New Belgian E-Learning Oriented IHO Cat. B Hydrography Program (2021)

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Key words: Education; Hydrography

SUMMARY

A study on hydrographic education in Belgium carried out a few years ago, pointed out a shortage in hydrographic training. Before the introduction of the new "Postgraduate in Hydrography", most hydrographic surveyors in Belgium work in one of the main European dredging companies where they received additional specific hydrographic surveying training. Therefore, in 2013, a 1-year English spoken curriculum degree of "Postgraduate in Hydrography" in Belgium was accredited by the IHO (International Hydrographic Organization). Then, in 2019, a renewed curriculum, including extensive e-learning facilities, was established. The program (Cat-B) is a cooperation between the Geography Department of Ghent University and the Institute for Hydrography of the Antwerp Maritime Academy, which is the hosting institute. The aim is to combine the compulsory theoretical courses with on-the-job training provided by partners in the industry to ensure maximum competences. All courses are lectured in Englis h, and can be taken up over several years to facilitate part-time work. These procedures allow for a qualitative and professional, yet accessible program. The theoretical courses are taught on two different campuses, the campus of the Antwerp Maritime Academy (HZS) and a campus of Ghent University (UGent) based on the available expertise and infrastructure, thus ensuring the quality. As travel time between both cities is relatively fast (ca. 45 min. travel time by public or private transport) together with the boundary condition that both locations are never used on the same day, this presents no problems to the students. The navigation related topics are taught at the Maritime Academy while the geodesy/data management/geology and ICT related topics are provided by the Geography, Geology and Informatics Departments at Ghent University.

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1. INTRODUCTION

The Belgian postgraduate programme cat. B is a collaboration between the Institute for Hydrography of the Antwerp Maritime Academy as hosting institute and Ghent University. It started on the 17 September 2012 and obtained its IHO accreditation in April 2013 [1], providing an answer on the large need for trained hydrographic surveyors [2], [3]. This unique joining of forces combines the geographical knowhow with maritime experience, solidly supported by a number of survey experts from state organizations and private companies.

The running of the Cat. B program since 2012 has flagged up some issues, mainly concerning the high quantity of contact hours, and the size of the tuition fees. These issues were addressed by including e-learning to reduce the number of contact hours and by reducing the tuition fee. IHO accreditation of the new adapted program is expected by spring 2020, as the Institute for Hydrography, along with its organizers, partners and supporters, remains dedicated to offering students an excellent education and preparation for their forays in the hydrographic field.

The introduction to the theoretical courses in the first 3 weeks are taught on two different campuses, the campus of the Antwerp Maritime Academy (HZS) and the campus of Ghent University (UGent), with a relatively fast access between both cities (ca. 45 min. travel time by public or private transport) and the boundary condition that both locations are never used on the same day. After the first weeks, the students switch to distant e-learning, where the Maritime Academy will typically be responsible for support for the navigation related topics and the Geography, Geology and Informatics Departments at the Academic University in Ghent for the support for geodesy/data management/geology, surveying and ICT related topics. The students are free to choose which topics they follow in the first and the second semester.

2. STRUCTURE OF THE PROGRAM

When the Hydrography Cat. B program was set out initially in 2012, it consisted of 12 contact weeks to cover the theory classes, divided into four blocks of three weeks spread over the academic year. All topics required by the “Standards of Competence” framework of the IHO were covered [4]. An additional three weeks were reserved for the integrated fieldwork, along with two blocks of two weeks for exams. This quantity of contact weeks discouraged some

potential candidates to participate in the program. Due to this feedback, we started looking into how to cater to people that were already working.

With the recent improvements and popularity of distance learning, the program was re-shaped to be more accessible while retaining key contact moments and a strict follow-up of the students. The academic year starts at the end of September and ends in September of the following year. The academic year is subdivided into 2 semesters ending with an examination period, a summer recession with at the end second chance exams and evaluation of the field training assessed by their "Training Record Book" to graduate in September. The year planning is summarized in Table 1 below.

Table 1. – Year planning of the courses

Period	**Duration**	**Content**
September	3 weeks	This introductory 3 weeks are a key part of the program as it includes introductions to all courses, basic safety classes etc.
October - December	10 weeks of "free" combination of field training and distance learning	Students will use the online learning platform Ufora to follow classes, engage with discussions and do assignments and tests. Because these classes are not location-based, it can easily be combined with a job or fieldwork placement on board or elsewhere, so students can choose when to do their classes.
December	2 weeks of study time	To prepare the exams of the first semester.
January	2 weeks of examinations	For all the courses of the first semester.
January - April	14 weeks of "free" combination of field training and distance learning	Together with the 10 weeks in October till December, the students have to fulfill a minimum of 100 days of fieldwork, of which, if they work already in a company or state office, at least 10 days outside their normal working environment.
May	4 weeks of "integrated fieldwork"	Mandatory contact weeks for an "integrated fieldwork" project in partnership with our private or state office survey partners.
June	2 weeks of study time	To prepare the exams of the second semester.
	2 weeks of examinations	For all the courses of the second semester.
September		Oral defense of all the competences acquired during the at least 100 days of fieldwork and registered and validated by recognized hydrographic surveyors in the "Training Record Book" (see further). Evaluation of all the reports of the student related to the field training. Deliberation and graduation.

3. STUDY SUBJECTS "POSTGRADUATE IN HYDROGRAPHY CAT. B"

Table 2 below gives an overview of the different courses taught with their ECTS weight.

Table 2. – Study subjects with ECTS weight

Course element	ECTS
Information & Communication Technology	4
ICT Theory	*3*
ICT Fieldwork	*1*
Navigation	**8**
Navigation Theory	*4*
Navigation Fieldwork	*1*
Meteorology and Oceanography Theory	*2*
Meteorology and Oceanography Fieldwork	*1*
Introduction to Safety	**5**
Safety Theory	*2*
GMDSS Theory	*1*
Safety Fieldwork	*2*
Seamanship	**4**
Seamanship Theory	*3*
Seamanship Fieldwork	*1*
Water Levels and Flow	**5**
Water Levels and Flow Theory	*3*
Water Levels and Flow Fieldwork	*2*
Geodesy and Cartographic systems	**5**
Geodesy and Cartographic systems Theory	*3*
Geodesy and Cartographic systems Fieldwork	*2*
Hydrographic Surveying	**10**
Hydrographic Surveying Theory	*6*
Hydrographic Surveying Fieldwork	*4*
Data Management	**5**
Data Management Theory	*3*
Data Management Fieldwork	*2*
Geology & Geophysics	**5**
Geology & Geophysics Theory	*3*
Geology & Geophysics Fieldwork	*2*
Legal Aspects	**4**
Legal Aspects Theory	*3*
Legal Aspects Fieldwork	*1*
Integrated Fieldwork (*compulsory for all students*)	**5**
TOTAL	60

4. FIELDWORK

The fieldwork is of primordial importance and accounts for 24 ECTS, subdivided into two parts. The “Integrated Fieldwork” (4 weeks in May, 5 ECTS) consists of 20 days of practical exercises, focussing on a “hydrographic project”, usually hosted in the harbour of Ostend. The “Field Training” (19 ECTS) on the other hand, consists of a minimum of 576 hours (ca. 5

months) of practical training in private companies or governmental offices in the hydrographic sector, during the period from October till April, and, if needed, also July and August.

4.1 Field training

Special attention has been given to the evaluation of this "field training", for which a "Training Record Book" (TRB) was introduced with an extensive list of skills that could (and should for the biggest part) be acquired (Figure 1). This comprehensive portfolio, used during their training and professional career, provides guidelines to the students of what to aim at during their fieldwork. Fieldwork supervisors can accurately assess skills, competences, and assignments and the Examination committee gets proof of student's practice during fieldwork. The TRB is closely modelled on the iconic Cadet Training Record Book in the maritime sector, and serves to keep an accurate record of the range of activities, and time spent. It is through this record keeping that the Board can assess if a student has sufficient fieldwork experience, furthermore, the TRB can be used as portfolio when applying for future job opportunities.

B2	Competence: INFORMATION AND COMMUNICATION TECHNOLOGY				Examination board Sign/ Date	
	Task	Supervisor's Initials/ Date		Evaluation/ remarks by supervisor		
B2.1	**Computer Fundamentals**					
	Set up a system for hydrographic use					
B2.2	**System and Application Software**					
	Operate application software (e.g. Caris)					
B2.3	**Programming**					
	Write an Excel routine to sort data					
B2.4	**Communication Tools and Internet**					
	Conduct searches for specialised information and make a report					
B2.5	**Database and Information Systems**					
	Operate and describe in a report a data management system (architecture, functions, operations and outcome)					

Figure 1. – Example of one of the ca. 20 pages of the "Training Record Book"

4.2 Integrated fieldwork

The 4 weeks of "integrated fieldwork" are centered around the "hydrographic/bathymetric measuring" week in the port of Ostend. Several smaller vessels are available, that have to be equipped in dry dock, 3D modelled (dry calibrated), put in the water, calibrated while surveying, etc. The students work in groups of 2 to 4 students at compulsory tasks. Non-sailing students perform geodetic tasks around the docks or install and check tide gauges. One week of preparation before the survey week and 2 weeks of processing and reporting afterwards are also included. Typical tasks (Figure 2) involve:

- Delivery, inspection and testing of the survey equipment (INS, GNSS, MBES, SBES, tide-gauges, PC software …)

- Testing the cables and connection between the sensors before mounting in the vessels.
- Installing the SBES and MBES on the mounting bracket and installing the RTK-GNSS antenna
- Prepare an antenna cable, stripping the cable, inserting and crimping the connector, taping off, checking insulation and signal strength.
- Installing the INS or RMU, testing the PPS signal and determination of the delays
- Installing the tide-gauge and performing a levelling between the tide-gauge and altimetric reference points.
- Topographic survey of the boundary with GNSS or total station.
- Mounting and connecting the devices and measuring the calibration offsets with total station.
- Creating a 3D model of the vessel using laser scanning
- Launching the vessel in the dock.
- Determination of axis orientation of the vessel in the water.
- Transforming the offsets from the land to the sea system.
- Calibrate the MBES by a Patch test.
- Planning and performing the actual bathymetric survey.
- Sailing orthogonal control lines.
- Demobilization of, cleaning, checking and packing the equipment.
- Organise transport of the equipment to the owner.

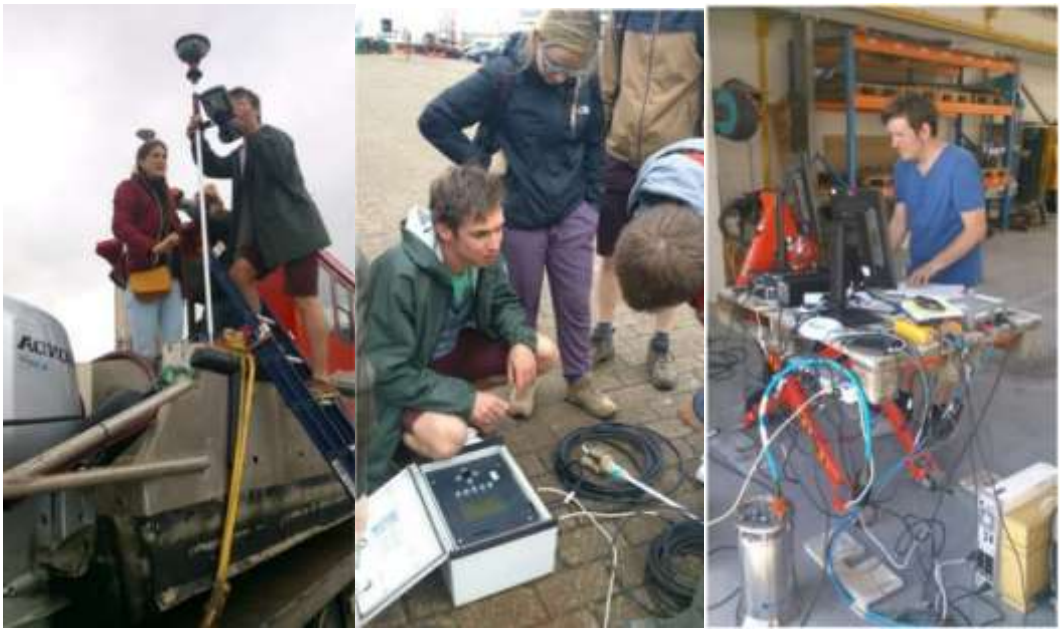

Figure 2. – Activities during the "Integrated Fieldwork" bathymetric week in the harbour of Ostend.

5. ASSESSMENT

Assessment of the educational program is a vital issue. The Antwerp Maritime Academy is ISO 9001-2008 certified and reviewed by internal and external audits (by "Det Norske Veritas") to guarantee the quality of the application of the IHO standards. All procedures are incorporated in the Internal Quality System (IKZ) of the Antwerp Maritime Academy and all courses and modules are also assessed by the students. IHO certification of the new program is expected by Spring 2020.

6. ONLINE E-LEARNING

Previous market research about hydrography in Belgium has indicated that there is both a lack of certified hydrographers (graduates and hydrographers already working in the field), and a lack of opportunities to pursue studies in Belgium in order to obtain a certificate.

Recent years have shown that potential students, especially those already working in the field, are held back from participating in this program because of the many contact hours stipulated. We therefore decided to address this issue by combining contact hours with 'distance learning': students are required to participate in key introductory classes, and continue with fieldwork and 'distance learning'. This enables them to be more flexible with their work and study time, as well as location.

Ufora is the new online learning environment of Ghent University. It offers a broad range of opportunities to make interactive learning possible, for example by using video and the creation of personal learning paths. In the e-learning programme the students follow the courses at their own planning in a programmed sequence. After each submodule, the student has to complete a multiple-choice test on the computer-based platform before he/ she can start the next submodule of the course. The student has to pass the multiple-choice test before access to the next module is granted.

7. ENTRY REQUIREMENTS AND APPLICATION PROCEDURE

Bachelor students wanting to specialize for a job with good work opportunities are one part of the main target group. The other part is the hydrographers in Belgium and abroad which are not properly certified. The organization of the course allows, in this way, people, already active in the hydrographic industry, to gain the minimum standards and get certified. The programme is accessible for an international public because it is entirely organized in the English language.

The application form for candidates is issued by the Antwerp Maritime Academy, Institute for Hydrography (AMA-IFH) in cooperation with its partners. The minimum age of entry is 18 years. The application form is a portfolio, consisting of: programme selection (part-time or full-time), personal and contact details, linguistic abilities (English), education history, employment history (if applicable), application assessment to be completed by the candidate.

Candidates wishing to participate in the programme need to comply with certain standards prior to the start of the course. The minimum entry requirements for the candidates are:

- Bachelor degree or equivalent from a European university or college, or from an overseas institution recognized by its government
- Proficiency in mathematics and physics
- Proficiency in English language

However, candidates without a Bachelor degree could apply in which case the Selection Committee will decide if the application is admissible based upon an equivalent knowledge and/or equivalent competences of the candidate. For Mathematics and Physics, candidates are

requested to prove their proficiency. A diploma supplement from a recognized educational institution is required. The diploma supplement should mention at least the same items of the IHO standards of competence. As the hydrographic programme is lectured in the English language, candidates have to prove sufficient knowledge and understanding in reading, speaking and understanding of the English language.

All applications are done by submitting the application portfolio, available on the website of the maritime academy [5]. The application portfolio and accompanying documents should be submitted by mail to hydrography@hzs.be. The applicants must bring the original documents with them for final enrolment. Candidates will be notified upon receipt. After payment of the registration fee the candidate will be interviewed to assess the skills and competences mentioned in the portfolio. The Selection Committee may grant the candidate exemptions for items of which the knowledge and/or competences have been proven. After payment of the total or partial tuition fee, the student is enrolled for the full or partial programme. A candidate can spread the studies over a maximum period of five years.

8. INDUSTRY AND PARTNERS

The emphasis of our educational program lies on a solid theoretical framework complemented by practical and hands-on experience. For the integrated fieldwork and for the fieldwork-related aspects, the IVH relies on its partners from the industry and governmental organizations. Below, a summary of the partners is given in Table 3.

Table 3. – Overview of the partners from the industry and governmental organizations.

Partner	**Description of their Activities**
Flanders Marine Institute (VLIZ) [6]	The governmental organization VLIZ promotes accumulation of marine knowledge and excellence in marine research in Flanders. The marine research areas are the ocean and seas, the coast and the tidal systems. The target groups for knowledge accumulation are the marine research community as well as educational institutions, the general public, policymakers and the industry (within the scope of the blue economy).
Agency of Maritime and Coastal Services (MDK) [7]	Ensuring safe and smooth shipping traffic at sea from and to the coastal ports and the River Scheldt is a core task of the governmental Agency for Maritime and Coastal Services. The MCS-Coastal Division supports the safety of shipping through its Flemish Hydrography department. The Flemish Hydrography department is responsible for the coordination and management of bathymetric, nautical and hydrometeorological information. Their main activities are bathymetric surveying at sea and the river Scheldt; detecting wrecks and storing them in database; providing sailing information to anyone in shipping; producing publications for the shipping industry; collecting hydrometeorological data; managing and maintaining the Flemish Banks Monitoring Network System; coordinating the Oceanographic Meteorological Station; reporting coastal weather [8].
Flanders Hydraulics Research (FHR) [9]	For more than 80 years, FHR has been a centre of expertise for research and advice on hydraulic, nautical, sediment-related and hydrological topics. As a scientific institute and technical support service, they are a division of the department of Mobility and Public Works of the Government of Flanders. FHR supports the preparation and execution of the policy of the Government of Flanders by providing comprehensive, scientifically sound knowledge, knowledge products and advice on water systems. Besides activities on behalf of the policy domain Mobility and Public Works, FHR develops activities for other entities within the Government of Flanders, for other domestic and foreign government services and for the private sector. Research projects for third parties are facilitated by Flanders Hydraulics Public Agency.

DEME [10]	A world leader in the highly specialised fields of dredging, marine engineering and environmental remediation. DEME can build on more than 140y of know-how and experience and has fostered a pioneering approach throughout its history, being a front runner in innovation and new technologies. Although DEME's activities originated with its core dredging business, the portfolio diversified substantially over the decades. Today's activities encompass dredging, land reclamation, hydraulic engineering, services for the offshore oil & gas and renewable energy industries and environmental works. While the company's roots are in Belgium, DEME has built a strong presence in all of the world's seas and continents, operating in more than 90 countries worldwide. DEME can rely on 5,200 highly skilled professionals across the globe and a versatile fleet of over 100 main vessels.
Jan De Nul [11]	Jan De Nul Group is specialised in dredging or maintenance dredging, land reclamation or beach replenishments, construction or maintenance of harbours, coastal and bank protection works or ecodredging. Jan De Nul owes its position as a global player mainly to its technical knowhow and continuous investments in an extensive high performance modern fleet, which is kept geographically well spread. The group focusses on big and complex projects worldwide without losing sight of interesting local opportunities. Today the emphasis is on combined hydraulic works, comprising civil construction and dredging, and increasingly on offering and executing the design autonomously. Always a creative and innovative solution, tailor-made for the client.
GEOxyz [12]	GEOxyz is an independent company, specialising in hydrographic, geophysical & geotechnical surveys. Through local offices and representatives, they provide services to Authorities, the Dredging-, Marine construction- & Offshore industry and also to consulting companies and research centres. They work throughout Europe, from Russia to the Mediterranean coastline and provide specific project support all over the world. GEOxyz utilises its own highly professional and specialised staff, advanced technologies and state-of-the-art survey systems. GEOxyz employs more than 115 personnel and owns a fleet of dedicated survey vessels. GEOxyz performs Hydrographic surveys for Local Authorities, the Dredging- & Marine construction industry and consultants.

9. INTERNATIONAL COOPERATION AND RESEARCH

Especially in the research field, international cooperation is essential to scientifically sustain education programs. Research activities at Antwerp Maritime Academy take place in four distinct multidisciplinary research teams, consisting of people with a nautical background and people with an academic background, to ensure scientific quality and maritime (practical) relevance for the outcome of the different projects. Research projects fall in four different categories:

Corrosion and fouling

- Assessing long-term corrosion processes in the North Sea;
- Using a corrosivity sensor system linked to a cloud application for smart maintenance of corrosion development.

Sustainable transport and air quality

- VLIRUOS South Initiative AIR@PORT low-cost decision support system to evaluate the impact of ships on the air quality in the port city Cienfuegos;
- TETRA project ELGAS: assessing the air quality in crew accommodations and its impact on crew health;
- LIVING LAB (Flemish government): Participative research with students into the energy consumption, thermal comfort and energy loss of a classified monument and a new building.

Training the maritime officer of the 21st century

- Current research aims at improving knowledge and proficiency in maritime English by creating multidisciplinary bridge simulator training exercises;

- A second topic addressed at Antwerp Maritime Academy is the fact that officers often have to deal with information overload during their bridge watch;
- A third topic deals with the transfer of soft skills such entrepreneurship and is supported by the European Maritime and Fisheries Fund. This project aims to create a student-centred, hands on course to facilitate the acquisition of soft skills for future maritime professionals;

Hydrography and the physical environment at sea

- Study of sedimentation and channel formation in a newly constructed tidal area
- Physical disturbance of tide areas by waves produced by ships in the Scheldt estuary
- Sub-Nyquist signal processing in marine radar applications using a bespoke algorithm. The algorithm has been developed at the Department of Mathematics of the University of Antwerp and is being tested in different relevant conditions at our Institute.

At the Geography Department of Ghent University, many research projects are running. As an example, three important hydrographic projects are described hereunder.

Climate Resilient Coast (CREST) Project (www.crestproject.be/en)

Together with nine partner institutes from the academic world, the Flemish government and the private sector, the Department of Geography, has carried out research on coastal processes over a period of four years. Despite the fact that sand supply is an old and widely used protection technique, the design and the implementation of an efficient and sustainable nourishment is still a big challenge. Local accretion and erosion of our beaches are indeed complex and the result of a combination of different processes like waves, tides, sediment transport, wind … Within the demand for a better understanding of the flood risks along the coast, a flood impact assessment tool (FLIAT) [13] was developed at the Department of Geography. The 3D Data Acquisition Research Group performed a variety of activities including innovative beach monitoring techniques using long-range static and short-range mobile LiDAR (Figure 3) in selected pilot areas [14]–[16]. Aforementioned survey data was compared with UAV photogrammetry, multibeam and other topographic/bathymetric measurements.

Figure 3: Long-range static and Mobile LIDAR for beach monitoring

HydroBECS project

In this project (Figure 4), the various hydrodynamic and geomorphological processes are numerically modelled for the entire Belgian continental shelf, using the hydrodynamic model ROMS (Regional Ocean Modelling System developed and supported by researchers at the Rutgers University, University of California Los Angeles and contributors worldwide) and coupled with the phase-averaging numerical wave model SWASH (Simulating WAves Nearshore developed and maintained by TU-Delft). The accurate modelling of theses physical process will aid in short- and medium-term forecasting, scenario modelling and aid as a decision making tool for the assessment of coastal flooding, beach erosion and sea water level evolution, which are crucial aspects for the design of coastal defence and ship navigation.

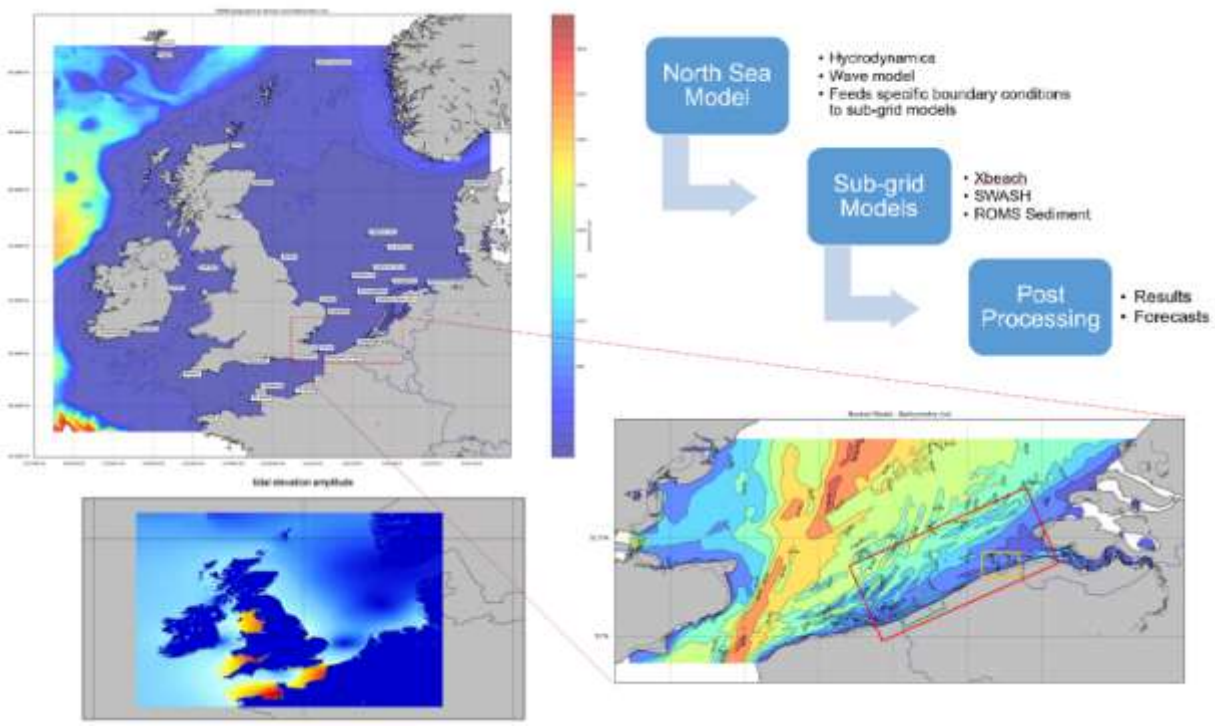

Figure 4: Summary of the HydroBECS Activites

GeoBeCS project

In the GeoBeCS-project (Geoid for the Belgian Continental Shelf), fundamental research is performed and implemented to enhance the geoid model for the Belgian Continental Shelf and the Belgian mainland. Insights in and optimization of a geoid model is crucial in the determination of marine vertical reference levels by using a hydrodynamic model, since the zero-level of a hydrodynamic model essentially is an equipotential surface.

A first goal of the project was the creation of a database containing all relevant gravity data compliant to the new ISO19115-1 profile for gravity data, which has been completed and reported in [17]. The next step of the research (Figure 5) is the optimization of the pre-processing step in the geoid modelling procedure by implementing enhanced insights in the influence of the topography on the observed gravity.

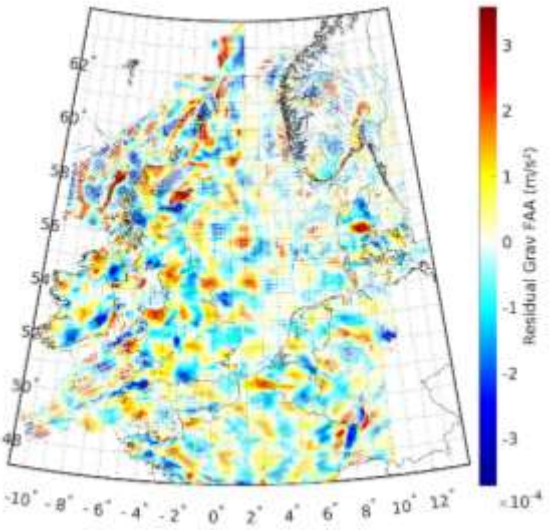

Figure 5: Preliminary results of the geoid modelling procedure

Finally, the geoid model should be determined and validated on sea by developing a method based on GNSS/IMU-measurements of survey vessels in combination with the developed hydrodynamic model.

10. CONCLUSION

The start in Belgium of the first higher hydrography cat. B education [1] in 2012 marked a milestone. The initiative was taken by The Antwerp Maritime Academy as hosting Institute and, together with Ghent University as academic partner was logistically supported by different governmental departments and private hydrographic companies.

An attractive program was developed in accordance with the IHO rules, which resulted in the IHO accreditation of the "Hydrographic Surveying cat. B program" in April 2013. Special care was drawn to the quality assessment of both the program, using internal and external auditing, and of the fieldwork of the students by introducing the concept of a "Training Record Book" Starting in September 2020, a renewed e-learning oriented program with the same content and cooperation structure will start. IHO accreditation is expected in Spring 2020.

International cooperation is highly appreciated as demonstrated by the described existing international research projects in the field of hydrography (and the "Erasmus Intensive Training Program" with ENSTA Brest [18] and HafenCity University Hamburg [19] in the past), giving a scientific base for the education program as such scientific experiences provide a very high added value for the students, the staff and the industry.

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BIOGRAPHICAL NOTES

Prof. dr. ir. Alain De Wulf is full professor at Ghent University (Belgium), researching and lecturing on the general principles of 3D data-acquisition techniques in the domains of land and hydrographic surveying and quality aspects of geodesy in particular.
He is vice-chairman and secretary of the Hydrographic Society Benelux. With his expertise in hydrographic surveying, he is developing specialised software for the processing and quality assessment of hydrographic data acquisition sensors.
He was and is involved with his scientific research team in different projects, ranging from topographic campaigns for archaeological projects (Malta, Altai (Russia), Thorikos, Titani (Greece), etc.) till bathymetric projects involving vertical reference surfaces and GNSS buoy tide measurements. In these projects, recent developments in surveying engineering, photogrammetry, bathymetry and geomatics are actively applied in state-of-the-art and integrated 3D data acquisition techniques and platforms.
He has been appointed in 2021 as Benelux representative in the Steering Group of the IFHS (International Federation of Hydrographic Societies) that will officially and permanently assess the HPAS (Hydrographic Professional Accreditation Scheme) level of hydrographers. The HPAS is certified by the International Board of Standards of Competence for hydrographic surveyors and nautical cartographers (IBSC) under the guidance of the FIG (International Federation of Surveyors), the IHO (International Hydrographic Organization) and the ICA (International Cartographic Organization).

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