-knowns* and *unknowns* of this topic, using the scientific expertise of both networks and beyond. This compilation is currently in preparation and will be finished in February 2019. Possible transformations of the results are exhibition modules in the MfN, graphics, artwork or films. In this way, the TerraP outreach project will enable identifying open research questions, initiate dialogue across the different expert group within the networks Geo.X and ESKP and beyond, and provide a basis for action for decision-makers in Germany.



## 5.6 Building new international alliances

The consolidation of the Geo.X brand is based on a communication and internationalization strategy driven by the six strong pillars of the network. These strengths are supported by the spatial proximity of the network partners. In order to leverage the individual strengths, customized measures were developed for the Geo.X brand.

### 5.6.1 (Co-)organization and partnership of conferences in Berlin and Potsdam

A major tool on the way to strengthen the visibility of the brand Geo.X is the co-organization and/or representation of the network at conferences taking place in our region and through providing a platform for communication. In this role, Geo.X can offer different measures to the different target groups, especially the group of young scientists and those groups that are interested in collaborative interdisciplinary geoscientific research efforts. During the funding period, Geo.X has (co)hosted for instance the 79<sup>th</sup> Annual Meeting of The Meteoritical Society (organized by the MfN), the IUGG Planetary Science Symposium 2017 (organized by DLR), the GeoIT WhereCamp Conference 2017 (TU), the Research Data Alliance Plenary Meeting 2018 (organized by GFZ) or the Geoscience Berlin international conference (all partners) as well as the international conference on Natural Hazards, Georisks and Globalization (GFZ, UP, FU) that were pivotal in the successful application for the graduate-school proposals StRATEGy and NatRiskChange. The full list of events with Geo.X involvement is given in Appendix 8.

In addition to the network-wide events, short courses and field schools organized by the DFG-financed International Graduate Training Network (Ph.D. school) StRATEGy or the Ph.D. training network NatRiskChange have helped to strengthen the regional and international visibility and reputation of the Geo.X network.

### 5.6.2 Cooperation with national and European geoscientific networks

To increase the perception of geoscientific research in the region of Berlin/Potsdam Geo.X is in contact with national and international geoscientific networks. The Geoverbund ABC/J in northwestern Germany is comparable to Geo.X. We cooperate with ABC/J via mutual exchange on organizational matters as well as on scientific collaboration, see also Appendix 8.5. Through GFZ's European network *Geo.8 - European Alliance for Earth Sciences* Geo.X is involved in the exchange of ideas and expertise among core partners of a European consortium which aims at bundling interests, in particular within the European research framework. Therefore, Geo.8 provides excellent opportunities for cooperation with the key partners in France, the Netherlands, Italy, Poland, Spain, Switzerland, and the United Kingdom.

### 5.6.3 Providing travel grants

In order to stimulate regional and international exchange and cooperation, Geo.X provides the opportunity to compete for travel grants. This funding instrument consists of three pillars: (a) Geo.X Conference Travel Grant for Early Career Scientists; (b) Geo.X Travel Grant for Outgoing Early Career

Scientists; and (c) Geo.X Travel Grant for Visiting Scientists. It is expected that these measures will ultimately result in joint research projects, joint supervision of thesis projects, and joint publications in the international realm and will act as Geo.X ambassadors. The travel grants can also be considered as tools fostering the scientific training of Early Career Scientists. Under the auspices of Geo.X, junior scientists will spread the networking idea at the international level, especially when they jointly present at international conferences and workshops. Geo.X travel grants are closely aligned with the relevant topics in the Geo.X key research fields; funding is granted if there is a clearly recognizable benefit for at least two partner institutions.

Table 4: 84 out of 112 applications for Geo.X travel grants were approved

Geo.X Conference Travel Grant		Geo.X Travel Grant for Outgoing Early Career Scientist		Geo.X Travel Grant for Guest Scientists	
Conference participation	Different countries	Outgoing scientists	Different countries	Invited guest scientists	Different countries
66	<b>20</b>	<b>11</b>	<b>9</b>	<b>7</b>	<b>7</b>

#### 5.6.4 Presentation of the Geo.X network at international conferences

Improving the international visibility of Geo.X is a requirement for developing the brand, which in turn strengthens the network. The international outreach of Geo.X comprises the (co)organization and participation in various event formats, which serve the promotion and presentation of the geosciences and the Geo.X partner institutions. As part of the Geo.X internationalization concept, the Geo.X working group *International Affairs* was constituted in 2017. The goals of the working group are to coordinate the international cooperation of the Geo.X network and to harmonize it strategically. The members of the working group come from all partner institutions chaired by the international office at GFZ; the members inform each other about ongoing or planned international events with relevance to Geo.X and discuss common future activities. The members of the working group have agreed to include the Geo.X network into their own activities and to present and support each other at events.

##### Presentation of Geo.X at International Conferences

The Geo.X network presented itself twice at the AGU fall meeting in San Francisco (2016) and in New Orleans (2017) as part of the German community booth *Research in Germany*. A minimum of 2000 young scientists from different disciplinary backgrounds visited the booth. At the annual EGU conferences, Geo.X was always presented at the stands of its partner institutions.

The GFZ International Office was additionally present at the Belt and Road Forum for Young Scientists & Technologists in Chengdu (China) in August 2018, informing about Chinese-German cooperation, research and study opportunities within the Geo.X network.

##### Young Earth Scientist Network YES

In 2017, the German chapter of the Young Earth Scientist Network YES, an organization affiliated to the IUGS (International Union of Geological Science) was established. Its members originate from the Geo.X network as well as universities all over Germany. In 2019, the 5<sup>th</sup> International YES Congress *Rocking Earth's Future* will be held in Berlin. Geo.X, GFZ and its International Office are supporting the chapter's effort to organize this event. It is expected that around 800 to 1300 international junior geoscientists will gather in September 2019 at the FU in Berlin.

### German Science Day

In July 2018, the FU Berlin arranged the 7<sup>th</sup> German Science Day in its Cairo Office in cooperation with eight other organizations including the DAAD. During this event, German universities and research institutions introduced themselves and offered scientists the opportunity to discuss their research projects. On this occasion, the Geo.X network and the Young Academy were introduced.

### DFG Ideas Competition Award *International Research Marketing* 2016

In 2016, for the second time, the German Research Foundation DFG honored ideas for international research marketing in a competition. With their concept, *The international Geo-Campus Potsdam/Berlin – Enhancing the international visibility of GFZ and the Geo.X Network to capitalize a worldwide unique constellation of research and training opportunities*, the International Office at GFZ and the Geo.X network were among the three awardees.

The joint research marketing concept of GFZ and Geo.X focuses on the two target regions Russia and the Near and Middle East with the aim of informing young scientists about the educational and research opportunities and the excellent research infrastructures of the consortium. The selection of the target regions is motivated by the fact that science should act as a means of maintaining dialogue and as an instrument of peace. Concentrating on these target countries should also help to promote scientific cooperation in regions that have received little attention in the past. In this context, the GFZ and Geo.X network will jointly organize summer schools and workshops, especially for young scientists. Furthermore, networking opportunities will be offered within the framework of Geoscience Days at the German embassies of the target regions.

#### GFZ/Geo.X International Research Marketing

- *German-Israeli Research and Innovation Forum* in Munich 2018  
Co-organization with acatech, the Israeli consulate in Munich, the TECHNION in Haifa, and the German TECHNION society
- *Two German-Russian summer schools*  
Co-organization with the Russian Vernadsky Foundation  
1<sup>st</sup> school in October 2016 in Sochi, Russia  
2<sup>nd</sup> summer school in August 2018, Germany
- *Geosciences Days in Oman and Russia in 2017*
- *Geoscience Day at GFZ partnering France* in September 2017  
Elaboration of a common position paper on new research perspectives in Earth system dynamics and presentation to the ministers of research and science in France and Germany

Infobox 12

### 5.6.5 Visibility through working groups

Since the Geo.X working groups are an important pillar of the Geo.X network, their contributions are essential for the visibility of the network. The group's activities are important in fomenting new research activities and linking different groups with each other, who otherwise may have worked in disciplinary isolation; by nature, this activity is bi-directional and helps to forge new alliances. This is a bottom-up process, facilitated and partly accompanied by the Geo.X Head Office and the Steering Committee, which also enables to respond to specific needs such as the establishment of the Geo.Data Clearing House.

### 5.6.6 Communication via the Geo.X website in and outside the network

The main communication channel in and outside the network is the Geo.X website [www.geo-x.net](http://www.geo-x.net) which has been completely revised and re-launched in 2017. Primarily, we inform about network activities: Young Academy and ECSS initiatives, Geo.X organized events in Berlin and Potsdam, and, in particular, calls for Geo.X funding and positions. For this purpose, we developed a state-of-the-art online application tool running on our website. It allows electronic submission, decentralized pre-selection involving scientists from all partner institutions, as well as online rating during the final workshop where the selection of the best candidates will be made (see also section 3.2). The tool has been accepted by all Geo.X partner institutions and can be swiftly adapted to the particular needs that may arise in other collaborative initiatives. For example, the DFG Collaborative Research Cluster SFB 1294, as well as the DFG Research Training Group NatRiskChange, used it successfully for recruiting Ph.D. candidates and postdocs for their open positions. In close coordination with the public relations departments of our partner institutions, we also announce geoscientific or geoscience-related events, conferences, talks and workshops in the area, as well as geoscientific job offers.

Under the heading *Geo meets X*, the Geo.X network and its Young Academy were presented in the weekly's *Die ZEIT ONLINE* section under the heading of Interdisciplinary Research. The article is also available on the Geo.X website.

## 7 Strategy for the next three years

The Geo.X strategy for the next years will be centered around five fields of action: (1) Stimulation of joint collaborative projects: We will continue and expand the stimulation of new joint projects through the Geo.X seed funding program. (2) Adaptive talent management and development of an alumni network: The offers for career development within Geo.X will be continuously adapted to the needs identified by results of the accompanying research projects. (3) Geo.X will implement and establish the use of the Geo.Data Clearing House. (4) The key project portfolio within the Young Academy will be expanded. (5) Positioning Geo.X for the Future: Links to already existing university and non-university structures will be consolidated. In parallel, Geo.X will engage in overarching initiatives in Germany as a place to support interdisciplinary geoscientific research.

### 7.1 Stimulation of joint collaborative projects

The *Geo.X seed funding program* is being well received by the Geo.X community. We plan to continue and expand the seed funding program in order to attract additional network projects over the next three years.

Ongoing activities include the preparation for a renewal grant of the Research Training Group NatRiskChange and the International Training Center (IGRK) StRATEGy, which are both funded by DFG. If successful, this application will provide funds for 20 PhD student positions and consumables for the consortium. The review of the IGRK will be done jointly with the partnering Argentine university consortium.

We are also preparing a DAAD joint proposal organized by Kiel University, FU, UP and GFZ and the IITs of Kanpur and Gandhinagar in India (*GIGEON – German-Indian Geoscience Network*) to carry out a 4-year program of field-based trainings and embedded method workshops in the Alps and the Indian Himalaya (PhD and MSc levels). This project will ultimately constitute the platform for a German-Indian IGRK spearheaded by UP, HU, FU, AWI, and GFZ. Currently, we are designing a number of workshops together with our Indian colleagues aimed at bringing together experts from the geologic and climate-studies communities to develop joint efforts for quantifying landscape changes and mass-flux processes in the high terrains of the Himalaya. This will be partly funded by DFG. Due to their experience in conducting an IGRK, UP was asked to organize workshops in India with the goal to advertise funding opportunities for bi-national graduate education and research.

### 7.2 Adaptive talent management

Geo.X seeks to stimulate self-organized interdisciplinary geoscience. First results of the accompanying research study show that members of the Young Academy and the ECSS value Geo.X's promotion of self-responsibility as well as the training of scientific and transferable skill sets. This seems to be a promising way of building successful careers in academia. Thus, Geo.X will continue refining the concept of the Young Academy, strengthening efforts to promote interdisciplinary projects throughout the network, for instance through the provision of seed funding, in particular for early career scientists.

The accompanying research study also exposes a need for strategically planned, interdisciplinary events, which facilitate interaction between young researchers, their scientific supervisors and PIs from the network. Among the latter, the Geo.X network needs to generate awareness of the importance of leadership as providers of scientific innovation and scientific-careers advice. This aspect is particularly emphasized by responses from female participants in the survey and, therefore, requires Geo.X's increased attention. To improve the culture of communication and scientific feedback, Geo.X will also offer an expanded range of opportunities for scientific exchange throughout the network.

Geo.X will also create awareness of alternative career paths. Within the format of the *Innovators Camp* (see also section 5.3.4) young researchers will be familiarized with opportunities as to how their research can serve economic interests, the public sector or different stakeholder groups.

In addition, Geo.X will establish an alumni network with the Young Academy fellows at its core. We aim to win our alumni as mentors for the upcoming Young Academy classes and integrate them into the whole Geo.X network as cooperation partners.

### 7.3 Geo.Data Clearing House

The keystone for setting up the Geo.Data Clearing House is the identification of the data management strategies of the Geo.X partner institutions and the development of a joint strategy. The requirement analysis for the discovery portal, where the research infrastructure and data of all institutions will be findable and give information on accessibility will be done after identifying the needs and requests of the Geo.X partners. This will result in a concept for the implementation of the portal which will be realized in close collaboration with the Library Wissenschaftspark Albert Einstein. Based on the model of the discovery portal for research infrastructures and data at GFZ ([RI@GFZ](#)), the new portal of the Geo.Data Clearing House will include descriptions and guidelines to data and research infrastructure with specific links to datasets, websites, and contact persons.

We have decided to start with a laboratory infrastructure portal comprising available equipment at the Geo.X partner institutions, since laboratories are one of the main data-generating facilities. The implementation of the infrastructure portal contributes to the discussion among the Geo.X community how quality assurance, joint education of students and young scientists, common further development through exchange of experiences and mutual support in the operation of infrastructure – all of them Geo.X concerns – can be supported and finally, how data can be produced to make them better reusable according to the FAIR principles. In addition, the discussion on access policies for the laboratory infrastructure for the Geo.X partners will be promoted.

### 7.4 Expansion of the Geo.X key project portfolio within the Geo.X Young Academy

Geo.X continues to build its interdisciplinary network of early career scientists. In the second cohort of the Young Academy Geo.X plans to pursue and deepen the scientific approach of Geo.Data Science. Additionally, the thematic spectrum of the new class will be broadened with the new topic *Geo.Society*. Here, we will combine social science perspectives with our core geoscientific research fields. Changes in the Earth system are societally relevant and, while many may be foreseeable, they remain highly unpredictable and may exist in a transient state. Assessing Earth's behavior in states of transition,

however, is a key to mitigating the effects of environmental change and to assessing the vulnerability, adaptivity and regenerative potential of societies.

### Geo.Society

Future Young Academy fellows will focus on societal challenges that can only be tackled by joint efforts among geo and social scientists. These challenges include environmental hazards such as floods, landslides, earthquakes, meteorite impacts, global climate and ecosystem changes on decadal to millennial scales, and air pollution, as well as natural resource management. The challenges can and should be tackled in tandem with societal stakeholders to find sustainable solutions for current and future generations. Since knowledge on these matters is widely dispersed in society, the research approach will, where appropriate, be transdisciplinary, i.e. include stakeholder and local knowledge. Managing these challenges also requires understanding the role and politics of geoscientific knowledge in controversies surrounding these issues, stakeholder reactions in past events as well as according governance challenges. The new cohort of Geo.X fellows will bridge between the geo and social sciences, spark innovative collaborations, explicitly link scientific efforts to societal problems, and become a new generation of leaders that will be characterized by an advanced degree of Earth and Social Science literacy. These future leaders will be capable of conversing and collaborating across disciplinary boundaries to address the urgent challenges of our time.

### Geo.X Key Research Fields

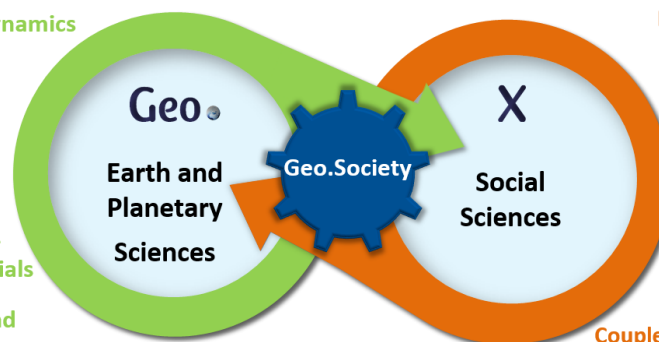
(Planetary) Geodynamics

Natural Hazards  
and Risks

Geo-Bio-  
Interactions

Natural Resources  
and Energy Materials

Human Habitat and  
Sustainability



### Methodological Research Fields

Risk Assessment and Natural  
Resource Management

Knowledge Exchange  
and co-Creation

Science &  
Technology Studies

Mixed Methods Research  
on Human-Environment  
Relations

Coupled geo/social Science Models

Figure 9: Geo.X Young Academy projects contribute to five geoscientific research fields and interact with methodological research areas from social sciences

## 7.5 Positioning Geo.X for the future

In order to anchor the topic of Geo.Data Science in university and non-university research in the long run, existing connections in both directions will be systematically consolidated:

Research in the Geo.Data Science class of the Geo.X Young Academy has many scientific interfaces with university structures in Data Science, foremost the mathematical DFG research clusters [SFB 1294 Data Assimilation](#) and [SFB 1114 Scale Cascades in Complex Systems](#). In addition, the inter-institutional SFB initiative *Foundation for large-scale scientific data analysis* in computer science with geoscientific applications is currently being prepared at HU Berlin. We plan to deepen the cooperation with these clusters by systematically integrating mathematicians and computer scientists into the Young Academy training offers, workshops, and conferences. Over the long term, possible interfaces will be explored



for collaboration with educational components of the recently approved, cross-institutional [Math+ cluster](#) of the Berlin University Alliance.

Beyond these alliances, Geo.X is connected with the Helmholtz Einstein International Research School in Data Science ([HEIBRiDS](#)). Similar to the mission of the Geo.X Young Academy, HEIBRiDS combines disciplinary knowledge with competence in data science. HEIBRiDS brings together several Helmholtz Centers and ECDF (Einstein Center Digital Future) partners, all working at the intersection of databases and data mining, machine learning, network science, statistics and statistical physics, information retrieval, applied mathematics, and analyses of complex networks. Doctoral researchers from HEIBRiDS, who are associated with one of our Helmholtz Centers AWI, DLR, and GFZ, are already integrated into the Geo.X Young Academy as fellows and participate in the Academy training program.

It is in the mutual interest of HEIBRiDS and Geo.X to pool their strengths for training a *critical mass* of young researchers in data science. Therefore, joint lecture series, tutorials in data science methodologies, internships, and customized course offers are in the implementation phase. Moreover, postdoctoral fellows of the Geo.X Young Academy mentor HEIBRiDS doctoral students and stimulate the direct exchange of scientific knowledge and experience.

By joining forces, HEIBRiDS and the Geo.X Young Academy are working towards becoming the *Academy Site* for Geo.Data Science in the Helmholtz Information & Data Science Academy (HIDA). This linkage would significantly enrich the scientific spectrum of the Geo.Data Science research field and foster the fit of geosciences with other scientific disciplines and communities over the long-term.

Geo.X aims to be the nexus and driving force for knowledge transfer and cooperation in the field of Geo.Data Science between scientists from its university partner institutions and researchers of the Helmholtz community.

**The Helmholtz Information and Data Academy (HIDA)** builds a Helmholtz-wide network for education and training in the field of Information & Data Science and will start in early 2019. HIDA bundles the information & data science-related activities at all Helmholtz centers and is one of four platforms of the Helmholtz Association that together form the new Helmholtz Information & Data Science Framework.

*Infobox 13*

In the long run, Geo.X aims to expand this role with new interdisciplinary research fields on a national level. For example, research data management will be shaped in the future by the planned National Research Data Infrastructure (NFDI). Consortia with the broad support of a research community on a national level are considered in the NFDI as a base for all actions. Geo.X will act as a common interest group within a current plan for a consortium NFDI4earth (NFDI for earth system science). Geo.X is the ideal fundament for all partners to give their institution a voice in the further development of NFDI4earth. Geo.X partners who also participate in NFDI approaches for other research communities can act as knots to strengthen interdisciplinary ties.

The envisaged topic *Geo.Society* will tie in with existing institutional structures such as the *Integrative Research Institute on Transformations of Human-Environment Systems* ([IRITHESyS](#)) at HU and will create new interfaces to social science research clusters in the region (e.g. [SFB 1265 Re-Figuration of Spaces](#), or the interdisciplinary [WEXICOM](#) project at FU which aims to advance the communication, understanding and use of uncertainty of weather warnings and weather risks. Thus, Geo.X will connect even more strongly with the Berlin University Alliance between HU, FU, TU, and Charité – Universitätsmedizin Berlin. This alliance strengthens and supports cooperation at the institutional level



and aims to open up opportunities for new innovative research projects and to shape the future together.

The planned German Earth System Alliance (DESA) Initiative can be a further opportunity for Geo.X to get involved as a regional geoscientific node. DESA is intended to unite German university and non-university research institutions active in Earth system research in order to jointly meet the challenges of a globally networked society in dealing with changes in the environment. As Geo.X does at a regional level, DESA will foster innovative research covering different thematic hubs in Germany, expand research infrastructure, increase knowledge transfer, and improve data management and retrieval. On the European level, Geo.X seeks to get involved in the [ExtremeEarth](#) initiative. ExtremeEarth aims to understand and advance society's ability to predict the frequency of occurrence and intensity of extremes reliably.