

**Stellungnahme zum
Leibniz-Institut für Ostseeforschung Warnemünde (IOW)**

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Vorbemerkung

Die Einrichtungen der Forschung und der wissenschaftlichen Infrastruktur, die sich in der Leibniz-Gemeinschaft zusammengeschlossen haben, werden von Bund und Ländern wegen ihrer überregionalen Bedeutung und eines gesamtstaatlichen wissenschaftspolitischen Interesses gemeinsam gefördert. Turnusmäßig, spätestens alle sieben Jahre, überprüfen Bund und Länder, ob die Voraussetzungen für die gemeinsame Förderung einer Leibniz-Einrichtung noch erfüllt sind.¹

Die wesentliche Grundlage für die Überprüfung in der Gemeinsamen Wissenschaftskonferenz ist regelmäßig eine unabhängige Evaluierung durch den Senat der Leibniz-Gemeinschaft. Die Stellungnahmen des Senats bereitet der Senatsausschuss Evaluierung vor. Für die Bewertung einer Einrichtung setzt der Ausschuss Bewertungsgruppen mit unabhängigen, fachlich einschlägigen Sachverständigen ein.

Vor diesem Hintergrund besuchte eine Bewertungsgruppe am 24. und 25. Oktober 2019 das IOW in Warnemünde. Ihr stand eine vom IOW erstellte Evaluierungsunterlage zur Verfügung. Die wesentlichen Aussagen dieser Unterlage sind in der Darstellung (Anlage A dieser Stellungnahme) zusammengefasst. Die Bewertungsgruppe erstellte im Anschluss an den Besuch den Bewertungsbericht (Anlage B). Das IOW nahm dazu Stellung (Anlage C). Der Senat der Leibniz-Gemeinschaft verabschiedete am 15. Juli 2020 auf dieser Grundlage die vorliegende Stellungnahme. Der Senat dankt den Mitgliedern der Bewertungsgruppe und des Senatsausschusses Evaluierung für ihre Arbeit.

1. Beurteilung und Empfehlungen

Der Senat schließt sich den Beurteilungen und Empfehlungen der Bewertungsgruppe an. Das IOW erforscht die Ökosysteme von Küsten- und Randmeeren mit dem Schwerpunkt Ostsee. Die Arbeiten reichen von der Untersuchung grundlegender physikalischer, chemischer, biologischer und geologischer Einzelprozesse im mikroskopischen Bereich bis zur Erforschung langfristiger beckenweiter Veränderungen und deren sozio-ökonomischen Folgen für die Küstenregionen. Daneben nimmt das IOW wichtige Infrastruktur- und Transferaufgaben wahr.

Das IOW hat seit der letzten Evaluierung sein wissenschaftliches Profil sehr überzeugend weiterentwickelt. Dieser Prozess wurde durch sehr gute gemeinsame Berufungen auf der Leitungsebene unterstützt. Wie empfohlen konnten die Publikationsleistungen weiter verbessert und die kompetitiv bei DFG und EU eingeworbenen Drittmittel substantiell gesteigert werden. Im Rahmen einer sehr gut funktionierenden und effizienten Organisationsstruktur bearbeiten die vier disziplinär ausgerichteten Abteilungen gemeinsam vier Forschungsschwerpunkte, die schlüssig aufeinander aufbauen. Die **Leistungen** der vier Schwerpunkte werden als „sehr gut bis exzellent“, „sehr gut“, „gut bis sehr gut“ und „gut“ bewertet.

¹ Ausführungsvereinbarung zum GWK-Abkommen über die gemeinsame Förderung der Mitgliedseinrichtungen der Wissenschaftsgemeinschaft Gottfried Wilhelm Leibniz e. V.

Die **Forschungsarbeiten** des IOW sind in einer guten Balance sowohl auf den einzigartigen Naturraum Ostsee als auch auf systemübergreifende und modellorientierte globale Fragen ausgerichtet. Mit seinen Arbeiten etwa zum Klimawandel und seinen Folgen, zu zunehmendem Müll und abnehmender Biodiversität in den Meeren wird das IOW seinem Anspruch gerecht, Ergebnisse zu erzielen, die über spezifische Erkenntnisse zur Ostsee hinaus relevant sind. Das IOW sollte diese künftig häufiger in Zeitschriften veröffentlichen, die ein breiteres wissenschaftliches Publikum erreichen. Projekte in anderen Küsten- und Randmeeren sollten, wie das Institut selbst vorsieht, konsequent in diese Gesamtstrategie eingepasst sein.

Die **Forschungsinfrastrukturleistungen** des IOW bilden die außerordentlich wertvolle Grundlage sowohl für die eigenen Forschungs- und Beratungsleistungen des Instituts als auch für die externe Nutzung. Von zentraler Bedeutung ist das Monitoring-Programm zur Überwachung der Meeresumwelt der Ostsee, das das IOW unter anderem für das Bundesamt für Seeschifffahrt und Hydrographie durchführt. Die erhobenen Daten stellt das IOW der wissenschaftlichen Gemeinschaft in einer Datenbank zur Verfügung, in der über 70 Millionen ozeanographische Messwerte und Metadaten aus den letzten 150 Jahren enthalten sind.

Außerdem erbringt das IOW stark nachgefragte **Beratungs- und Transferleistungen**, beispielsweise zur Erhaltung der Leistungsfähigkeit mariner Ökosysteme oder zur Kartierung des Meeresbodens. Die Aktivitäten des IOW zur Entwicklung einer Indikatorik, mit der die Wirkung der vielfältigen Transferaktivitäten erfasst werden kann, sind sehr zu begrüßen. Auf dieser Grundlage sollte das IOW die Transferleistungen fortentwickeln und ihre Sichtbarkeit weiter erhöhen.

Bislang beschäftigt sich das IOW überwiegend mit der offenen See und mit dem küstennahen Festland. Im Anschluss an sehr überzeugende Vorarbeiten plant das Institut nun, sein technisches und methodisches Spektrum zu erweitern, um auch flache Küstengewässer in die Arbeiten einzubeziehen. Zur Umsetzung sieht das IOW ab 2022 **zusätzliche Mittel der institutionellen Förderung** in Höhe von jährlich 2,0 Mio. Euro vor (und einen Eigenanteil von 0,5 Mio. Euro). Die vorgesehenen Mittel sind plausibel begründet. Die geplante Erweiterung schließt schlüssig an Empfehlungen der letzten Evaluierung und des Wissenschaftlichen Beirats an. Es wird nachdrücklich befürwortet, für diese Maßnahme einen Antrag für einen Sondertatbestand im Rahmen des dafür vorgesehenen Verfahrens bei Bund und Ländern vorzulegen.

Das IOW verfügt über eine angemessene und moderne **Ausstattung**. Das Institut weist sehr klar nach, dass sich der Betrieb des eigenen Forschungsschiffs *Elisabeth Mann Borgese* wissenschaftlich lohnt und das Schiff angemessen ausgelastet ist. Eine Nutzung von Schiffen anderer Institutionen würde den spezifischen Belangen des IOW nicht in gleicher Weise gerecht werden. Es wird deshalb begrüßt, dass Bund und Länder die institutionelle Förderung erhöhten, damit der laufende Betrieb und die seit einiger Zeit anfallenden Steuern für die Bereederung des Schiffs vom Institut dauerhaft finanziert werden können.

Das IOW kooperiert eng mit den Universitäten in Rostock und Greifswald. Alle neun Wissenschaftlerinnen und Wissenschaftler in **Leitungspositionen** sind gemeinsam mit einer

der beiden Hochschulen berufen. Von besonderer Bedeutung für die zukünftige Entwicklung wird die 2021 ruhestandsbedingt anstehende Neubesetzung der wissenschaftlichen Leitung sein. Es wird sehr begrüßt, dass dieser Prozess bereits frühzeitig eingeleitet wurde.

Bei der letzten Evaluierung gab es am IOW keine **Wissenschaftlerin in leitender Position**. Seitdem wurden zwei der vier Abteilungsleitungen neu besetzt, eine davon mit einer Frau. Das IOW ist jedoch weiterhin aufgefordert, hier Verbesserungen zu erreichen. Mit anstehenden personellen Wechsels bestehen dazu in den kommenden Jahren gute Chancen. **Promovierende und Postdocs** finden am IOW mit Betreuungskomitees und strukturierten Programmen sehr gute Bedingungen vor. Wie geplant sollte das IOW verstärkt auch Mitarbeitende aus dem Ausland gewinnen.

Wie bei der letzten Evaluierung empfohlen hat das IOW seine internationalen **Kooperationen** intensiviert, insbesondere im Ostseeraum. Zur besseren Vernetzung trug die Beteiligung an einer Vielzahl von Verbundprojekten bei. Um die internationale Sichtbarkeit des IOW noch weiter zu erhöhen, sollte das Institut auf diesem Weg voranschreiten.

Die Erfüllung der langfristigen Forschungs-, Transfer- und Infrastrukturaufgaben, die das IOW im Hinblick auf marine Ökosysteme erbringt, ist in dieser Form an einer Hochschule nicht möglich. Eine Eingliederung des IOW in eine Hochschule wird daher nicht empfohlen. Das IOW erfüllt die Anforderungen, die an eine Einrichtung von überregionaler Bedeutung und gesamtstaatlichem wissenschaftspolitischen Interesse zu stellen sind.

2. Zur Stellungnahme des IOW

Der Senat begrüßt, dass das IOW beabsichtigt, die Empfehlungen und Hinweise aus dem Bewertungsbericht bei seiner weiteren Arbeit zu berücksichtigen.

3. Förderempfehlung

Der Senat der Leibniz-Gemeinschaft empfiehlt Bund und Ländern, das IOW als Einrichtung der Forschung und der wissenschaftlichen Infrastruktur auf der Grundlage der Ausführungsvereinbarung WGL weiter zu fördern.

Annex A: Status report

Leibniz Institute for Baltic Sea Research Warnemünde (IOW)

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1. Key data, structure and tasks

Key data

Year established:	1992
Admission to joint funding by Federal and <i>Länder</i> Governments:	1992
Admission to the Leibniz Association:	1992
Last statement by the Leibniz Senate:	2013
Legal form:	Public Law Foundation
Responsible department at <i>Länder</i> level:	Ministry of Education, Science and Culture, Mecklenburg Western Pomerania
Responsible department at Federal level:	Federal Ministry of Education and Research (BMBF)

Total budget (as of 31 December 2018)

- € 13.4 m institutional funding
- € 10.8 m revenue from project grants
- € 0.4 m revenue from services

Number of staff (as of 31 December 2018)

- 122 individuals in research and scientific services
- 81 individuals in service sector
- 24 individuals in administration

Mission and tasks

The mission of the IOW is to promote and perform scientific marine research with a particular focus on marginal seas, shelf areas, and the ecosystem of the Baltic Sea including scientific monitoring.

Organisation

The work at IOW is organised in a matrix structure (see organisational chart in appendix 1). The first dimension is given by the four departments "Physical Oceanography and Instrumentation", "Marine Chemistry", "Biological Oceanography" and "Marine Geology". Furthermore, there is one more unit conducting research, the "Coastal Sea: Management and Planning" working group, which is affiliated to the director.

The four departments work together in the second dimension of the matrix, given by the following four research foci (RFs): RF1: "Small and meso-scale processes", RF2: "Basin-scale ecosystem dynamics", RF3: "Changing ecosystems" and RF4: "Coastal seas and society". The working group contributes to RF4. In this report the work and results of IOW are presented according to the four RFs (see chapter 7).

In addition, the two cross-cutting activities (CCAs), “Modelling development” and “Innovative instrumentation”, aim at fostering the development of methodical aspects that extend beyond the disciplinary boundaries of the departments. Both CCAs primarily serve as communication platforms. The products emerging in response to discussion processes in this context are mainly connected to the scientific demands of the respective RF.

2. Overall concept, activities and results

Overall concept

The overall objective of the IOW is to understand the key processes in the Baltic Sea and how they develop in a changing environment. Based on its results, IOW strives to establish regional Earth system models able to provide projections of future conditions. In the following, the four RFs and two CCAs are briefly described:

- RF1 “Small and meso-scale processes” focusses on those processes relevant for the overall functioning of the Baltic Sea system. This primarily includes the processes occurring at interfaces but also the transport processes within the water column.
- RF2 “Basin-scale ecosystem dynamics” explores fundamental processes on a basin scale including interactions of marine system processes as well as the changes in biodiversity and ecosystem functions occurring along spatial gradients.
- RF3 “Changing ecosystems” combines the work on processes (RF1) and ecosystem functions (RF2) with a temporal perspective. Investigations tackle geological and historical time-scales of several millennia and centuries as well as the decadal time-scales encompassed by IOW’s long-term monitoring programme.
- RF4 “Coastal sea and society” comprises applied research conducted in cooperation with end-users. It focuses on interventions such as the discharge of pollutants, on improvements in the implementation of marine and coastal policies and on the development of adaptation measures in response to global change effects.

Research conducted in RF1 and RF2 is of a generic nature, oriented towards a better understanding of system functioning. This is also the case for the majority of studies within RF3. However, the long-term observation programme that is carried out within RF3 is also linked to applied aspects and creates products needed by the authorities, but which are also of interest to the public. These products are the main source of IOW’s transfer activities (see below). Research in RF4 responds to environmental issues that are considered a potential threat for the near future. This applied research is mostly conducted in cooperation with stakeholders and generates insights transferable to society.

The basis for research at IOW is the data that is collected by the institute. The majority of data is gained by its long-term observation programme, which consists of five cruises the IOW runs each year during which hydrographic, chemical, biological and geological variables are measured at up to 100 stations, spanning the area between the western and central Baltic Sea. At key stations, these measurements are supplemented by the high-resolution datasets of autonomous operating fixed platforms and moorings. The collected

data is freely accessible to the scientific community at the IOW database IOWDB (see below).

Within the German exclusive economic zone (EEZ), the observations are carried out for the HELCOM (Helsinki Commission) monitoring programme. This task has been assigned to the IOW by the Federal Maritime and Hydrographic Agency (*Bundesamt für Seeschifffahrt und Hydrographie*, BSH), including the operation and maintenance of three autonomous measuring stations. The BSH allocates a yearly budget of approximately 2 M€ to the IOW for the implementation of these two tasks (see chapter 4 and appendix 3).

Beside its comprehensive consideration of the Baltic Sea, the institute is also investigating research questions in other coastal seas, because, according to IOW, (a) understanding of Baltic Sea processes can be improved by comparisons of different environmental conditions, (b) certain processes can be better investigated outside the Baltic and (c) the expertise of IOW scientists is required in cooperative projects. These activities are exclusively supported by third-party funds.

Activities and results

Between the three typical types of work conducted at Leibniz institutions (research/operation of research infrastructures/transfer) IOW's focus strongly lies on research. However, IOW also runs four research infrastructures open for the scientific community and it aims at the transfer of research results to the relevant target groups.

Research

Between 2016 and 2018 scientists from IOW published research results in 516 publications of which 412 were articles in peer-reviewed journals (see appendix 2). The IOW highlights research results in the following seven areas, which, in view of the institute, are not only relevant for understanding problems faced by the Baltic Sea but which are also current "hot topics" of oceanography on a global scale:

- the increase in eutrophication,
- the spread of oxygen minimum zones,
- biodiversity and food webs,
- climate variability and climate change impact,
- the growing burden of marine litter,
- the discharge of emerging contaminants,
- a better understanding of greenhouse gas dynamics.

Operation of research infrastructures

The IOW provides four research infrastructures for use by the scientific community:

- The IOW operates and maintains the database IOWDB, which currently comprises more than 70 million oceanographic readings and metadata covering the years 1877–2019. Phyto- and zooplankton data are available for the period 1988–2018. The IT

group has developed a research tool (ODIN2) for searching and visualisations of the retrieved information.

- The IOW is member of the German network ICOS-D. This is the German part of the European consortium Integrated Carbon Observation System (ICOS), which provides data on greenhouse gas concentrations. Among the IOW's tasks are the continuous acquisition of pCO₂ and pCH₄ data on a "voluntary operating ship" (VOS), the cargo ferry Finnmaid, which commutes between Lübeck and Helsinki. The data are delivered to the Surface Ocean CO₂ Atlas (SOCAT) from where they are publicly available. ICOS is a European Research Infrastructure.
- The CAMECA NanoSIMS 50L is a secondary-ion mass spectrometer. This device enables visualisation of the distribution of individual elements or isotopes in solid samples and has a lateral resolution of up to 50 nm. There are only about 25 NanoSIMS in Europe. A contribution to cover the running expenses is required from external users.
- Finally, the IOW operates the research vessel Elisabeth Mann Borgese (see chapter 4).

Transfer

For its transfer activities, IOW distinguishes the following three different target groups, where the first one is the main target group: (1) authorities/agencies involved in the implementation of marine policy; (2) the general public but also, specifically, schools and (3) enterprises developing marine research technologies. In the following, IOW's transfer activities are described according to these three target groups:

An example for target group (1) is given by IOW's long-term cooperation with the BSH and the Federal Agency for Nature Conservation (*Bundesamt für Naturschutz*, BfN). For both, the IOW is conducting monitoring programmes with the aim of assessing the state of German waters of the Baltic Sea in general and that of benthic habitats in particular. Among the resulting products are i) annual assessments of the state of the Baltic Sea environment, ii) maps of anoxic areas and of benthic habitats and iii) comprehensive datasets freely accessible via the IOWDB or the Baltic Sea Atlas, which is a Geo-information system (GIS) offering maps of a variety of environmental variables. As members of HELCOM Expert Network groups (EN) and related groups on federal or *Länder* level, IOW supports the processes required for the implementation of the Baltic Sea Action Plan (BSAP) and of other European regulations.

(2) To provide the public with information on topics of common concern, such as the overfertilisation of the Baltic Sea or its expanding "dead zones", the institute offers regular discussion rounds. An exhibition in the Forschungsvilla Ostsee presents IOW's work. In the school programmes MariSchool and PlasticSchool, special teaching modules are offered.

(3) Technology transfer aims at improving marine research technologies and supporting enterprises to develop new products to fulfil scientific needs. To improve marine research technologies, IOW technicians adjust commercially available equipment to the special conditions of the Baltic Sea or to meet a specific scientific demand. The products are used by IOW and other German scientists. Recent examples are a research winch with Active

Heave Compensation or the Self-cleaning Monitoring Box (SMB) for continuous, on-route analyses of surface water on board of research vessels. To support enterprises, IOW scientists cooperate in third party funded projects on, e.g. new marine research instrumentation or environmentally friendly applications.

3. Changes and planning

Development since the previous evaluation

Changes in personell and research areas

In 2012, one month prior to the last evaluation visit in 2012, the newly appointed head of the Biological Oceanography department arrived at the IOW. She rearranged the different approaches in microbiology existing at the department into the three working groups Microbial Ecology, Environmental Microbiology and Geomicrobiology whose focuses are the structure and function, importance, and metabolic pathways and element fluxes of the microorganisms and microbial communities found in marine aquatic ecosystems.

In 2012, the IOW received additional financial support for four years, a so-called “temporary extraordinary item of expenditure” (*temporärer Sondertatbestand*), to establish next-generation systems allowing long-term investigations in the central Baltic. The newly employed scientists and technicians implemented new underwater technologies and automatic monitoring stations, established chemical analytical tools for use in measuring emerging contaminants, consolidated the capacity to determine changes in plankton and benthic communities and related processes, implemented high-resolution sea mapping capacities and improved the resolution and capacity of coupled marine physico-biochemical models. The results were reported in publications or led to the development of instruments.

In December 2014, a Major Baltic Inflow (MBI) occurred. It was the third-largest inflow event of North Sea water into the Baltic Sea since the beginning of oceanographic measurements. To monitor the event, the IOW changed the 2015 schedule of its research cruises. Subsequent studies aimed at the basin-wide implications of such inflow events, with the results reported in more than 10 publications.

In 2015, the newly appointed head of the Physical Oceanography and Instrumentation department arrived at the IOW. He established a new working group on the dynamics of regional climate systems. Its focus is the development of regional climate models for the Baltic Sea. His expertise filled a long-time gap in the IOW’s scientific portfolio and reinforced the institute’s contribution to the pan-Baltic network Baltic Earth (see chapter 6).

Strategic work planning for the coming years

The IOW Director and the head of the Marine Chemistry department (who is also the current Deputy Director) will retire in 2021 and 2023. For their positions, IOW strives to attract internationally renowned, high-level scientists. The procedure to appoint a new Director has already started, in the form of an international announcement and the establishment of an Appointment Committee. The procedure to fill high level scientific positions is described in Chapter 5.

The IOW strives to continue to actively advance the coastal sea research landscape in Germany. The IOW leads the strategic planning and operationalisation of coastal sea research in the mission “Use and Protection of the Ocean” of the German Alliance for Marine Science (*Deutsche Allianz für Meeresforschung*, DAM). The basis for these activities is laid out in the Strategy Group “Coastal Research” of the German Marine Research Consortium (*Konsortium Deutsche Meeresforschung*, KDM). The DAM seeks to place German marine science in the international forefront.

IOW aims at the continuation of the DFG Research Training Unit “Baltic TRANSCOAST” until 2024. The Leibniz ScienceCampus on Phosphorus (P) Research at Rostock, in which the IOW has the coordinating role, very recently received funding for the next 4 years. As in current EU-BONUS programmes, the IOW will strive for international cooperation under the upcoming follow-up programme EU-BANOS.

The IOW’s current research programme will end in 2022 and the institute, with its new Director, will establish a new 10-year scientific programme. The system approach of the current programme relies on all four RF to meet its general objective of a systematically based understanding of the Baltic Sea ecosystem. Given the many still unsolved questions, the new programme will need to continue to pursue the main lines of the current programme. However new priorities and emerging topics will be subject of future discussions. In particular, IOW sees demand to expand its scientific profile to include assessments of multiscale processes in shallow coastal water (see below).

Planning for additional funds deriving from institutional funding

The IOW has recently intensified research in shallow coastal environments within the framework of collaborative projects, such as the BMBF-funded PhosWam and the DFG Research Training Group Baltic TRANSCOAST. However, in view of the institute, it’s current capacity does not allow investigations of the functioning of the complex coastal interface and its overall impact on the marine ecosystem. Therefore, the IOW plans to apply for a permanent increase of it’s institutional funding (permanent extraordinary item of expenditure of a scientific nature) to extend IOW’s infrastructure and personnel and to enable IOW to develop new observational, experimental and modelling tools that can be used to study critical shallow coastal processes and their impact on the open sea. On its meeting on June 25, 2019, the IOW’s Board of Governors approved the institute’s application on the basis of a respective recommendation of the institute’s Scientific Advisory Board.

In order to implement this expansion, IOW plans to establish a new instrumentation unit in addition to the four scientific departments, headed by a W2-professor for Instrumentational Infrastructure. The staff to be newly recruited (one W2-professor, 13 scientists and 8 technicians, see below for details) will become either members of the new instrumentation unit (in case of technicians) or of the four scientific departments according to their respective disciplinary background (in case of scientists). The head of the instrumentation unit will then be one of the two speakers of a new RF5: “Multiscale processes in shallow coastal waters”. The new RF5 will be structured into the following six activity packages, for which IOW applies for the additional institutional funding:

Package 1: Shallow-water time series station

The availability of long-term data in high-energy intermittent environments is a technical requirement for the identification of “hot moments”. Such data will be obtained by establishing resistant long-term moorings equipped with specifically designed instruments and installed at 2–3 representative coastal sites.

- Investments and maintenance: Fixed poles, instruments with in-situ sensors, underwater acoustics and optics.
- Personnel: W2-professor (0.33 %), 2 scientists at paygroup (*Entgeltgruppe*) EG 13 and 2 technicians (EG 12 and 11).

Package 2: Autonomous vehicles and sampling devices for the coastal zone

Autonomous technologies will be used to develop a new set of in-situ devices and vehicles that study critical processes in coastal zones, including underwater autonomous vehicles (AUV), flying drones and swimming catamarans, all equipped with multiple sensor packages. Specialised in-situ systems (AFIS-Sys) for biological sampling and automated underwater microscopes (phyto- and zooplankton), both with data processing and transfer capabilities, will be adapted for coastal applications.

- Investments and maintenance: AUV, drones, autonomous catamaran, AFIS-Sys, phytoplankton imaging flow cytobot and an optical zooplankton imaging system.
- Personnel: W2-professor (0.33 %), 3 scientists (EG 13), 2 technicians (EG 12 and 9).

Package 3: Processes at the sediment-water interface, specialised benthic mooring systems

Field experiments in shallow coastal environments will be conducted using specialised benthic mooring systems to study key processes in benthic-pelagic coupling. A newly developed instrumentation with sediment profilers able to measure subsurface parameters will be used to investigate process rates in incubation and tracer experiments.

- Investments and maintenance: eddy-covariance, mini-profilers, chamber landers, optical systems for sediment transport, stationary hydro-acoustics (rotating transducers/sonars), optic laser, LISST, camera systems, small vibro-corer.
- Personnel: W2-professor (0.33 %), 3 scientists (EG 13), 2 technicians (EG11 and 9).

Package 4: Coastal incubation laboratory

A coastal incubation laboratory will be established that is equipped with incubation and flow-through chambers adapted for experiments performed under controlled fluctuating conditions. The experiments will be designed so as to simulate the physical processes occurring in situ, investigate the responses of benthic and planktonic biological communities and determine biogeochemical process rates.

- Investments and maintenance: coastal incubation laboratory.
- Personnel: 2 scientists (EG 13), 2 technicians (EG 9 and 7).

Package 5: Multi-scale coupled physical-biogeochemical numerical modelling

A multi-scale modelling system will be developed to quantify the key processes in shallow coastal environments and their feedback to the marginal sea. These models will include interactive coupling with surface waves and with benthic, sea-ice and atmospheric modules for shallow water. The consistent integration of a coupled pelagic-benthic biogeochemical module is a key element of the model system. Field and laboratory data from packages 1–4 will be exploited for parameter optimisation to maximise the predictability of the coastal ocean modelling system.

- Personnel: 2 scientists (EG 13).

Package 6: Management & Planning Tool Box for science-policy transfer

The Management & Planning tool box will integrate existing and suitable new approaches under the umbrella of a Systems Approach Framework. Additional tools will be developed for spatially refined and explicit approaches. For this purpose, data and information from the spatial monitoring approaches (packages 1–3) and the adapted model system (package 5) will be utilised. The Tool Box will enable IOW to meet a demand for information by the authorities. The involved staff will develop a permanent science-policy transfer plan.

- Personnel: 1 scientist (EG 13).

The sum of the investment, operational and personnel costs of the six packages is given in the table below for each year from 2022 on. In the last two rows the financing by IOW's existing funding and the additional funds is shown.

Costs of the 6 packages in k€	2022	2023	2024	2025	Permanently
(Initial) investments costs	632	704	628	564	455
Operational costs	114	92	179	135	257
Personnel costs (22 persons)	1.534	1.565	1.603	1.761	1.798
Total costs	2.280	2.361	2.410	2.460	2.510
Funds from existing funding	500	510	520	530	540
Additional funds	1.780	1.851	1.890	1.930	1.970

4. Controlling and quality management

Facilities, equipment and funding

Funding

In 2018, IOW's institutional funding was approx. 13.4 M€ (see appendix 3).

Additionally, 10.7 M€ were spent from revenues from project grants (corresponding to 44 % of the overall budget). The revenues split into 3.7 M€ from Federal grants, 2.5 M€ from the Federal Maritime and Hydrographic Agency (BSH), 2.1 M€ from the EU, 1.3 M€ from the DFG and 0.8 M€ from the Leibniz competitive procedure.

The large revenues from federal grants reflect the role played by the IOW in the implementation of the German marine research programmes (MARE:N) of the Federal Ministry of Education and Research (BMBF), in particular regarding the funding programmes for coastal research in the North Sea and Baltic Sea (“KüNO – Küstenforschung Nordsee/Ostsee”). They also include funds from the BfN, which support an assessment of the status of individual protected areas in Germany’s EEZ. Funds from the BSH, which finance the implementation of HELCOM monitoring, a sovereign task, are of a similar but permanent nature. Due to this speciality, the BSH funds are indicated separately from the federal grants.

The EU funding is dominated by grants under BONUS, a European programme that provides funds for the promotion of Baltic Sea research. The revenues from the DFG increased especially due to the approval of the Baltic TransCoast Research Training Group and IOW’s participation in the Collaborative Research Centre (SFB) Transregio 181 “Energy transfers in Atmosphere and Ocean”, which is coordinated by the University of Hamburg.

Revenues for Servies are low, since commercial exploitation of results is not among the major goals of IOW. Inventions that are submitted for patenting or transfer to companies under a license agreement (3 inventions within the last 3 years of which one yielded a license agreement) are usually created as by-products of optimisation of the technology used at the IOW.

Research vessel Elisabeth Mann Borgese: Recommendations of the last evaluation

In 2011, shortly before the last evaluation, the IOW commissioned the new ship Elisabeth Mann Borgese (EMB). As this vessel is considerably larger than its predecessor this was accompanied by a permanent increase of approx. 0.5 M€ per year in operating costs. At that time, the IOW assumed that the joint funding by the federal and *Länder* governments assigned for Leibniz institutions would increase at a rate of 3% of the institutional funding each year according to the so-called Pact for Research and Innovation III. However, as Pact III provided a growth rates of 1.5 %, this turned out to be not the case. Therefore, in 2012 at the time of the last evaluation it was not clear how to cover the additional costs. The Senate of the Leibniz Association expected the IOW and its funding bodies to find a solution to this problem and to inform the Senate about this solution.

In 2016, IOW reported that the problem has been solved. According to an agreement concluded with the Ministry of Education, Science and Culture of Mecklenburg-Western Pomerania, the gap in the core budget of the IOW has been covered within the framework of coverage eligibility given in the state budget. In reaction to this, the Senate asked the IOW to report on two points in the context of the 2019 evaluation: (a) IOW should consider whether the operation of its own research vessel makes sense in the long term or whether other solutions are more viable. To do so, IOW should (b) coordinate its strategy with the German Marine Research Consortium and with the “German Research Vessels” Federal-*Länder* group. Regarding these two points, IOW states the following:

(a) The need for an own research vessel: The EMB is adapted to the IOW’s needs. It is a multi-purpose ship that can host interdisciplinary groups of up to 12 scientists and has a range of 4,000 nautical miles. The ship serves as a working platform for sea-borne measuring and sampling activities and provides laboratory space for on-site analytical

work. The flexibility to react to unforeseen events or natural phenomena requires a flexible shipping schedule.

The technical and operative management is outsourced on the basis of multiannual contracts to a shipping company (Briese). All in all, the ship is in operation for an average of 300 days per year for the following purposes:

- 110 days per year for sea-going research projects of IOW.
- 120 days per year for operation by IOW to conduct HELCOM monitoring and the long-term observation programme, to maintain the three permanent measuring platforms (MARNET stations) and to offer on-board academic courses to students.
- 70 days per year until 2022 for operation by the German navy as specified in the purchase agreement by the state of Mecklenburg-Western Pomerania with the ship's former owner, the Federal Ministry of Defense. A request for a similar contract of 40 days of operation per year thereafter is currently under consideration.

(b) The coordination of efforts with the German Marine Research Consortium and with the "German Research Vessels" Federal-state group: With the approval of MV, the IOW has included the EMB in the access pool comprising all German research vessels. Thus, the German coastal sea research community can participate in its use by applying ship-time. This pool is centrally organised via a web site and specific proposal standards (application days, proposal outline, and international evaluation procedures).

IOW states that examinations of further options to reduce the risk of financial shortfalls caused by increasing ship costs should be subject of joint considerations of all ship owning states. Many German research vessels are funded according to different funding schemes. The responsible Federal-state group "German Research Vessels" has been working since several years on harmonising concepts. The German Marine Research Consortium (*Kon-sortium Deutsche Meeresforschung*, KDM) is a private organisation and does not have the funds to operate research vessels. However, with the 2019 founded German Alliance for Marine Science (*Deutsche Allianz für Meeresforschung*, DAM) coming to work in the very near future, joint solutions will get promoted.

For longer expeditions in connection with large third-party projects requiring the participation of more than 12 scientists on board, the IOW uses the German research vessels SONNE, METEOR or MARIA S. MERIAN. In the past, the institute some times switched to the research vessels ALKOR or POSEIDON, in case the time schedule of the EMB did not offer shiptime during the time slot demanded by the research to be done. Both ships are of similar size and opportunities as EMB. The research vessel Poseidon will be decommissioned by the end of the year.

The Elisabeth Mann Borgese is designed and equipped according to the special environmental conditions in the Baltic Sea and the IOW's main tasks. A separated CTD room with a gate to outboard enables to tap samples from the water bottles of the CTD probe in a protected surrounding. This allows for water sampling in winter, too, since every low air temperatures cause the equipment to freeze if operated for a longer time on deck due to the low salinity of Baltic Sea water. Measurements in the stratified water body of the Baltic Sea also need a precise position of instruments. With a swell compensation, the EMB is

well equipped for these precise measurements. Other research vessels like Alkor or Poseidon do not provide these benefits. Furthermore, the EMB is a multi-purpose-ship which offers a balanced relation between the size of teams to be hosted on board and the costs of shiptime. All disciplines of the IOW can work their equipment with this ship.

Research vessel Elisabeth Mann Borgese: New financial challenges

Recently, fiscal authorities ruled that (related to all German research vessels) there is no legal basis for a tax-free technical and operative management by the shipping company (Briese), such that a turnover tax had to be applied to these costs in contrast to previous practice. Consequently, the institute now faces two additional challenges: the reimbursement of taxes since 2011 and the funding of tax costs in the future. The ship's owner, the state Mecklenburg Western Pomerania, will cover the former. To cover the costs in the years 2020 and 2021 the funding bodies have approved additional funding (temporary general extraordinary item of expenditure). For the following years, the approval of permanent additional funding (permanent extraordinary item of expenditure of a non-scientific nature) is envisaged in case of a positive outcome of the evaluation in 2019.

Facilities and equipment

IOW buildings provide space for offices, laboratories and workshops as well as lecture and consulting rooms. Most of the laboratories are typical of marine science institutes. However, some of them include advanced facilities described in the following list:

- The NanoSIMS Laboratory is home to the CAMECA NanoSIMS 50L (see chapter 2).
- The equipment housed in the Stable Isotope Laboratory include one isotope ratio mass spectrometer (IRMS) fitted with an element analyser and another IRMS connected to a gas bench. This configuration enables the conversion of dissolved and particulate matter into gases that can be measured by IRMS. A speciality of the Stable Isotope Laboratory is its ability to run labelled and unlabelled samples.
- The Radioisotope Laboratory has the main task to measure standard microbial activities using radioisotope tracers. The laboratory is further equipped with incubators and measuring devices.
- The Walk-in Chambers are used for culturing phytoplankton and zooplankton in experiments requiring controlled conditions.
- The microbial S1 laboratories enable molecular and microbial work to be conducted in a clean bench environment. They are equipped with PCR cyclers and other devices, such as an ultracentrifuge and a digital quantitative PCR.
- The microbial S2 laboratory (biological safety level) is used to isolate and cultivate pathogenic bacteria. It can be completely isolated from the rest of the institute.
- In the SEM-EDX Laboratory (scanning electron microscope with energy dispersive X-ray fluorescence) sample imaging and determinations of the major element composition of single specimens are possible.

- In the Central Laboratory for Organic Trace Substances the analysis of organic trace compounds is carried out. Modern laboratory facilities (Clean-Lab) are available for the analysis of trace organic substances and biomarkers by mass spectrometry.

IT infrastructure

The IT service group is responsible for providing an efficient and reliable IT infrastructure. Beside the standard demands of research institutes in terms of communication, software provision, update and contract management, data storage and backup services, there are special demands that must be served to allow the work of the IOW's modelling and bioinformatics groups. Extensive modelling tasks are usually carried out on the servers of the North-German Supercomputing Alliance (Norddeutscher Verbund zur Förderung des Hoch- und Höchstleistungsrechnens, HLRN). Computation- and memory-intensive analyses, however, take place on local servers optimised for these tasks.

Organisational and operational structure

The IOW Director represents the institute legally and externally and oversees the IOW staff. The Director is responsible for implementing the research programme. Although the Director is appointed to oversee the budget, he has delegated this task to the Head of Administration. Supervision of the staff of the departments has been assigned to the department heads.

Two internal advisory bodies support the work of the Director. The Steering Committee ("Leitungsberatung") consists of the Director, the Head of Administration, the Executive Officer, the four department heads and their deputies as well as the Equal Opportunities Officer. At monthly meetings the operational day-to-day business is decided. In addition, the Steering Committee holds yearly discussions of annual budget allocations, based on their scientific performance and the strategic demands.

In the Scientific Council (SC) decisions of major scientific significance are discussed and made. It consists of 12 members: all four department heads and their deputies as well as four members elected by the scientific staff, one from each department. Co-speakers of the four research foci, if other than the department representatives, are regular guests of the SC as are representatives of the PhD students and postdocs.

The IOW involves all scientists and technicians in the implementation of the research programme through a series of meetings and seminars, including monthly meetings in the scientific departments and two meetings per year of the RFs. Annual workshops with participants from the various RF enable the bottom-up evolvement of ideas. The top-down guidance of the programme is ensured by retreats of the leading scientists.

The research programme is implemented via projects. To address applications to be submitted for third-party funding and discuss suitable funding programmes, the IOW uses the venue of the above-mentioned annual workshops. Applications are sent to the director, the members of the Scientific Council as well as to the co-speakers of the RF for approval. It is at this stage that the compatibility of the proposal with the institute's research programme as well as the availability of offices, laboratory space and ship time are determined.

Quality Management

The institute does not practise a performance-based allocation of resources. However, successful acquisition of third-party funds is rewarded by making 60 % of the granted overhead funds available to the project leader. Performance-related feedback on an individual basis is offered at least once a year.

The institute recommends to publish in open access journals. The IOW participates in the so called DEAL of German science organisations and has terminated subscriptions to the journals of double-dipping publishers. Consequently, the number of articles published by IOW researchers in newly established open access journals has increased considerably. The IOW library continuously provides updated lists of such journals, and also informs researchers about potentially predatory publishers.

In 2002, the IOW adopted rules to ensure good scientific practice on the basis of the rules recommended by the DFG and later by the Leibniz Association. The IOW has an ombuds-person. Further important features of quality management described in the rules of good scientific practice concern the duties of documenting and archiving all steps involved in the generation of data and results and the obligation to present research findings within the respective working group prior to their publication.

The IOW Data Policy describes the handling, publication and dissemination of environmental data. The IT group maintains data management systems. The most important system, the IOWDB, is a direct-access database for oceanographic observational data. Within the framework of the IOW Data Policy, a standard-compliant metadata repository, IOWMETA, serves as an umbrella structure with which to access and document all types of measurement data and the results of modelling runs available in the institute.

To ensure the quality in the operation of IOW's research infrastructure, the IOW has published appropriate guidelines for its users. Applications for research cruises on the Elisabeth Mann Borgese are synchronised with the standard procedures of the German marine research fleet.

The transfer activities comprise data acquisition and analysis for public authorities, the transfer of research results to schools and teachers as well as technology transfer to enterprises. Each of these categories is subject to a specific form of quality management at IOW.

Quality management by the advisory board and supervisory board

The Scientific Advisory Board (SAB) assesses the scientific work of the IOW and presents the results to the Board of Governors (BoG, see below). The SAB consists of up to ten scientists active in the area of marine science. SAB members are appointed by the BoG for a period of 4 years, with only one possibility for reappointment. The SAB convenes at least once per year. It also performs the regular audit required by the Senate of the Leibniz Association in-between two evaluations. The last audit took place in 2016.

The Board of Governors (BoG) consists of up to eight members. These are two representatives of the ministry responsible for science of the *Land* Mecklenburg-West Pommern (one of them as chair), two representatives of the federal ministry responsible for science

(one of them as deputy chair), the principal of the University of Rostock, the chair of the SAB, the president of the BSH, and one representative from industry. The BoG adopts resolutions concerning all matters of fundamental significance for the IOW. In particular, this includes the issuing and changing of the statutes; the appointment of the Director, Deputy Director, department heads and head of administration; the endorsement of the programme budget and the confirmation of the annual accounts.

5. Human Resources

On 31 December 2018, IOW had 226 employees (without student assistants, apprentice and scholarship recipients, see annex 4). 122 persons worked in research (including 31 doctoral candidates), 80 persons had service positions (e.g. scientific management, laboratory or technical staff) and 24 persons had administrative tasks.

Management

The IOW is led by the Director and the department heads. The Deputy Director is appointed by the Director from among the department heads. The joint appointment of a Director together with the University of Rostock follows the guidelines of the Leibniz Association, but also has to be conducted in accordance with the appointment rules of the university. The main features of the procedure include (i) an international announcement of the vacancy, (ii) the establishment of an appointment commission in which members of the IOW and the University of Rostock are represented and which is chaired by a leading scientist of the IOW and (iii) comparing assessments of the selected candidates by internationally renowned scientists.

In principal, the procedures to fill the positions of the department heads and their deputies follow the same scheme, except that a stronger emphasis is placed on the compatibility of the candidate's expertise with the field of science of the respective department.

Postdoctoral staff

The IOW has a budget to employ one postdoc per department based on a limited contract. The majority of postdocs are employed in third party funded projects. Postdocs participate in a structured programme offering (a) guidance and advice, mainly in an orientation period during the first 2 years after attainment of their doctoral degree and (b) financial support and help from mentors during a consolidation phase. Postdocs, who have successfully developed their own scientific profile are granted an "associate scientist" status. The IOW has introduced this status to emphasise the professional progress made by the researcher.

In 2013 the IOW implemented a tenure track programme. The selection of candidates for a tenure-track position is subject to a recruitment procedure similar to that for the leading scientists. After a 3-year period, the performance of the candidate is reviewed by his or her superiors. A decision can be postponed by extending the contract for 2 years.

In specific cases, the IOW also offers employees the opportunity to obtain a permanent position without the tenure track procedure. With the support of their superior, scientists

can apply to change a limited into a permanent contract. However, the success of these applications depends on the availability of funds and a demand for the expertise of the candidate. Consequently, this route is the exception rather than the rule.

The "Standard arrangement for the appointment procedure" makes the appointment procedure at the IOW transparent. Among the topics addressed are: 1) the different steps necessary for the appointment of scientific and non-scientific employees, 2) the initiation of tenure track procedures and 3) the composition of recruitment committees. Additional information on the opportunities available to postdocs is provided in the documents "Career Levels at the IOW" and "Short Guideline for Career Planning: Criteria for a Successful Tenure Track Procedure". The postdocs elect representatives who attend the discussion rounds of the Scientific Council and the meetings of the Internal Equality Committee.

Doctoral Candidates

As of 31 December 2018, IOW employed 31 doctoral candidates (PhD candidates) and hosted four scholarship recipients. Between 2016 and 2018 18 doctoral candidates successfully completed their work at IOW. PhD students typically receive a 3-year contract, with the option of a 3-month prolongation for each manuscript submitted for publication. The majority of the PhD students finalise their theses within their fourth year. In 2020, IOW plans to develop a strategy regarding the creation of an alumni network.

The majority of IOW's candidates are enrolled at the University of Rostock. Students seeking a degree in the field of Geosciences are linked to the University of Greifswald. The IOW recommends that the PhD thesis be concluded in the form of a cumulative. In conjunction with both university partners and in response to a recommendation of the last evaluation, regulations have been implemented regarding the conditions for the delivery of a cumulative work or a monograph.

The IOW's management has prepared "Guidelines for doctoral training and supervision at the IOW". PhD students of the IOW elect representatives for the discussions of the Scientific Council and of the Internal Equality Committee. The IOW has thesis committees, which besides the student's official supervisor consists of senior scientists of IOW as well as external experts.

Together with the University of Rostock, the IOW developed a qualification plan for early-career researchers investigating coastal processes. In 2016, this led to the establishment of the DFG Research Training Group "Baltic TransCoast" at the University of Rostock. Within the first cohort (2016–2018) 4 of the 12 PhD students were supervised at the IOW. Within the second cohort (2019–2021) 5 of 14 students are supervised at IOW.

Non-scientific staff

Training courses are regularly offered to all employees. The qualification requirements are determined in annual talks with their superiors. In addition, the institute fosters individual career planning. For example, between 2016 and 2018, three non-scientific employees were given the opportunity for part-time study and part-time further education.

The IOW offers apprenticeships in four training areas: chemical laboratory technician, industrial mechanic, IT specialist for system integration and office management clerk. The training programme lasts 3 years. Between 2016 and 2018, the IOW successfully trained four apprentices (one in each area). As of 31 December, 2018, IOW employed one apprentice.

Equal opportunities and work-life balance

Equal opportunities

As of 31 December 2018, 56 out of 122 scientists were female (46 %, see appendix 4). Out of the 9 leading scientists (director, 4 department heads and 4 deputies) one was female (11 %). In non-executive positions 39 out of 79 were female (50 %). Out of 31 doctoral candidates 14 were female (45 %).

Since the last evaluation, the only opportunity to increase the number of women at the institute's highest leadership level came with the re-appointment of the head of the Physical Oceanography department. According to IOW, only a few female scientists applied for this position. As the differences in the qualifications and research compatibility among the best candidates were undisputable, according to IOW, giving preference to a female candidate with equal qualifications was not possible.

An increase in the proportion of women in the 1st and 2nd management levels of the IOW will be possible with the replacement of the positions of Director (in 2021) and head of the Marine Chemistry department (2023). The IOW states that, in recognition of the upcoming unique opportunities for the urgently needed increase in the proportion of women, the institute's management has initiated the procedure at an early stage. This will allow the procedure to be extended or re-launched in the event of an insufficient number or qualification of female applicants. In the salary group TV-L E15 the IOW increased the number of women from one to three (one of them listed under „Scientific Management“ in appendix 4). Furthermore, two adjunct professorships at the University of Rostock were filled by women.

The Internal Equality Commission was established in 2011. Members include the Director and the department heads. The equality work at the IOW was certified with the Total Equality Certificate in 2013, 2016 and 2019.

The Equal Opportunities Officer of the IOW is a regular member of the Steering Committee (Leitungsberatung). She is involved in all personnel matters and has a budget available to support topic-related activities. In 2016, she started with the work in the European project Baltic Gender funded for 4 years under the Horizon 2020 programme. It brings together eight scientific institutions in five countries around the Baltic Sea to work on reducing gender inequalities in Marine Science and Technology.

Compatibility of family and career

IOW employees are offered flexible working hours. The framework conditions for a flexible schedule were negotiated in a mutual agreement (Dienstvereinbarung) with the Staff

Council and the Equal Opportunities Officer. The IOW is developing a service agreement to allow its staff to work at home (Home Office).

All employees receive support in their search for childcare. To this end, a contract has been concluded with a kindergarten in the vicinity of the institute that grants the IOW a set number of places. IOW has a family office.

With its "Come-back to Research" programme, the IOW supports researchers who wish to return to research after a family-related career break. Funding of up to half a year makes it possible to complete a dissertation, finalise a scientific manuscript or apply for third-party funding for a position.

6. Cooperation and environment

Cooperation with universities

The IOW has close relationships with the universities in Rostock and Greifswald. The director of the IOW and the six leading scientists of three departments are jointly appointed with the University of Rostock (three W3, one W2, one C4 and two C3). The two leading scientists of the department "Marine Geology" are jointly appointed with the University of Greifswald (one W3 and one W2). Two more senior scientists of the IOW were appointed as adjunct professors (so called apl. professorships) at the University of Rostock. The total teaching load of the institute staff at the two universities is, on average, 48 hours per week during each semester. In addition, two IOW scientists have been appointed as professors at the University of Klaipeda (Lithuania), with annual teaching commitments of approx. six hours per week during each semester.

IOW cooperates with the University of Rostock in the DFG Research Training Group "Baltic TransCoast". IOW also cooperates with the University of Hamburg in the DFG Collaborative Research Centre TRR 181 "Energy transfers in atmosphere and oceans".

Cooperation with Leibniz institutes

The Leibniz Science Campus Phosphorus Research is an organisation comprising the University of Rostock the IOW and four other Leibniz institutes: Leibniz Institute for Catalysis (LIKAT) in Rostock, Leibniz Institute for Farm Animal Biology (FBN) in Dummerstorf, Leibniz Institute for Plant Genetics and Crop Plant Research (IPK) in Gatersleben, and the Leibniz Institute for Plasma Research and Technology (INP) in Greifswald. Its mission is to explore the options allowing a more sustainable management of phosphorus. Research within the Science Campus is divided into four clusters, with the IOW responsible for the coordination of this network. The IOW director serves as the speaker of this organisation.

IOW also participates in the graduate school Leibniz graduate school ILWAO, which is a joint effort of the Leibniz Institute of Atmospheric Physics (IAP) in Rostock and the University of Rostock.

The IOW is also involved in the Leibniz Research Alliance "Biodiversity". Among the 20 partners within this alliance, the Leibniz Institute DSMZ-German Collection of Microorganisms and Cell Cultures in Braunschweig, the Leibniz Institute of Freshwater Ecology

and Inland Fisheries (IGB) in Berlin, the Leibniz Center for Tropical Marine Research (ZMT) in Bremen and the Senckenberg Gesellschaft für Naturforschung (Senckenberg am Meer) in Wilhelmshafen are those with the closest relationship to the IOW.

Further collaborations with Leibniz institutes exist with the Leibniz Institute for Tropospheric Research (TROPOS) in Leipzig, the Potsdam Institute for Climate Impact Research (PIK), the Leibniz Institute for Polymer Research (IPF) in Dresden, and the Leibniz Institute of Ecological Urban and Regional Development (IÖR) in Dresden.

National and international networking

There are two German coastal sea research networks in which the IOW has played a coordinating role: i) Over the past 6 years, the IOW has been commissioned by the BMBF to coordinate its projects in the North and Baltic Sea, within the KüNO (Küstenforschung Nordsee Ostsee) umbrella project. For this purpose, the IOW has organised conferences, fostered exchange with stakeholders, presented its research results in brochures and organised joint summer schools. ii) Within the Strategy Group “Coastal Research” of the German Marine Research Consortium (KDM), representatives of the German centres of coastal sea research come together to define future research topics and initiate research collaborations. Recently, the IOW was a founding member of the German Alliance for Marine Science (*Deutsche Allianz für Meeresforschung*, DAM).

Since 2014, the IOW has implemented many of its research activities within the collaborative framework of BONUS, a joint Baltic Sea Research and Development Programme supported by the EU states around the Baltic Sea and by the European Union. IOW was partner in six projects, that have been completed (three projects were coordinated by the IOW) and is partner in eight ongoing projects (two of them are coordinated by the IOW).

In addition, the IOW is integrated in Baltic Earth, a researcher network with a holistic perspective on the Baltic Sea that addresses processes in the atmosphere, on land and in the sea, as well as those evoked by human activity.

There is a long ongoing partnership between the IOW and the SYKE institute (the Finnish Environmental Institute/Marine Research Centre) for the joint use of the ship VOS Finnmaid, which conducts autonomous measurements in the surface waters of the Baltic Sea during its daily crossing between Helsinki and Lübeck.

Institution's status in the specialist environment

In German research landscape of coastal sea research, the IOW is the only institution focussed on the Baltic Sea. The institutes most comparable to the IOW in terms of a holistic interdisciplinary approach of system analyses in a regional sea are the Alfred-Wegener-Institute – Helmholtz-Centre of Polar and Marine Research (Helgoland and Sylt sites) and the Helmholtz Centre Geesthacht – Institute of Coastal Research (HZG).

On the international level, SYKE (see above) and the Stockholm University Baltic Sea Centre are important participants in Baltic Sea research. Research in the North Sea based on a concept comparable to that adopted by the IOW is conducted by the Royal Netherlands Institute for Sea Research (NIOZ).

7. Subdivisions of IOW

Research Focus 1: Small- and meso-scale processes

[31,68 FTE, thereof 16,16 FTE Research, 4,55 FTE Doctoral candidates, and 10,97 FTE Service staff]

RF1 combines research on small- and meso-scale processes that cannot be resolved in current numerical models but are understood to be relevant for overall system functioning. The research thus includes analyses of the abiotic and biotic factors controlling biogeochemical processes as well as investigations of key organisms and biotic communities. RF1 is structured in three subtopics:

- RF1.1 focuses on surface-layer processes and air-sea exchange.
- RF1.2 focuses on small-scale physical and biogeochemical processes in the stratified interior region, and specifically in the redoxcline.
- RF1.3 focuses on the processes in the vicinity of the sediment-water interface.

Conceptually, the goal of RF1 is to develop the process understanding required for the analysis of the systems explored in RF2. Research in RF1 relies on laboratory experiments, numerical studies, and in-situ observations. It strongly relies on IOW's ability to develop tailor-made instrumentation for the investigation of individual processes. Among recent in-house instrument developments are the autonomous profiling station GODESS, a pump-CTD for the resolution of small-scale biogeochemical gradients, an automatic in-situ fixation sampler (AFIS), allowing for the unbiased detection of transcripts in microbial communities. A NanoSIMS is operated for single-cell analysis.

In recent years, new insights into processes at different spatial scales were acquired, from gas exchange across the surface microlayer, to element transformations in the redoxcline, and to sediment-water exchange. Research in RF1 was strengthened by appointing new scientists in geomicrobiology and organic proxy development, and by starting a laboratory for lipid biomarkers. Additionally, new cell-specific techniques such as NanoSIMS and amino acid stable isotope analyses were established, which made it possible to relate the physiology of planktonic taxa to food web alterations. Important recent advances include the identification and quantification of small-scale mixing processes in the Baltic Sea, and assessing their impact on microbial activities and biogeochemistry in pelagic redox gradients. For a range of different processes, from methane transformations to nitrogen cycling, the responsible prokaryotic key players were identified, and regulating mechanisms were examined in field studies and laboratory experiments, leading to a better understanding of oxygen-deficient systems. New inorganic and organic proxies could be developed, which are essential for the reconstruction of past ecosystem states. For an integrated understanding of the processes connecting the open Baltic Sea with the coastal zone, it is planned to extend the major themes and approaches of RF1 to the shallow, coastal waters of the Baltic Sea.

Between 2016 and 2018 the RF1 published 123 articles in peer-reviewed journals. In the same period the institutional funding was 5 M€ (Ø 1.7 M€ p.a.). The revenue from project grants totalled approx. 3.3 M€ (Ø 1.1 M€ p.a.), with 2 M€ spent from DFG, 0.4 M€ spent

from EU-grants, and 0.4 M€ from the Leibniz Association. In the same period, 8 doctoral and 10 academic degrees were completed.

Research Focus 2: Basin-scale ecosystem dynamics

[35,32 FTE, thereof 22,12 FTE Research, 4,05 FTE Doctoral candidates, and 9,15 FTE Service staff]

RF2 explores fundamental processes on a basin-wide scale in order to understand the functioning and dynamics of coastal seas as a whole. This includes determinations of process interactions, biodiversity, and ecosystem functioning as well as their changes along spatial gradients. Three subtopics make up RF2:

- RF2.1 studies basin-scale circulation and transport, including estuarine circulation, upwelling, and land-sea flux regimes.
- RF2.2 studies functional biodiversity in the gradients of marginal seas.
- RF2.3 studies biogeochemistry of coastal seas.

The general approach in RF2 is to study the interaction of relevant processes on a basin-scale using observations, experiments, and numerical modelling. Observational data are acquired mainly by cruises on the ship ELISABETH MANN BORGESE, and the use of instrumentation adapted specifically for coastal ocean applications. The IOW's automated pCO₂ and trace gas system, installed on the VOS FINNMAID, running between Helsinki and Lübeck, complements the research-vessel-based efforts. Integration of the obtained knowledge in numerical models is achieved using tools developed or co-developed at the IOW, such as the hydrodynamic models GETM and MOM and the biogeochemical model ERGOM.

In recent years, new insights into the relationships between mixing and exchange flow have been acquired for a large number of estuarine circulation regimes. The exceptionally strong Major Baltic Inflow of 2014 enabled unprecedented studies of the dynamics of these events and of their implications for the ecosystem. Research into the Benguela upwelling led to a quantitative understanding of the combined hydrodynamic, biogeochemical and biological drivers of oxygen deficiency in such systems. Thanks to the IOW's maintenance of continuous pCO₂ surface measurements on a ship of opportunity, the variability of primary production processes in the Baltic Proper could be identified and subsequently attributed to external drivers and internal dynamics. Novel insights into food web structure and species composition and interactions were obtained as well, by means of newly established methods such as metatranscriptomics and analyses of the isotopic composition of single amino acids. The functional traits of macrozoobenthos were studied to identify the links between biodiversity and ecosystem functioning. Extensive studies of land-sea interactions were carried out to quantify coastal impacts on the functioning of marginal sea systems. Research on this topic will be strengthened in the IOW's future research agenda.

Between 2016 and 2018 the RF2 published 114 articles in peer-reviewed journals. In the same period the institutional funding was almost 4.5 M€ (Ø 1.5 M€ p.a.). The revenue from project grants totalled approx. 4.3 M€ (Ø 1.4 M€ p.a.), with approx. 1 M€ spent from

DFG, 1 M€ spent from EU-grants, and 1.5 M€ spent from Federal and *Länder* governments (BMBF). In the same period 3 doctoral and 5 academic degrees were completed.

Research Focus 3: Changing ecosystems

[53,99 FTE, thereof 26,0 FTE Research, 3,6 FTE Doctoral candidates, and 24,39 FTE Service staff]

RF3 relates work on the process (RF1) and ecosystem (RF2) levels to the associated time-scales to understand the development of coastal seas like the Baltic Sea over the course of their geological history and the factors that have controlled ecosystem variability and trends in the recent past (instrumental period), specifically during the era of increased human impact. RF3 is subdivided into three subtopics:

- RF3.1 focuses on proxy-based paleo-environmental reconstructions using sedimentary archives.
- RF3.2 follows a long-term environmental observational program aimed at elucidating ecosystem changes.
- RF3.3 develops numerical regional climate and ecosystem models with predictive capacities.

Whereas the comprehensive paleo-environmental reconstructions in RF3.1 are based on precise stratigraphic assignments and multi-proxy applications, RF3.2 relies on analyses and assessments of long-term environmental monitoring data. The results of both efforts are available to national and regional authorities in the form of regular reports on the state of the Baltic Sea. An integral part of RF3.2 is the operation and further technical development of moorings and ship-based observational systems as well as the provision of long-term observational data through databases. The research in RF3.3 also makes use of the different numerical model systems developed at the IOW.

The goal of RF3 is to understand the past and provide projections for the near future. The focus lies on finding out how the Baltic Sea and its many processes have changed over the course of decades, centuries and millennia. Of particular interest is the response of coastal and marginal seas to climate change and intensive anthropogenic influences along a variety of time scales. Regional climate and ecosystem models are being tested against proxy and observational data to provide projections on future system development, considering various scenarios of climate change and anthropogenic influence. The ecosystem models are calibrated against observational records and the natural "archives" of the sediments. Both sources of information are extended by measurements from buoys, probes, time series stations, satellites and research cruises, as well as by the latest analyses of sediment samples from the ocean floor. Together, they provide insights into the Baltic Sea of the past and improve the accuracy of the models' predictive capacities. IOW's expertise in monitoring and the development of new methods allows to follow the trends that develop over different time and space scales and to monitor the status of the Baltic Sea environment. This knowledge opens up new opportunities for cooperation within the framework of bilateral projects focusing on the burden imposed on the coastal ocean by an increasing human population.

Between 2016 and 2018 the research focus published 110 articles in peer-reviewed journals. In the same time period the institutional funding was almost 7.8 M€ (Ø 2.6 M€ p.a.). The revenue from project grants totalled 9.7 M€ (Ø 3.2 M€ p.a.), with approx. 7.3 M€ spent from Federal Maritime and Hydrographic Agency, 0.9 M€ from Federal and *Länder* governments (BMBF), 0.7 M€ from the Leibniz association and 0.6 M€ from the DFG. Between 2016 and 2018 3 doctoral and 2 academic degrees were completed.

Research Focus 4: Coastal sea and society

[38,32 FTE, thereof 19,28 FTE Research , 9,45 FTE Doctoral candidates, and 9,59 FTE Service staff]

The aims of RF4 are to understand the interactions between the Baltic Sea ecosystem and human activities and their consequences, to offer advice on the more sustainable use of the sea's resources, to transfer the IOW's findings to environmental policymakers and finally to promote the implementation of legislative measures at national and international levels. RF4 pursues its research priorities in three sub-themes:

- RF 4.1 investigates how marine ecosystems are affected by human uses, pollution, and interventions and provides advice for the sustainable management of these ecosystems.
- RF 4.2 focuses on the implementation of marine and coastal policy, i.e., the BSAP and the Marine Strategy Framework Directive.
- RF 4.3 addresses regional changes, such as climate change, the increasing pressure on coasts and seas arising from human activities, land-use changes and their effects on the marine environment and its provision of ecosystem services, and the development of adaptation measures.

Research in RF4 makes use of a cascade of different data acquisition and processing steps ranging from the generation of field and experimental data to modeling. The integration, aggregation, and generalisation of the data comprise another step that generates information and knowledge of practical relevance. RF4 is characterised by multi-disciplinary research that, in general, consists of activities carried out in contact with researchers in the social, economic, planning, and engineering sciences and that serve as an interface with authorities and ministries.

Important recent results include the recognition of glyphosate and several pharmaceuticals as organic pollutants and contaminants of emerging concern in marine systems. A infrastructure was created at the IOW for the isolation, purification, identification and monitoring of (micro-)plastics. It provides the data needed for the modelling of transport of these pollutants from the hinterland to the open Baltic Sea. In addition, based on measurements and model simulations in rivers and coastal waters, target values for nitrogen and phosphorus concentrations and other water-quality indicators were proposed that have since become legally binding in Germany. RF4 developed tools such as the Marine Ecosystem Service Assessment Tool, an indicator-based best practice evaluation tool for Integrated Coastal Management, and the Stakeholder Preference and Planning Tool to support stakeholder involvement processes. New procedures to map and quantify the

characteristics, functioning and sensitivity of the seafloor were developed and their results, together with the related acquired expertise, were utilised in national MSFD and Natura 2000-reporting, in the development of Red Lists of marine habitats and in the designation of so called Ecologically and Biologically Significant Areas. RF4 also introduced data on potentially pathogenic bacteria into model simulations to evaluate bathing-water quality for the Baltic Sea area. Along with the new tools and approaches that enable the integration of science into management and planning, RF4 has fostered the design and production of instruments such as the “Rocket” and “AFISsys”, to improve evaluations of anthropogenic impacts on coastal ecosystems.

Between 2016 and 2018 the research focus published 84 articles in peer-reviewed journals. In the same time period the institutional funding was 1 M€ (Ø 0.33 M€ p.a.). The revenue from project grants totalled approx. 11.5 M€ (Ø 3,8 M€ p.a.), with approx. 6,6 M€ spent from Federal and *Länder* governments, 4 M€ spent from EU-grants and 0.8 M€ from the Leibniz Association. Between 2016 and 2018 5 doctoral and 26 academic degrees were completed.

8. Handling of recommendations from the previous evaluation

Recommendations by the review panel

IOW responded as follows to the 13 recommendations of the last external evaluation (highlighted in *italics*, see also statement of the Senate of the Leibniz Association issued on 17 July 2013, pages B-2 - B-4):

*1. The **Baltic Sea provides IOW with a unique subject** and focus for research and a valuable resource within the marine science community with enormous potential to generate basic and applied knowledge. In the future, IOW should exploit this potential more thoroughly and systematically.*

Shortly after the last evaluation in 2012, IOW launched its new research programme with the objective to understand the Baltic Sea as a whole. The corresponding research areas are described in chapter 2 and 7.

*2. Since the last evaluation, IOW has produced a number of interesting, broad-ranging research results. The studies on structural and functional connections of the watersheds to the Baltic Sea proper, redoxcline and cyanobacterial blooms, for example, reflect both a high degree of quality and focus on contemporary issues that need to be resolved in order to gain a better understanding of how the Baltic Sea system functions and responds to environmental change. In the future, it is recommended that IOW expand its research scope and goals to couple **terrestrial factors** more closely, e. g. sediment and nutrient discharge from the catchment areas.*

According to IOW, this aspect became an integral part of RF2 (see chapter 7). IOW has successfully applied for third-party-funded projects in this research focus, e.g. the DFG Research Training Group “Baltic TransCoast” and the BMBF project PHOSWAM.

*3. **Publication activity** has increased significantly, both in quantity and quality, since the last evaluation [2006]. This positive development should be continued. IOW's efforts to increase the number of high-impact publications are welcomed.*

According to IOW, the number of peer-reviewed publications by IOW researchers has increased over the last 7 years, from 579 (2005–2011) to 798 (2012–2018). The number of publications in journals with an impact factor > 4 grew from 136 to 150.

*4. With regard to **information and technology transfer** opportunities, IOW has not yet made full use of its potential. It is recommended that the institute develop a corporate marketing strategy to optimise the exploitation of its transfer opportunities more effectively, both in scientific and, when possible, economic terms.*

For IOW's transfer activities see chapter 2.

*5. The review board endorses IOW's intention to maintain the **disciplinary expertise** of the departments as the solid foundation of research, and it encourages the networking of these strengths in the form of interdisciplinary and multi-institutional collaborations.*

According to IOW, the institute has followed this approach very closely (see chapters 2 and 7).

*6. **Physical oceanography and process-level modelling** are viewed as two of IOW's notable strengths. In the future, **other disciplines should benefit more from these strengths**, especially as larger-scale interdisciplinary, cross-boundary, long-term research efforts are undertaken. The institute should also be able to enhance the validity and applications of predictions derived from model simulations, especially as they apply to the effects of climatic and anthropogenically-driven change.*

According to IOW, the institute has fostered the development of model components of the marine ecosystem to facilitate interdisciplinary cooperation. For instance a complex sediment model was developed that will be implemented in 3D circulation models, thus allowing mapping of the seabed (including nutrient and carbon fluxes and benthic habitats). Projections of hydrography and biogeochemical cycles have been used to develop target values for the EU Marine Strategy Framework Directive. In addition, combined climate and socio-economic scenarios have supported assessments of the implementation of HELCOM's Baltic Sea Action Plan and of fisheries management strategies. Based upon the model data obtained from the large ensembles generated within several BONUS projects, the validity of those projections and the sources of their uncertainties have been evaluated.

*7. The proposed extension of studies by incorporating influences of climate change is in line with current research directions, and it is welcomed. The identification of impact factors and the differentiation between anthropogenically triggered and natural causes and changes poses a particular challenge. In order to be able to respond better to such issues in the future, IOW must improve its **expertise in statistical analyses and applications**.*

The 2015 appointed new head of the Physical Oceanography department established a new working group "Dynamics of regional climate systems", in which two tenure track

positions were filled with scientists possessing expertise in statistical analyses. In addition, IOW organised a winter school on the “Analysis of Climate Variability” that also offered training in statistical methods.

*8. External, third-party fund raising has increased considerably since the last evaluation and has now reached a desirable level. It is expected that this level will be maintained in the future. Efforts should focus on **increasing the proportion of competitively raised funding** (e. g. DFG and EU) within the third-party funding portfolio.*

According to IOW, EU-related funding programmes accounted for 1.8 M€ within the period 2005-2011 and for 6.6 M€ during the period 2012-2018. DFG funds increased from 5.2 M€ between 2005-2011 to 6.2 M€ between 2012-2018. In addition, funds acquired in the competitive procedure of the Leibniz Association increased from 1.5 M€ between 2005-2011 to 5.5 M€ between 2012-2018 (see also chapter 4).

*9. Plans to develop the cross-cutting activity “Coastal Seas and Society” into a new, fourth research focus are in line with the growing importance of the field, and they are welcomed. Currently however, there are no economists or sociologists working at the institute. In order to be able to address the proposed spheres of extended activity appropriately, IOW must ensure that **expertise at the interface of social, cultural and political science** is present at the institute so that the necessary additional expertise can be incorporated through collaborations. In this context, the institute should make use of the Leibniz Association’s expertise in these disciplinary areas. It is recommended that IOW defines the goals and milestones for developing the new research focus clearly and that a roadmap and timetable be created to help reach these goals and evaluate the progress.*

An exchange between the natural sciences and humanities was established by creating and filling a permanent position for related tasks. The appointed scientist has since initiated co-operations with socio-economic and political stakeholders and has participated in and coordinated third-party funded projects. Today, 15 scientists in two working groups are working within the unit “Coastal Sea: Management & Planning”, which is associated with the IOW’s directorate.

*10. IOW should intensify its **collaborative networking** in the Baltic Sea region, particularly with Scandinavian and Finnish partners.*

IOW’s Pan-Baltic cooperation is described in chapter 6.

*11. “Women are significantly under-represented at IOW’s leadership level. The institute is strongly encouraged to make great efforts to increase the proportion of **women in leadership positions**. It is acknowledged that IOW has taken first steps towards achieving this goal.”*

The different measures to implement this recommendation are described in chapter 5.

*12. It is welcomed that besides handing in a classical dissertation (monograph or comparable sizeable document), **cumulative theses**, comprised of a set of manuscripts, are an alternative. However, against the backdrop of a proposed three-year doctoral period, the current*

*requirement for cumulative theses (three papers must be completed for a doctorate to be awarded, and two of them must have been published before the dissertation is submitted) is not realistic. The institute is recommended to appeal to the responsible universities to develop more flexible regulations. Efforts should also be made to ensure that the regulations on **additional qualifying courses** should be the same for all doctoral candidates at IOW.*

According to IOW, the new regulation allow for a reduction, upon request of the supervisor, in the number of manuscripts approved for publication to two, with one further manuscript submitted. The PhD representatives supported this revision. Degree acceptance is based on case-by-case assessments by the respective commissioners of the faculties at the universities in Rostock and Greifswald. Since the last evaluation, there have been no further cases of demands of additional courses.

*13. It is recommended that IOW enhance **active career-planning support for postdocs** and to enable them to build up a professional network, particularly by participating in pertinent conferences and workshops. The junior research group strategy that has been introduced for promoting postdocs is welcomed and should be extended further.*

According to IOW, it has invested considerable effort into the promotion of young scientists (see chapter 5).

Recommendations by the Senate of the Leibniz Association

The Leibniz Senate issued two further recommendations (see statement of the Senate of the Leibniz Association page 3):

*14. The **modernisation of long-term data collection** in the Baltic Sea should be implemented as planned by the IOW and the relevant "Fachressorts".*

From 2012 to 2015, the IOWs budget was temporarily increased to allow for the development and testing of new observation strategies (see chapter 2).

*15. It is very positive that the IOW now has a new research vessel, the **Elisabeth Mann Borgese**. However, the costs for its ongoing operation are considerably higher than for its predecessor. The state of Mecklenburg-Western Pomerania has not yet made sufficient financial provision in the IOW budget for this purpose. This is necessary to ensure that the investment in the procurement of the vessel achieves the expected benefits.*

The IOW management is requested to submit a report by 31 December 2015 on the implementation of the research programme and the consolidation of the spatial and financial situation.

After the IOW reported about the implementation of the research programme, the Senate was satisfied, but asked for a further report on the institute's ship-related budget development. IOW reported at the end of 2016 and in reaction to this report, the Senate recommended in 2017 in a letter to IOW:

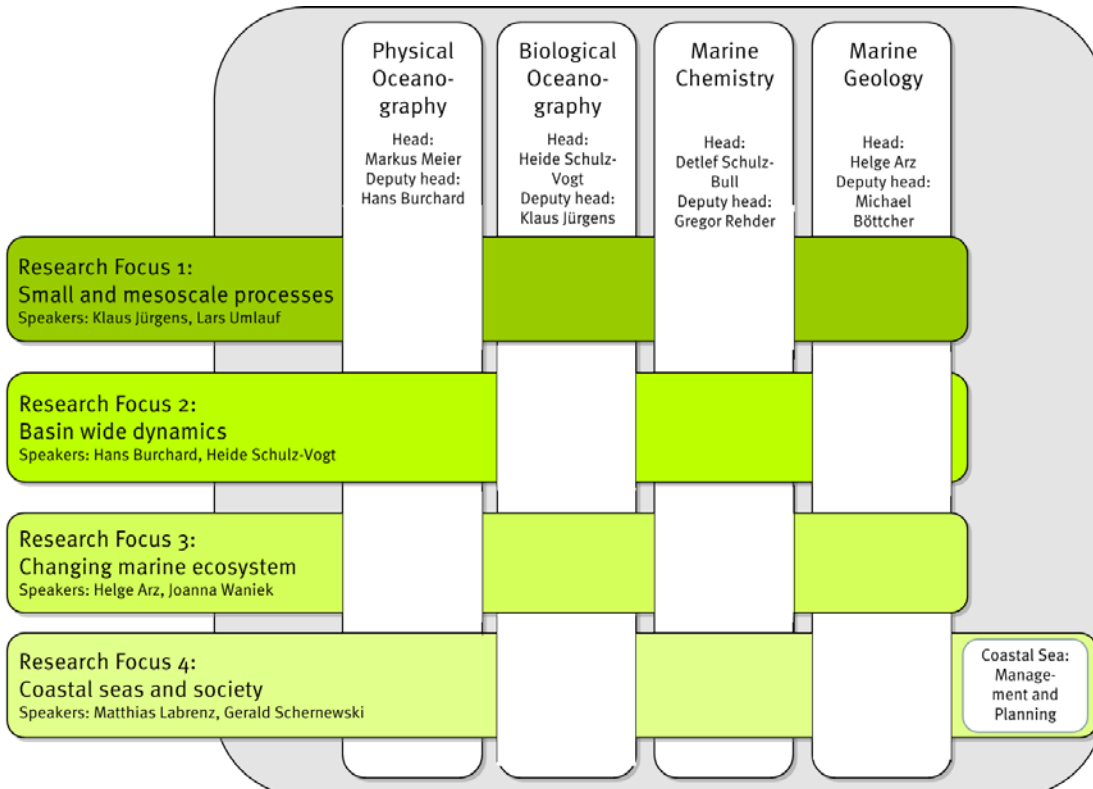
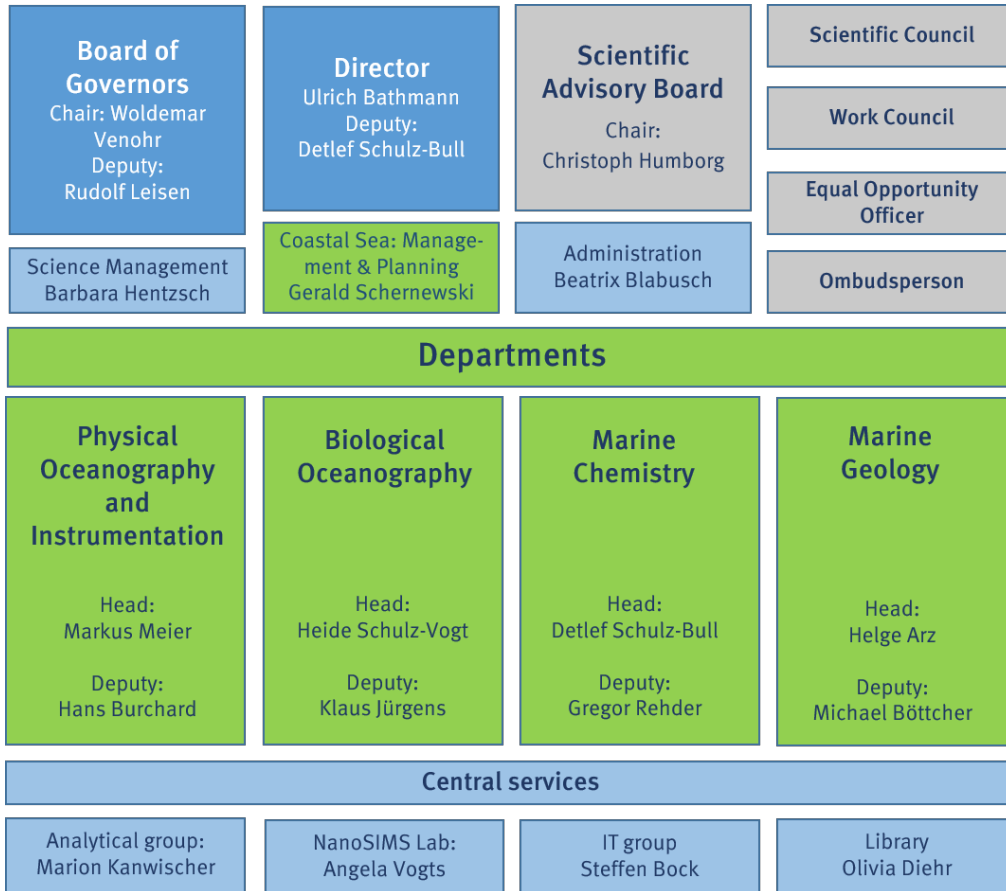
16. ...to consider whether the operation of its own research vessel makes sense in the long term or whether other solutions are more viable. He also recommends aligning the work

with the German Marine Research Consortium, in which the IOW is heavily involved, and with the "German Research Vessels" federal-state group. He asks to report on this examination in the context of the next evaluation.

See chapter 4 for IOW's answer to this question and for the development of ship-related costs.

Appendix 1

Organisational Chart



Appendix 2

Publications and patents

	Period		
	2016	2017	2018
Total number of publications	152	148	216
Monographs	11	4	4
Individual contributions to edited volumes	13	13	12
Articles in peer-reviewed journals ¹⁾	113	117	182
Articles in other journals	7	7	10
Working and discussion papers	7	5	7
Editorship of edited volumes	1	2	1

Industrial property rights (2016-2018) ²⁾	2016	2017	2018
Patents (granted / applied)	1/2	-	-
Other industrial property rights (granted / applied)	1/1	-	-
Exploitation rights / licences (number)	1	-	-

¹ Contributions that have been accepted for publication but not yet appeared are added in parenthesis.

² Concerning financial expenditures for revenues from patents, other industrial property rights and licences see Appendix 3.

Appendix 3

Revenue and Expenditure

Revenue		2016			2017			2018		
		k€	%	%	k€	%	%	k€	%	%
Total revenue (sum of I., II. and III.; excluding DFG fees)		23.616			24.486			24.601		
I.	Revenue (sum of I.1., I.2. and I.3)	23.441	100		24.223	100		24.502	100	
1.	<u>INSTITUTIONAL FUNDING (EXCLUDING CONSTRUCTION PROJECTS AND ACQUISITION OF PROPERTY)</u>	13.943	59		13.106	54		13.444	55	
1.1	Institutional funding (excluding construction projects and acquisition of property) by Federal and State governments according to AV-WGL	13.444			12.593			12.915		
1.2	Institutional funding (excluding construction projects and acquisition of property) not received in accordance with AV-WGL	499			514			529		
2.	<u>REVENUE FROM PROJECT GRANTS</u>	9.186	39	100	10.936	45	100	10.772	44	100
2.1	DFG	1.625		17.7	1.226		11.2	1.345		12.5
2.2	Leibniz competition	983		10.7	1.164		10.6	821		7.6
2.3	Federal grants (except BSH)	2.493		27.1	3.712		33.9	3.735		34.7
2.4	BSH (Federal Maritime and Hydrographic Agency)	2.395		26.1	2.453		22.4	2.521		23.4
2.5	State Mecklenburg Western Pomerania	130		1.4	100		0.9	85		0.8
2.6	EU	1.463		15.9	2.155		19.7	2.111		19.6
2.7	Industry	0		0	0		0	0		0
2.8	Foundations	79		0.9	75		0.7	29		0.3
2.9	Other	18		0.2	51		0.5	125		1.2
3.	<u>REVENUE FROM SERVICES</u>	312	1		181	1		285	1	
3.1	Revenue from commissioned work	302			175			281		
3.2	Revenue from publications									
3.3	Revenue from exploitation of intellectual property for which the institution holds industrial property rights (patents, utility models etc.)	10			6			4		
II.	Miscellaneous revenue (e.g. membership fees, donations, rental income, funds drawn from reserves)	175			263			100		
III.	Revenue for construction projects (institutional funding by Federal state governments, EU structural funds, etc.)									
Expenditures		k€			k€			k€		
Expenditures (excluding DFG fees)		23.616			24.486			24.625		
1.	Personnel	12.835			13.097			13.615		
2.	Material expenses	4.268			4.217			4.704		
3.	Equipment investments	1.018			2.613			2.600		
4.	Construction projects, acquisition of property	3			0			175		
5.	Other operating expenses	4.012			2.389			1.768		
6.	Other	1.481			2.170			1.763		
DFG fees (if paid for the institution – 2.5% of revenue from institutional funding)		308			312			318		

Appendix 4

Staff

(Basic financing and third-party funding / proportion of women (as of: 31/12/2018))

	Full time equivalents		Employees		Female employees		Foreigners
	Total	on third-party funding	Total	on temporary contracts	Total	on temporary contracts	Total
	Number	Percent	Number	Percent	Number	Percent	Number
Research	105.21	53%	122	71%	56	88%	16
1 st level (scientific directors)	1	-	1	-	0	-	0
2 nd level (department heads & their deputies)	8	-	8	-	1	-	-
Scientists in non-executive positions (E15 or equivalent)	3.25	-	4	25%	2	-	-
Scientists in non-executive positions (A13, A14, E13, E14 or equivalent)	71.31	56%	78	71%	39	90%	10
Doctoral candidates (A13, E13, E13/2 or equi.)	21.65	76%	31	100%	14	100%	6
Service positions	71.575	15.8%	80				
Scientific Management (E15, executive officer)	1	-	1				
Scientific Management (E13 to E14, senior service)	8.08	60%	12				
Laboratory (E9 to E12, upper-mid-level service)	7.5	0%	8				
Laboratory (E5 to Egk, mid-level service)	16.85	18%	19				
Workshops (E5 to Egk, mid-level service)	4	-	4				
Library (E9 to E12, upper-mid-level service)	1	-	1				
IT (from E13, senior service)	3	-	3				
IT (E9 to E12, upper-mid-level service)	2.75	-	3				
IT (E5 to Egk, mid-level service)	0.5	100%	1				
Technical (large equipment, service) (from E13, senior service)	4	25%	4				
Technical (large equipment, service) (E9 to E12, upper-mid-level service)	14.75	7%	15				
Technical (large equipment, service) (E5 to Egk, mid-level service)	8	13%	8				
Technical (large equipment, service) (E1 to E4)	0.15	0%	1				
Administration	21.4	2.3%	24				
Head of the administration	1	0%	1				
Internal administration (E9 to E12, upper-mid-level service)	4.65	0%	5				
Internal administration (E5 to Egk, mid-level service)	14.75	3.4%	17				
Building service (E1 to E4)	1	-	1				
Student assistants	5.45	56%	23				
Apprentices	1	-	1				
Scholarship recipients at the institution	4	100%	4		2		2
Doctoral candidates	4	100%	4		2		2

Annex B: Evaluation Report

Leibniz Institute for Baltic Sea Research Warnemünde (IOW)

Contents

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Appendix:

Members of Review Board

1. Summary and main recommendations

The Leibniz Institute for Baltic Sea Research Warnemünde (IOW) conducts fundamental research on the functioning of marine ecosystems, investigating both the specific features of the Baltic Sea and cross-system global questions. By combining empirical observations, experiments and modelling, the institute traces changes in the ecosystems it studies as well as the underlying processes, differentiating between anthropogenic and natural impact factors. Research ranges from physical, chemical, biological and geological issues at microscopic level through to long-term basin-wide change processes in marine ecosystems and their socioeconomic consequences for coastal regions and beyond.

Apart from research, IOW also has important infrastructure functions. The monitoring programme for the assessment of the marine environment of the Baltic Sea is of particular importance. IOW measures hydrographic variables at up to 100 stations in the Baltic Sea. The collected data can be accessed on the IOW database (IOWDB) and constitutes an exceptionally valuable basis for the institute's work as well as for external users. The monitoring part related to German waters has been assigned to IOW by the Federal Maritime and Hydrographic Agency (*Bundesamt für Seeschifffahrt und Hydrographie*, BSH).

Based on its research results, IOW provides highly coveted consultancy services for political decision-makers and other stakeholders. In this context it focuses on the interaction between the Baltic region's sea, land and atmosphere as well as on measures for conserving the ecological and economic capacity of marine ecosystems.

IOW comprises four discipline-based departments and one working group that is directly affiliated to the director. Organised in a very effective matrix structure, the departments and the working group jointly address four research foci (RFs), which build coherently on one another. The performance and plans of the four RFs were rated as "very good to excellent" (RF1), "very good" (RF2), "good" (RF3) and "good to very good" (RF4).

Since the last evaluation, IOW has developed very positively. In line with recommendations, its publication record has been enhanced. Third-party revenue has been maintained at a high level whereby income from the DFG and the EU has been increased substantially. IOW has also intensified its international collaborations, particularly in the Baltic Sea region. The institute's convincing development is partly due to very good recruitment since the last evaluation, especially at leadership level. In addition to a new head of department, who was appointed shortly before the last evaluation visit in 2012, another excellent appointment was made to a second department in 2015. It is welcomed that not only the director and the heads of department but also the deputy heads of department all hold joint professorships at the University of Rostock (seven appointments) or University of Greifswald (two appointments).

For IOW's future development it will be particularly crucial who succeeds the current director when he retires in 2021. It is welcomed that the procedure has already been launched in the form of an international call and the establishment of an Appointment Committee. In 2023, also the head of the Marine Chemistry Department will retire.

Special consideration should be given to the following main recommendations in the evaluation report (highlighted in **bold face** in the text):

Overall concept, activities and results (Chapter 2)

1. In recent years, IOW has managed very effectively to choose its research questions, on the one hand, with a view to the unique natural environment of the Baltic Sea and, on the other, to multi-scale, system-oriented global questions. At the last evaluation, it was pointed out that IOW should ensure a more appropriate balance in this respect. Also, IOW conducts comparative studies (third party funded) in other coastal and marginal seas, such as the South China Sea and the Benguela Upwelling System off the coast of West Africa. IOW should make the decision to conduct such comparative studies more directly dependent on whether these studies fit well with the institute's overall strategy. With the unique focus of IOW on the Baltic Sea, they are only meaningful if they are necessary as proof of concept or where the comparison helps to better understand specific features of the Baltic Sea.
2. IOW fulfils its objective of achieving research results that are relevant beyond the specific insights into the Baltic Sea. These include, for example, the work on climate variability and climate change impact, biodiversity and food webs, the growing burden of marine litter, the spread of oxygen minimum zones and the increase in eutrophication. In the future, IOW is encouraged to publish these results more frequently in journals that reach a broader scientific audience.
3. It is welcomed that IOW is developing a set of indicators to help measure the impact of its transfer activities which it plans to include in compiling its future programme budget. On the basis of these measurements, IOW should continue developing its diverse, very good transfer activities and enhance their visibility.

Changes and planning (Chapter 3)

4. Following up on very convincing preliminary work, IOW plans to develop new observational, experimental and modelling tools. Up to now, IOW's activities have largely focussed on the open sea and coastal zones. The envisaged developments will enable the institute to include shallow coastal waters. The planned, and necessary, expansion of its technical and methodological spectrum follows on coherently from the recommendations issued both at the last evaluation and by the Scientific Advisory Board.

For the purposes of implementation, IOW intends applying for a permanent extraordinary item of expenditure from 2022 onwards. This plan is supported. The funding foreseen for staffing, including a W2 professorship, investments and material expenses permanently amounting to approx. 2.5 M€ per year, is plausibly substantiated (2 M€ per year additional institutional funding, 0.5 M€ from the institute's existing budget; for details see Status Report, page A-9).

Controlling and quality management (Chapter 4)

5. At the last evaluation it was welcomed that IOW had a new research vessel at its disposal, the *Elisabeth Mann Borgese*. Following the evaluation, the Leibniz Association Senate suggested examining whether, in view of the high running costs, it was worthwhile for the institute to operate a vessel of its own or whether other solutions might be more viable. IOW was asked to coordinate with the German Marine Research Consortium

(*Konsortium Deutsche Meeresforschung, KDM*) and the German Research Vessels Federal-Länder group (*Bund-Länder-Arbeitsgruppe "Deutsche Forschungsschiffe", BLAG*) and to report back at the next evaluation.

IOW now very clearly demonstrates that it is scientifically valuable to operate a research vessel of its own and that the vessel is appropriately utilised. Using vessels belonging to other institutions would not fulfil IOW's specific requirements in the same way. Immediate access to *Elisabeth Mann Borgese* also means that unexpected events, such as the last Major Baltic Inflow in 2014, during which large amounts of saltwater entered the Baltic Sea, can be observed.

It is welcomed that the Federal and *Land* governments increased institutional funding to finance *Elisabeth Mann Borgese's* running costs and, recently, the tax payments required for vessel management. The required funding should continue to be provided in the future.

Human resources (Chapter 5)

6. It is welcomed that approximately equal numbers of men and women are employed in research and scientific services. However, IOW still needs to increase the percentage of women at leadership level. As of 31 December 2018, only one of the nine leading scientists (director; four heads of department; four deputies) was female. The two appointments scheduled to be made due to retirement are a good opportunity to improve the situation.

Cooperation and environment (Chapter 6)

7. As recommended at the last evaluation, IOW has intensified its international collaborations, especially in the Baltic Sea region. The institute should continue to pursue this path in order to enhance its international visibility. In the coming years, IOW should also initiate and coordinate major alliances.

2. Overall concept, activities and results

Overall concept and activities

IOW's portfolio covers i) research, ii) research infrastructure and iii) the transfer of scientific knowledge to multiple sectors of society.

I.

IOW conducts fundamental research on the functioning of marine ecosystems, investigating both the specific features of the Baltic Sea and cross-system global questions. By combining empirical observations, experiments and modelling, the institute traces changes in the ecosystems it studies as well as the underlying processes, differentiating between anthropogenic and natural impact factors. Research ranges from physical, chemical, biological and geological issues at microscopic level through to long-term basin-wide change processes in marine ecosystems and their socioeconomic consequences for coastal regions and beyond.

In recent years, IOW has managed very effectively to choose its research questions, on the one hand, with a view to the unique natural environment of the Baltic Sea and, on the other, to multi-scale, system-oriented global questions. At the last evaluation, it was pointed out that IOW should ensure a more appropriate balance in this respect. Also, IOW conducts comparative studies (third party funded) in other coastal and marginal seas, such as the South China Sea and the Benguela Upwelling System off the coast of West Africa. IOW should make the decision to conduct such comparative studies more directly dependent on whether these studies fit well with the institute's overall strategy. With the unique focus of IOW on the Baltic Sea, they are only meaningful if they are necessary as proof of concept or where the comparison helps to better understand specific features of the Baltic Sea.

II.

As a basis for its own research work, but also for external users, IOW carries out important research infrastructure tasks. The monitoring programme for the assessment of the marine environment of the Baltic Sea is of particular importance. It comprises (a) a monitoring programme involving sedimentological, marine physical, chemical and biological investigations on a network of internationally agreed stations in the Baltic Sea, (b) the development, operation and maintenance of an automated observation network (Baltic Sea-MARNET) as well as (c) data processing and data delivery. To this end, IOW operates five cruises per year with its own research vessel during which hydrographic variables are measured at up to 100 stations.

IOW conducts the programme part related to German waters on behalf of the Federal Maritime and Hydrographic Agency (BSH) that falls within the ambit of the Federal Ministry of Transport and Digital Infrastructure. For this purpose, BSH allocates an annual budget of approximately 2 M€ to IOW. This programme fulfils Germany's obligations under the Helsinki Commission (HELCOM), the governing body of the Convention on the Protection of the Marine Environment of the Baltic Sea Area (Helsinki Convention). The contracting parties are the European Union and the countries bordering the Baltic Sea.

The collected data are openly accessible via the IOW database (IOWDB) and constitute an exceptionally valuable basis for the institute's research and consultancy activities as well as for external users. Moreover, since the monitoring programme is embedded in the scientific environment of IOW, the high quality of the programme is guaranteed.

III.

Based on its research infrastructure activities and research results, IOW provides advisory and transfer services. They are highly sought-after by political decision-makers and other stakeholders. They focus, above all, on the interaction between territorial sea, land and atmosphere as well as measures for conserving the ecological and economic performance of marine ecosystems.

Results

Overview of the performance of the four research foci (see Chapter 7 for details)

IOW comprises four discipline-based departments: Physical Oceanography and Instrumentation, Marine Chemistry, Biological Oceanography and Marine Geology. A further unit, the working group “Coastal Sea: Management and Planning”, which is affiliated to the director, also conducts research. Organised in a very effective and efficient matrix structure, the departments jointly address four research foci (RFs), which build coherently on one another. The working group contributes exclusively to RF 4.

Activities in RF1, “Small and meso-scale processes,” are largely fundamental in nature and focus on the processes occurring at interfaces as well as the transport processes within the water column. RF1 is rated as “very good to excellent”.

Activities in RF2, “Basin-scale ecosystem dynamics”, which similarly concentrate on basic research, but address fundamental processes on a larger, basin-wide scale. RF2 is rated as “very good”.

RF3 “Changing ecosystems” combines the work of RF1 and RF2 with a temporal perspective. Amongst others, it conducts the monitoring programme on behalf of the BSH. This central research infrastructure service is very important. The scientific performance within RF3 based on it, however, is often less innovative than in the other areas of work. RF3 is rated as “good”. In order to enhance RF3’s performance, activities should be more clearly focussed. The plan of IOW to extend activities into the field of coastal shallow waters offers good opportunities to do so.

As planned, since the last evaluation, RF4, “Coastal sea and society”, has been built up on the basis of various earlier cross-cutting activities. It conducts applied research in cooperation with end-users focussing on improvements in the implementation of marine and coastal policies and on the development of adaptation measures in response to global change effects. RF4 thus constitutes an important intersection between science and society which, against the backdrop of the increased urgency of, and public interest in, a deep sustainability transition that addresses both climate change and the biodiversity crisis, is set to gain in importance in the future. In this context, it is welcomed that RF4 aims at interdisciplinary cooperation e.g. with social sciences including (but not limited to) economics. The potential gains from such interdisciplinary cooperation should be communicated beyond the institute more effectively and be reflected in a larger number of academic publications at high level. Due to its strongly practice-related orientation it is understandable that to date, a large percentage of RF4’s publications do not appear in peer-reviewed journals. In continuing its development, however, RF4 should aim even more at excellent, appropriately publishable research results which can then form the basis for transfer activities as a second step. Overall, RF4 holds great potential for transformative research which is not yet being fully exploited. RF4 is rated as “good to very good”.

Research

IOW fulfils its objective of achieving research results that are relevant beyond the specific insights into the Baltic Sea. These include, for example, the work on climate

variability and climate change impact, biodiversity and food webs, the growing burden of marine litter, the spread of oxygen minimum zones and the increase in eutrophication. In the future, IOW is encouraged to publish these results more frequently in journals that reach a broader scientific audience. With this in mind, it is welcomed that IOW recommends its scientists to publish in open access journals.

Research Infrastructures

Apart from its research activities, IOW also performs important services and infrastructure services. The comprehensive hydrographic, chemical, biological and geological data describing the condition of the Baltic Sea, in particular, are extremely valuable for external users. The IOW database (IOWDB) currently comprises more than 70 million oceanographic readings and metadata covering the years 1877–2019. Phyto- and zooplankton data are available for the period 1988–2018.

Other parts of IOW's central infrastructure can also be accessed by external scientists. These include a secondary-ion mass spectrometer (NanoSIMS), of which there are only some 25 in Europe. IOW's research vessel has now been integrated in a centrally organised pool of all German research vessels; external users can apply for shiptime (for details of financing the vessel, see Chapter 4).

Transfer

Based on its extensive data gathering and research results, IOW delivers important knowledge transfer to political decision-makers. Special mention should be made of IOW's results deriving from the monitoring programme it conducts on behalf of the BSH. The results flow, amongst others, into HELCOM's recommendations on environmental and conservation issues, such as the development of a system of protected areas consisting of Baltic Sea Protected Areas.

Another example of close cooperation with a political stakeholder is the collaboration with the Federal Agency for Nature Conservation (*Bundesamt für Naturschutz*, BfN). In the framework of extensive third-party projects, they work together on sea bottom mapping and assessment. The results have been utilised, for example, in the Marine Strategy Framework Directive (MSFD) and in the designation of so-called ecologically and biologically significant areas (EBSAs). Moreover, IOW cooperates closely with all agencies and authorities that are responsible for implementing multinational directives and laws pertaining to the Baltic Sea, such as the MSFD and the Baltic Sea Action Plan (BSAP).

IOW also reaches out to the public with its transfer activities. For example, in the institute's building that is situated directly on the promenade, there is an appealing exhibition of IOW's activities. Special mention should also be made of its cooperation with schools. In the IOW school students' lab, the institute runs events on topics like ocean acidification, eutrophication and microplastic. IOW is also involved in continuing education for teachers as well as teacher training.

In the technology transfer sector, IOW cooperates closely with firms to develop and adapt its instrumentation as well as technologies for the trouble-free use of precision measuring devices at sea. In some cases, patents have been registered, for example for a winch with

Active Heave Compensation, which makes it possible to take measurements at a constant depth despite the swell.

It is welcomed that IOW is developing a set of indicators to help measure the impact of its transfer activities which it plans to include in compiling its future programme budget. On the basis of these measurements IOW should continue developing its diverse, very good transfer activities and enhance their visibility.

3. Changes and planning

Development since the previous evaluation

IOW has developed very positively since the last evaluation. This is partly due to very good recruitment, especially at leadership level. Shortly before the last evaluation visit in 2012, an excellent appointment was made to head the Biological Oceanography Department. Moreover, in 2015, another excellent appointment was made to head the Physical Oceanography and Instrumentation Department. With their particular academic profiles, both heads of department have fitted in very well with the work conducted at IOW and developed it significantly further. As already planned at the last evaluation, the outstanding work on the dynamics of regional climate systems in the Physical Oceanography and Instrumentation Department has been expanded. In this context, the recommendation to extend expertise in statistical analyses and applications was also implemented by filling two tenure-track positions with scientists who hold the requisite expertise.

Another important measure was the modernisation of long-term data collection. As had been decided before the last evaluation, IOW received additional financial support for four years from 2012 to 2015 (temporary extraordinary item of expenditure) to employ scientists and technicians and to implement new underwater technologies as well as automatic monitoring stations. This allowed IOW's staffing and equipment provision to be maintained at the required level.

Strategic work planning for the coming years

For IOW's future development, it will be particularly crucial who succeeds the current director when he retires in 2021. It is welcomed that the procedure has already been launched in the form of an international call and the establishment of an Appointment Committee. In 2023, also the head of the Marine Chemistry Department will retire.

IOW's current research programme will end in 2022. Thus, together with the convincingly planned expansion of the methodology and technology spectrum (see below), the new director will be in an ideal position to highlight his or her particular thematic preferences in the successor programme.

Planning for additional funds deriving from institutional funding

Following up on very convincing preliminary work, IOW plans to develop new observational, experimental and modelling tools. Up to now, IOW's activities have largely focussed on the open sea and coastal zones. The envisaged developments will enable the institute to include shallow coastal waters. The planned, necessary expansion of

its technical and methodological spectrum follows on coherently from the recommendations issued both at the last evaluation and by the Scientific Advisory Board.

For the purposes of implementation, IOW intends applying for a permanent extraordinary item of expenditure from 2022 onwards. This plan is supported. The funding foreseen for staffing, including a W2 professorship, investments and material expenses permanently amounting to approx. 2.5 M€ per year, is plausibly substantiated (2 M€ per year additional institutional funding, 0.5 M€ from the institute's existing budget; for details see Status Report, page A-9).

As planned, when applying for the additional funding, IOW should describe in detail precisely which instruments will be required for the new activities. Exactly how they should be assigned organisationally should be determined in agreement with the new head of the new research area. In view of the huge volume of data that are expected to be generated by the new activities it is welcomed that IOW cooperates with the North-German Supercomputing Alliance.

4. Controlling and quality management

Facilities, equipment and funding

Funding

Institutional funding is adequate to fulfil IOW's current portfolio of activities (13.4 M€ in 2018).

As recommended at the last evaluation, IOW managed to maintain its revenue from project grants at a high level and concurrently increase its income through competitively acquired funding from the DFG and EU. In 2018, 8.2 M€ in spending derived from revenue from project grants (corresponding to 38 % of the overall budget). The revenue comprised 3.7 M€ from federal grants, 2.1 M€ from the EU, 1.3 M€ from the DFG and 0.8 M€ from the Leibniz Competition. If the 2.5 M€ from the Federal Maritime and Hydrographic Agency (BSH) is included, the share even rises to 44 percent. In addition to funding for research projects, the revenue from project grants also includes funding for services and transfer activities (e.g. for the BfN).

Commercial exploitation of results is not one of IOW's major goals. Inventions that are submitted for patenting or transfer to companies under a licensing agreement are usually by-products of optimising the technology used at IOW. To this extent, it is plausible that revenue for services is low (see Status Report, appendix 3, line 3).

Research vessel Elisabeth Mann Borgese

At the last evaluation it was welcomed that IOW had a new research vessel at its disposal, the *Elisabeth Mann Borgese*. Following the evaluation, the Leibniz Association Senate suggested examining whether, in view of the higher running costs, it was worthwhile for the institute to operate a vessel of its own or whether other solutions might be more viable. IOW was asked to coordinate with the German Marine Research

Consortium (KDM) and the German Research Vessels Federal-Länder group (BLAG) and to report back at the next evaluation.

IOW now very clearly demonstrates that it is scientifically valuable to operate a research vessel of its own and that the vessel is appropriately utilised. Using vessels belonging to other institutions would not fulfil IOW's specific requirements in the same way. Immediate access to *Elisabeth Mann Borgese* also means that unexpected events, such as the last Major Baltic Inflow in 2014, during which large amounts of saltwater entered the Baltic Sea, can be observed.

It is welcomed that the Federal and *Land* governments increased institutional funding to finance *Elisabeth Mann Borgese's* running costs and, recently, the tax payments required for vessel management. The required funding should continue to be provided in the future.

Facilities and equipment

IOW's facilities and equipment are modern and appropriate and can partly be accessed by external users (see Chapter 2). In addition to laboratories that are typical for marine science institutes they include a secondary-ion mass spectrometer (NanoSIMS), a Stable Isotope Laboratory as well as microbiological S1 and S2 laboratories.

The IT service group maintains an efficient IT infrastructure. Besides the standard requirements of research institutes, it meets the special demands that facilitate the work of IOW's modelling and bioinformatics groups. Computation- and memory-intensive analyses are located on local servers optimised for these tasks. Extensive modelling activities are usually carried out on the servers of the North-German Supercomputing Alliance.

Organisational and operational structure

IOW's organisational and operational structure is appropriate. Its scientific activities are organised according to a convincing structure (see Chapter 2). Moreover, IOW has established committees and formats suitable for communication at the institute.

Quality Management

IOW's internal scientific quality assurance is effective. The institute has adopted rules to ensure good scientific practice on the basis of the rules recommended by the DFG and later by the Leibniz Association. IOW has an ombudsperson. The institute does not implement performance-based allocation of resources. However, successful acquisition of third-party funds is rewarded by making 60 percent of the respective overhead funds available to the project leader.

Further important features of quality management described in the rules of good scientific practice concern the duties of documenting and archiving all steps involved in the generation of data. IOW Data Policy describes the handling, publication and dissemination of environmental data. The IT group maintains data management systems. In the future, too, IOW should ascribe top priority to validating data as a fundamental basis for its scientific work.

Quality management by the Scientific Advisory Board and Board of Governors

The Scientific Advisory Board (SAB) fulfils its remit very conscientiously. In 2016, it conducted the audit usually held at Leibniz institutes between two evaluations. The expertise of the SAB should be extended to embrace disciplines that are not currently represented by staff at IOW; social scientists and economists, for example, could be incorporated. Furthermore, the perspective of those using IOW results should also be included on the SAB.

The Board of Governors (BoG) carries out its role as IOW's supervisory body convincingly. It is particularly welcomed that the process of appointing a new scientific director was launched at an early stage.

5. Human Resources

Management

IOW is well managed by the director and the four heads of department. One of the heads of department is appointed by the director as deputy. The director's joint appointment with the University of Rostock follows the guidelines set out by the Leibniz Association. In principal, heads of department and their deputies are appointed on the same basis, except that a stronger emphasis is placed on the compatibility of the candidate's expertise with the scientific focus of the respective department.

Postdoctoral staff

Postdocs are very well supervised at IOW. The institute's budget covers one postdoc per department; the majority are employed in third-party funded projects. They all participate in a structured programme. Most of IOW's postdocs were previously employed at other institutions throughout Germany. As planned, IOW should increase the percentage of postdocs who completed their doctorates abroad, notably from countries around the Baltic Sea but also elsewhere.

It is welcomed that as early as 2013, IOW introduced a tenure-track programme (3+2 years). The selection of candidates is subject to a recruitment procedure similar to that for the leading scientists. The regulations governing appointments, extensions and potential tenure have been written down and are transparent for all members of staff. It is good that the institute has also prepared information on career levels at IOW and on career planning for young researchers. The institute should check whether more attention should be paid to career paths outside of research.

Doctoral candidates

The number of doctoral candidates as well as completed dissertations is appropriate. As of 31 December 2018, IOW employed 31 doctoral candidates and hosted four scholarship recipients. Between 2016 and 2018, 18 candidates successfully completed their doctorates. The average length of doctoral studies is also appropriate. Most doctoral candidates complete their theses during their fourth year.

The majority of IOW's doctoral candidates are enrolled at the University of Rostock; those studying geosciences are admitted to the University of Greifswald. In accordance with a

recommendation issued at the last evaluation, IOW and its university partners have amended the regulations pertaining to cumulative theses. Only two manuscripts now have to be accepted for publication instead of three.

It is welcomed that IOW has established individual thesis committees which include external experts. Doctoral candidates are very well supervised in accordance with the "Guidelines for doctoral training and supervision at the IOW" and have access to appropriate continuing education opportunities at the institute and the partner universities. IOW should pursue its plans to build an alumni network.

Non-scientific staff

IOW offers its non-scientific staff appropriate continuing education opportunities. It is welcomed that the institute also provides training positions for chemical laboratory technicians, industrial mechanics, IT specialists for system integration and office management clerks. Between 2016 and 2018, one trainee qualified successfully in each of these occupational fields.

Equal opportunities and work-life balance

Equal opportunities

It is welcomed that approximately equal numbers of men and women are employed in research and scientific services. However, IOW still needs to increase the percentage of women at leadership level. As of 31 December 2018, only one of the nine leading scientists (director; four heads of department; four deputies) was female. The two appointments scheduled to be made due to retirement are a good opportunity to improve the situation.

It is welcomed that IOW has an Equal Opportunities Officer and established an Internal Equality Commission which includes the top leadership level (director and heads of department) in 2011. IOW's engagement for equality is also documented by the award of the Total Equality Certificate in 2013, 2016 and 2019.

Compatibility of family and career

IOW offers its staff appropriate tools for promoting the reconciliation of work and family life. It maintains a family office and has concluded a contract with a kindergarten near the institute that reserves a specific number of places for the institute. IOW employees are offered flexible working hours and the institute is drawing up a service agreement to allow its staff to work from home (Home Office). With its "Come-back to Research" programme, IOW supports researchers who wish to return to research after a family-related career break.

6. Cooperation and environment

Cooperation with universities

IOW cooperates closely with the two universities in Rostock and Greifswald. In addition to the director, the heads and deputy heads of three of the four departments at IOW hold

joint professorships at the University of Rostock. Two further senior scientists have been appointed as adjunct professors (“außerplanmäßige/apl. Professuren”) at the University of Rostock. The head and deputy head of the fourth department “Marine Geology” hold joint professorial appointments at the University of Greifswald. IOW staff are intensively involved in teaching at the two universities. Moreover, two IOW scientists have been appointed guest professors at the University of Klaipeda (Lithuania) and contribute to the teaching programme there, too.

With regard to research collaborations, particular mention should be made of IOW’s cooperation with the University of Rostock in the DFG Research Training Group “Baltic TransCoast” and with the University of Hamburg in the DFG Collaborative Research Centre TRR 181 “Energy transfers in atmosphere and oceans”.

Cooperation with Leibniz institutes

Within the Leibniz Association, IOW is well connected. Special mention should be made of the Leibniz Science Campus Phosphorus Research which focusses on a more sustainable management of phosphorus. In addition to IOW and the University of Rostock, four other Leibniz institutes are involved.

IOW is also a member of the Leibniz Research Alliance “Biodiversity”, a collaboration involving 19 Leibniz institutes. Furthermore, other individual collaborations exist with various Leibniz institutes, such as the Potsdam Institute for Climate Impact Research (PIK) and the Leibniz Institute for Tropospheric Research (TROPOS) in Leipzig.

Cooperation with other national and international institutions

In Germany, IOW plays a central role in the field of Baltic Sea-related marine and coastal research. Against this backdrop, the institute collaborates closely with political decision-makers responsible for implementing the regulations and laws relating to the Baltic Sea. Of particular significance in this context is its long-term cooperation with the Federal Maritime and Hydrographic Agency (BSH) and the Federal Agency for Nature Conservation (BfN, see Chapter 2).

Over the last six years, IOW has also been commissioned by the BMBF to coordinate its projects in the North and Baltic Seas under the KüNO (coastal research North Sea Baltic Sea) umbrella project. Moreover, the institute is on the Board of the German Marine Research Consortium (KDM) and is a member of the new German Alliance for Marine Science (DAM).

As recommended at the last evaluation, IOW has intensified its international collaborations, especially in the Baltic Sea region. The institute should continue to pursue this path in order to enhance its international visibility. In the coming years, IOW should also initiate and coordinate major alliances. One of the main reasons for the improvement in the institute’s networking is its involvement in a raft of collaborative projects funded under the BONUS programme (BONUS is a joint Baltic Sea research and development programme supported by the EU states around the Baltic Sea as well as the European Union). IOW was a partner in six completed projects (three of which were coordinated by IOW) and is a partner in eight ongoing projects (two of which are coordinated by IOW).

7. Subdivisions of IOW

Research Focus 1: Small- and meso-scale processes

[31,68 FTE, thereof 16,16 FTE Research, 4,55 FTE Doctoral candidates, and 10,97 FTE Service staff]

The very successful activities conducted in RF1 seek to identify, understand and quantify the physical, chemical and biological processes from the sea surface to the sediments. In the context of a convincing, coherent strategy, various state-of-the-art cell-specific techniques are used, such as a secondary ion mass spectrometer (NanoSIMS) and amino acid stable isotope analyses. The research results are very good, in some cases, excellent. Furthermore, they form the basis for many of the activities conducted in other RFs whereby cooperation of a complementary nature is particularly close with RF2.

Special mention should be made of RF1's excellent work on establishing new qualitative and quantitative proxies (tracers) to reconstruct and understand past environmental changes in order to improve future climate projections. A further highlight is the work on phyto- and zooplankton in a changing climate, with a focus on the resilience to warming and low salinity. Additional very good work has been done on mixing and transport processes due to changing environmental conditions, biogeochemical processes at pelagic redoxclines as well as on methane sinks and sources triggered by climate change.

The RF's research results are regularly published in high-ranking journals. Given the high quality of the work, the RF should publish even more often in journals with an internationally high impact. Third-party funding income for research projects is high and comprises, in particular, substantial funding from the DFG. Apart from various individually funded projects, since 2016, this has also included participation in the Collaborative Research Center/Transregio "Energy transfers in atmosphere and ocean" which is coordinated by the University of Hamburg.

Research Focus 1 is rated as "very good to excellent".

Research Focus 2: Basin-scale ecosystem dynamics

[35,32 FTE, thereof 22,12 FTE Research, 4,05 FTE Doctoral candidates, and 9,15 FTE Service staff]

RF2 systematically builds on the insights into individual processes acquired in RF1 and addresses them in a basin-wide context. Activities contribute to understanding the Baltic Sea system as a whole by conducting observations and experiments which are then simulated in near-realistic computer models. For this purpose, high-quality, multi-parameter observational datasets are generated at high spatial resolution. A very good numerical modelling system has been developed, for example, that is capable to quantitatively reproduce system-wide transformation processes.

RF2 produces high-quality research results. Special mention should be made of the work on biological communities in the salinity gradient of the Baltic Sea and nitrogen processes in the Baltic coastal zones. As recommended at the last evaluation, greater attention is now paid to terrestrial factors like sediment discharge from the catchment areas.

The work on major barotropic inflow events, during which large amounts of saltwater enter the Baltic Sea (also known as Major Baltic Inflows – MBI), is also very good. As IOW has a vessel of its own, it was able to respond rapidly to the last MBI in December 2014 and organise cruises at short notice. The important observations made during this campaign formed the basis for investigating the impact of MBI on the ecosystem and its biodiversity. When planning the future development of activities directly related to the Baltic Sea, IOW should consider to what extent it should include investigations of sea ice. This could be undertaken in the framework of collaborations, for example with the Alfred Wegener Institute – the Helmholtz Centre for Polar and Marine Research (AWI).

In the context of third-party projects, RF2 also carries out studies on other coastal and marginal seas. The objective is to compare results with the research on the Baltic Sea. Irrespective of the quality of this work, this strategic goal is not always being achieved at present. For instance, very good results were produced on eastern boundary upwelling systems off the West African coast. The observations led to a quantitative understanding of the hydrodynamic, biogeochemical and biological drivers of oxygen deficiency in such systems. Because there are only few points of connection to other activities at IOW, this work should be integrated to a greater extent in international networks.

Overall, RF2's research results are published very well. Third-party income for research projects is high. In addition to funding from the Federation and the *Land*, it includes significant revenue from the EU and the DFG. In particular, the DFG Research Training Group "Baltic TransCoast" was established together with the University of Rostock in 2016.

Research Focus 2 is rated as "very good".

Research Focus 3: Changing ecosystems

[53,99 FTE, thereof 26,0 FTE Research, 3,6 FTE Doctoral candidates, and 24,39 FTE Service staff]

RF3 relates work on the process (RF1) and ecosystem (RF2) levels to the associated time-scales with the aim of understanding coastal seas like the Baltic over the course of their geological history and, specifically, during the era of increased human impact. To do so, past ecosystem states are reconstructed, present trends in ecosystems investigated and prediction models for future ecosystems developed.

One of the main focus areas is the collection and processing of numerous observations. Most of these data are gathered under IOW's long-term observation programme. A major part of this programme is the monitoring IOW carries out on behalf of the Federal Maritime and Hydrographic Agency (BSH). The data are used for research activities that form the basis for important advisory services for different target groups, including HELCOM (Helsinki Commission).

The work on regional climate system models is excellent. By dynamically downscaling a global paleoclimate simulation, for example, RF3 successfully demonstrated that Atlantic multidecadal oscillations have a considerable impact on the Baltic Sea climate. The assessment of eutrophication abatement scenarios by multi-model ensemble simulations is also

very good. These results have delivered important indicators for the effectiveness of measures in the Baltic Sea Action Plan (BSAP).

The work on holocene environmental changes in the Baltic Sea is interesting but tends to be descriptive. A connection has been made between a climate-related drop in the oxygen content of the Baltic Sea some 6,000 years ago and the transition from a fisher-hunter-gatherer dominated culture to a farming culture due to the reduction in marine resources, such as fish.

In addition to its activities directly relating to the Baltic Sea, RF3 also conducts third-party research projects in other regions, which are partly intended to serve as comparative studies. Examples include environmental transitions in the Black Sea and pollution history in the South China Sea. Sound results have been produced. It is, however, not always clear how the individual projects fit into the overall strategy of both RF3 and IOW as a whole.

All in all, with its collection and processing of various data, RF3 delivers an indispensable basis for IOW's activities. Whilst its own research results are, however, interesting and important, they are mostly less innovative in scientific terms. RF3's publication record is good. Apart from extensive funding from BSH, between 2016 and 2018, RF3 received significantly less third-party funding than the other RFs. In order to enhance RF3's performance, work should be more clearly focussed. IOW's plan to extend activities into the field of coastal shallow waters offers good opportunities to do so.

Research Focus 3 is rated as "good".

Research Focus 4: Coastal sea and society

[38,32 FTE, thereof 19,28 FTE Research, 9,45 FTE Doctoral candidates, and 9,59 FTE Service staff]

Shortly before the last evaluation, IOW's important cross-cutting activities on the interaction between the Baltic Sea ecosystem and human activity were transferred to an independent, strongly interdisciplinary RF4. This was welcomed at the last evaluation. The institute was recommended to utilise targeted collaborations to achieve the necessary involvement of economic and social scientific expertise and to establish a hub for this at IOW. The challenging task of finding partners in economics and social sciences and planning concrete projects with them has been taken on by a working group reporting directly to the director: "Coastal Sea: Management and Planning". In the future, this group is supposed to further raise awareness of IOW's performance in the disciplines not represented at the institute and thus trigger additional collaborations. The gains from interdisciplinary cooperation should be communicated beyond the institute more effectively and be reflected in a larger number of academic publications.

Based on the research results, important advisory activities are provided for environmental policymakers, and the implementation of legislative measures at national and international level is promoted. RF4 thus constitutes an important intersection between science and society which, against the backdrop of public debates on climate change, is set to gain in importance in the future.

An example of close cooperation with a political stakeholder is the work undertaken together with the Federal Agency for Nature Conservation (BfN) that provides extensive third-party funding to support work on sea bottom mapping and assessment. In this context, IOW has developed new procedures to map and quantify the characteristics, functioning and sensitivity of the seafloor ecosystem. The results were utilised, for example, in the national Marine Strategy Framework Directive (MSFD) and in the designation of so-called Ecologically and Biologically Significant Areas.

The results in the field of plastic and microplastic pollution are of great relevance to political decision-makers and also flow into the MSFD. With its various projects, IOW covers the entire course from plastic sources in the catchment area through to sinks in the Baltic Sea. For this purpose, IOW has developed a system that facilitates the modelling of pollutant transport from the hinterland to the open Baltic Sea. Furthermore, based on IOW measurements and simulations, target values for nitrogen and phosphorus concentrations were proposed that have become legally binding in Germany.

To support the practical implementation of coastal and marine policies adapted by the EU or HELCOM, IOW develops useful tools and approaches for integrating scientific results into management and planning procedures in cooperation with end users. These include, for example, the Baltic Sea Atlas, a geo-information system that serves as a comprehensive uniform storage, working, and display unit for spatial data and model results. The tools are used to support authorities in their decision-making as well as for knowledge sharing with stakeholders and society.

Between 2016 and 2018, RF4's third-party income was very high, especially from BfN and the BMBF. Revenue from the EU was also high. However, no revenue was acquired for basic research, as funded by the DFG, for example. The publication record is appropriate. Due to its strongly practice-related orientation it is understandable that a large percentage of RF4's publications do not appear in peer-reviewed journals. In continuing its development, however, IOW should focus even more strongly on excellent, appropriately publishable research results which can then form the basis for transfer activities as a second step. Overall, RF4 holds very great potential which is not yet being fully exploited.

Research Focus 4 is rated as "good to very good".

8. Handling of recommendations from the last external evaluation

Recommendations by the Review Board

IOW has implemented the recommendations issued at the last evaluation almost completely (see Status Report, p. A-24f). With regard to a higher percentage of women at leadership level, however, further progress is necessary.

Appendix

1. Review Board

Chair (Member of the Leibniz Senate Evaluation Committee)

Wolfgang Cramer

Mediterranean Institute of Marine and Terrestrial Biodiversity and Ecology, Aix-en-Provence (France)

Deputy Chair (Member of the Leibniz Senate Evaluation Committee)

Evamarie Hey-Hawkins

Institute of Inorganic Chemistry, University of Leipzig (Germany)

Reviewers

Tony Clare

School of Natural and Environmental Sciences, Newcastle University (United Kingdom)

Mike Elliott

Institute of Estuarine & Coastal Studies, The University of Hull (UK)

Kjell Gundersen

Institute of Marine Research (Norway)

Nadia Pinardi

Department of Physics and Astronomy, University of Bologna (Italy)

Carol Robinson

Centre for Ocean and Atmospheric Sciences (COAS), University of East Anglia (UK)

Sabrina Speich

Ecole Normale Supérieure, Department of Geosciences, Laboratoire de Météorologie Dynamique, Paris (France)

Jürgen Thurow

Professor of Palaeoceanography and Sedimentology, University College London (UK)

Angela Wulff

Department of Biological and Environmental Sciences, University of Gothenburg (Sweden)

absent with apologies

[Ecotoxicology and Ecology]

Representative of the Federal Government (Member of the Leibniz Senate Evaluation Committee)

absent with apologies

Representative of the Länder Governments (Member of the Leibniz Senate Evaluation Committee)

Heide Ahrens

The Senator for Science and Ports of the Free Hanseatic City of Bremen

7 April 2020

Annex C: Statement of the Institution on the Evaluation Report

**Leibniz Institute for Baltic Sea Research
Warnemünde (IOW)**

We would like to thank the review panel for the intensive analysis of our report, for thrilling and constructive discussions during the poster sessions and for a fair and respectful treatment during the entire evaluation process.

We are pleased that the reviewers acknowledge our general research objectives – to understand the unique natural environment of the Baltic Sea on the one hand and to find answers to multiscale, system-oriented global questions – and agree that research projects located in sea areas other than the Baltic Sea must serve these broad objectives.

To publish our research results in journals which reach a broad audience is one of our constant aims. In this respect, we are absolutely in line with the recommendations of the reviewers that this has to be continued and even enforced wherever possible.

We feel confirmed in our transfer strategy by the reviewers' comments and agree that defining appropriate indicators for their impact is the next step.

Encouraged by the unambiguously positive assessment of the reviewers, we will go on with great enthusiasm to apply for a permanent budget increase in order to implement a new research direction in shallow coastal waters. In parallel, we will follow the reviewers' advice to apply for a second extraordinary item of expenditure of administrative nature to account for additional burden in new tax regulations for ship operation and maintenance costs.

To increase the percentage of women in the leadership of the IOW is of very high priority. We are striving to succeed in this respect during the current and future appointment procedures.

We thank the review panel for acknowledging the growth in our international co-operations and welcome the recommendation to initiate and coordinate major alliances in the coming years.

With deep gratitude we acknowledge the comprehensive analyses of our results in research, transfer and infrastructure. In two cases only, our perspectives deviate from those underlying the reviewers' conclusions and we would like to take the opportunity to explain this:

Referring to RF 2, the review panel comments on the „very good results...produced on Eastern boundary upwelling systems off the West African coast“: „Because there are only few points of connections to other activities at IOW, this work should be integrated to a greater extent in international networks.“ We regret having failed to elucidate the character and the

embedding of these activities in an appropriate way. In fact, the activities described base on the same approach of combining theory, observation and modeling with which IOW scientists investigate upwelling in the Baltic. This includes the interdisciplinary interweaving of physical oceanographic with planktological and benthological studies. Because this approach is successfully approved in the Baltic, we can apply it in regions where we learn more about the broad varieties of upwelling and help to answer a global question on the linkage of climate and oceanographic models in crucial regions. IOW is doing research in the Eastern Boundary System off West Africa since many decades, in the framework of the restricted level of project funding and always embedded in larger national and international networks. We apologize for having described this in a misleading way.

Referring to RF 3, the panel came to the conclusion that „work on holocene environmental changes in the Baltic Sea is interesting but tends to be descriptive”. We want to take the opportunity of this statement to stress the meaning of environmental reconstructions on a scale of several millennia to decades like published in renown peer-review journals by e.g. Häusler et al. (2017, 2018), Warden et al. (2017) and Moros et al.(2017). Studies like these provide us on the one hand with the knowledge on the bandwidth of natural variations of the system and elucidate simultaneously how the brackish system reacted in the past on climate changes like those we will face in the course of global change. On the other hand, event-stratigraphy based paleoenvironmental proxy records of the last centuries deliver the unique opportunity to prolong our long-term data series beyond the beginning of oceanographic measurements in the Baltic Sea. Generating and improving such stratigraphies and environmental proxy records might be considered descriptive on the first sight, but they are the backbone for any oceanographic reconstructions and for the understanding of a marine system as a whole. Therefore, they are of extremely high value for the RF 3 research objectives.