Contents

Abbreviations used in this document

EVRS	European Vertical Reference System
ICG	Icelandic Coast Guard - Hydrographic and Maritime Safety Department
IHO	International Hydrographic Organization
IMO	Icelandic Meteorological Office
IRCA	Icelandic Road and Coastal Administration
MDK	Flemish Hydrography (Maritieme Dienstverlening en Kust)
NHS	Norwegian Hydrographic Service (Kartverket sjødivisjonen)
NLHO	Royal Netherlands Navy Hydrographic Office (Dienst der Hydrografie)
NSHC	North Sea Hydrographic Commission
SHOM	French Naval Hydrographic and Oceanographic Service (Service hydrographique et océanographique de la marine)
TWG	Tidal Working Group
TWCWG	Tides, Water Level and Currents Working Group
UKHO	United Kingdom Hydrographic Office

Other abbreviations are written out when first used.

Location

Icelandic Coast Guard, Reykjavík, Iceland.

Participants

Aksel Voldsund	NHS	Norway
Andreas Boesch	BSH	Germany
Chris Jones	UKHO	United Kingdom
Giuseppe Masetti	GST	Denmark
Johan Verstraeten	MDK	Belgium
Ronald Kuilman	NLHO	Netherlands
Thomas Hammarklint	SMA	Sweden
Andri Leifsson	ICG	Iceland
Angel Ruiz Angulo	IMO	Iceland
Árni Þór Vésteinsson	ICG	Iceland
Bryndís Tryggvadóttir	IRCA	Iceland
G. Orri Gröndal	IRCA	Iceland
Greipur Gísli Sigurðsson	IRCA	Iceland
Guðmundur Birkir Agnarsson	ICG	Iceland
Halldór Björnsson	IMO	Iceland
Níels Bjarki Finsen	ICG	Iceland

Opening

The chair, Árni Þór Vésteinsson (ICE), welcomed everyone and thanked the members for taking the time to travel to Iceland and participate in the working group. He also welcomed the Icelandic guests. The opening ended with each member introducing themselves giving a short overview of their tasks.

Adoption of the Agenda

The agenda was adopted (see ANNEX B).

Adoption of the Minutes of the 22nd NSHC TWG Meeting

The Minutes were adopted.

Adoption of the Minutes of the 33rd NSHC Conference

The Minutes were adopted.

Participant Presentations

Draft for a new German chart-datum-surface

(TWG23-BSH-ChartDatumSurface_pub.pdf)

Andreas Boesch (DE) gave a presentation on new LAT chart datum surface replacing an older coarser grid and filling in gaps in the surface. The draft for a new chart-datum-surface is built on new grid with spatial resolution around 400 m with multiple German, Danish and Dutch tide gauges, with 175 LAT model points. They have developed a new version of chart-datum-surface, used observation from tide gauges and numerical simulations. One of the results is that on the Dutch-German border the differences will be smaller.

Baltic Sea Chart Datum 2000 – a common reference level for nautical charts and sea level information in the Baltic Sea

(TWG23_Baltic Sea Chart Datum 2000_2020-02-05.pdf)

Thomas Hammerklint (SE) gave a presentation on Baltic Sea Chart Datum 2000, a project under the BSHC Chart Datum Working Group where they are trying to implement a common reference level in the Baltic Sea http://www.bshc.pro/working-groups/cdwg

The datum refers to each Baltic country´s realization of the European Vertical Reference System (EVRS) with land-uplift epoch 2000, which is connected to the Normaal Amsterdams Peil (NAP).

The Baltic Sea is an international shallow, non-tidal area in the northern part of Europe with dense traffic. IHO BSHC has approved the name and the adoption of the Baltic Sea Chart Datum 2000. The BSCD2000 datum is now included in IHO Geospatial Information (GI) Registry as chart datum number 44.

New info sheet about the transition to BSCD2000 has been published, *New reference system for sea level, nautical charts and warnings.*
http://www.bshc.pro/media/documents/CDWG/Infoblad_RH2000_english.pdf

Common reference frame for sea and land – challenges and recommendations

(Common reference frame_Aksel_Island.pdf)

Aksel Voldsund (NO) gave a presentation that continued a previous one from the last meeting on the determination on the relationship between the height datum on land and the chart datum using the ellipsoid as a common reference. They are trying to develop guidelines for a method that can be used along the entire Norwegian coast. This is a collaboration between the Hydrographic Service and the Geodetic Institute within the Norwegian Mapping Authority.

The rough topography close to the coastline with high mountains and deep narrow fjords make it a challenging work and the strong tidal currents don't help. Lot of fieldwork was carried out, water level measurements with temporal tide gauges, gravity and GNSS measurements were used. This was done to both improve the height reference model, to determine a MDT-model and to make a model for the tidal amplitude.

Conclusions

- The variations in the MDT are much smaller and have longer wavelengths than variations in the Quasi geoid
- Water level observations could contribute to improve the Quasi geoid at large distances from the levelling network
- There are challenges related to transfering information from the permanent tide gauges to the temporal tide gauges
- At the time being, hydrodynamic models are not suitable for calculating the MDT inside fjords, but we are optimistic regarding the future
- Satellite altimetry has its primary strengths off shore, but this might change in the near future

Recommendations

- Start by calculating separation models covering the entire Norwegian coast based on existing data, and update these models continuously as more data is collected
- Continue improving the source data by measuring the water level, and carry out GNSS and levelling campaigns
- Increase the density of the permanent tide gauge network to minimize errors associated with transferring information from long to short time series
- Follow the development regarding satellite altimetry and hydrodynamical models
- Start the work where the need for information is largest
- Just get started!

Merging land and sea into a seamless chart.

(Merging land and sea data into a seamless chart_TWG23.pdf)

Ronald Kuilman (NL) gave a presentation on merging land and sea data together into a seamless chart, NL GEO2018, the new Dutch quasi-geoid model. The connection of reference surfaces between land and sea becomes more important. The Dutch approach to realize chart datum with respect to a reference ellipsoid (GRS80) uses the geoid rather than the MSL as the intermediate

surface. In the vertical coordinate reference system at sea you can use LAT for navigational purposes and the geoid for other purposes.

National tidal observation network

(kynning_4feb-en-vg.pdf)

G. Orri Gröndal (ICE) introduced the national tidal observation network in Iceland. It was established in the 1990's and its aim is to improve safety at sea, be a aid to navigation and planning work at sea and the coast and to publish observations and predictions.

He also discussed the different types of tide gauges and the IRCA's role, both present and in the future.

The aim to future should be to standardise the work involved with tide gauges installation and maintenance, to minimise systematic errors and strengthen the network and also to update MSL benchmarks that were made in the late 1970' when the MSL surveys were performed locally in harbours around Iceland.

Short introduction to IMO & Ocean models, storm surge modelling, risk assessment etc.

(IMO_NSHC-TWG_meeting_FEB2020V2_ARA.pdf)

Halldór Björnsson and Angel Ruiz-Angulo (ICE) represented the Icelandic Met Office and gave a short introduction on the work they do there.

IMO monitors and issues forecast for a large area, land and sea cover over 1,460 thousand km2 of that, Iceland is only just over 100,000 km2.

They talked about a new ocean modelling challenges, including regional ice and ocean model, storm surge model and risk assessment. They ended with showing a model for avalanche induced tsunami that hit a town in Iceland which occurred recently (can be seen in the presentation).

Adaption of multivariate extreme value modelling for extreme coastal events

(Multivariate extreme value modelling - Bryndis Tryggvadottir.pdf)

Bryndís Trygvadóttir (ICE) gave a presentation on her Master thesis were she looked at coastal flooding and risk analysis based on SoN Flood Risk Analysis.

The thesis showed that with better data such as from meta model, wind and wave surge, bathymetric mapping near the coast that improvements would benefit the Risk Analysis.

Discussion and shearing of experience on the role as water level authority in each country

Each country gave an overview of their current state.

United Kingdom

- Tidal observations (long term) are mainly provided by 'third parties', i.e. Port Authorities, Harbour Masters, Engineering Companies etc.
- Tidal observation (short term) are mainly sourced from hydrographic surveys (Royal Navy and 'Civil' Hydrographic Programme).
    - (Additionally we are more likely to obtain tidal **stream** data through the survey programmes).
- UKHO acts as the repository for a large amount of tidal observations **but** does not necessarily own all of the data (other than some of the Survey-sourced data).
- In the UK, the National Oceanography Centre (NOC) host the National Tidal & Sea Level Facility (NTSLF);
    - run by the UK Environment Agency
    - 44 permanent tide gauges around the UK Coast
    - Used in UK's Storm Surge Forecasting Service.
- The British Oceanographic Data Centre (BODC) databases the data from the NTSLF.

Tidal Developments

Measurements

- No current facility to make available tidal observations.

Digital Tide Tables

- UKHO produces **ADMIRALTY Digital Publication TotalTide** – see https://www.admiralty.co.uk/digital-services/admiralty-digital-publications/admiralty-totaltide
    - Global predictions; approx. 7000 port locations; approx. 3000 tidal stream positions
    - There is a Software Developer Kit (SDK) available - supports programmatic access to the functionality of the software. Supports an Application Programming Interface (API).

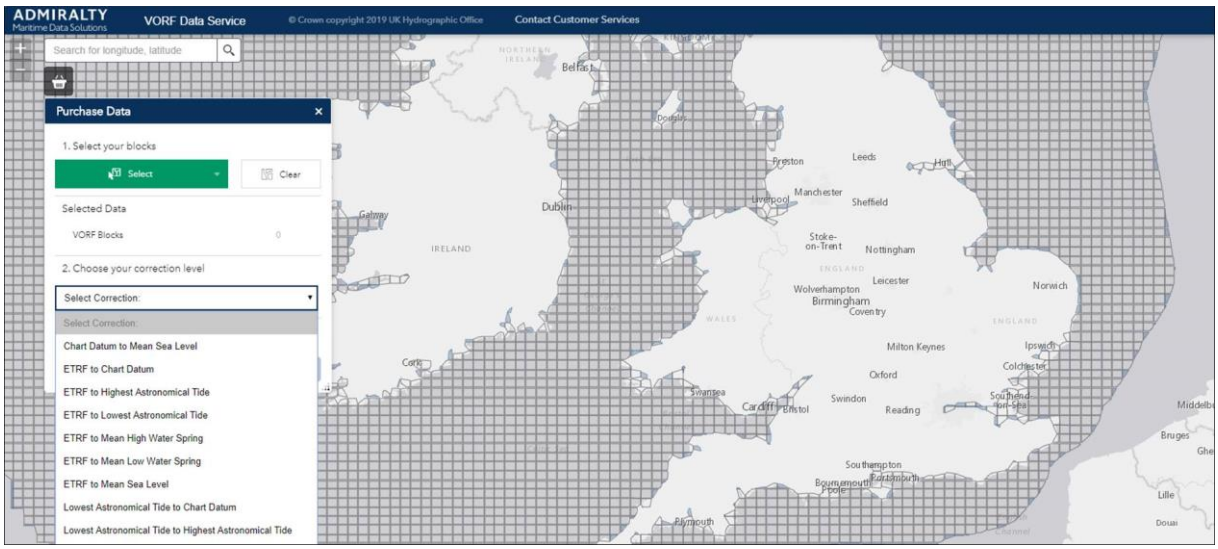
Website Predictions

- **UKHO EasyTide** – tidal height predictions globally – see http://www.ukho.gov.uk/easytide/EasyTide/index.aspx
    - Date range Year 100AD to 'current year plus 50 years'
    - 7-days free of charge
    - Other periods charged for via an "enhanced" service.
    - HW / LW and Predicted Curve
    - Enhanced service includes sunset / sunrise, moon phase and Spring and Neap dates.

- **Tidal API -** https://www.admiralty.co.uk/digital-services/data-solutions/uk-tidal-api
  - Predictions of HW and LW for "today and up to six days in advance"
  - Over 600 UK locations
  - Retrieve up to 10 requests per second and 10,000 per month for free.
  - Output formats are JSON and XML
  - Access to the Developer Portal

Developments in GNSS Based Surveys

- UKHO now exclusively uses its **Vertical Offshore Reference Frame (VORF)** software for UK surveys. This is the case with all 'Civil Hydrographic Programme (CHP)' surveys, which are undertaken under the authority of the UK Government's Maritime and Coastguard Agency (MCA) (see https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/785833/CHAS_2019_Yearbook.pdf for details of the 2019 programme). Most of the UK Defence Hydrographic Programme (DHP) is also now using the same approach.
- The VORF software allows for the transformation of bathymetric data, collected with reference to the ETRF89 Ellipsoid, to one of many vertical datums in use within the UK's 'home waters'. Most usually the transformation is from ETRF89 to Admiralty Chart Datum (which is approximately the level of Lowest Astronomical Tide, LAT).
- Details of the VORF project and its development can be viewed on the website at https://www.ucl.ac.uk/civil-environmental-geomatic-engineering/research/groups-and-centres/vertical-offshore-reference-frames-vorf. (Note that this is a University College London [UCL] website, who commenced the construction of the VORF model in 2005, under contract to the UKHO).
- Separation 'surfaces' (actually xyz files) from the VORF model can be purchased via the UKHO's **Marine Data Portal** (https://data.admiralty.co.uk/portal/apps/sites/#/marine-data-portal and specifically https://data.admiralty.co.uk/portal/apps/webappviewer/index.html?id=ff5d236a3d4d4f1ca20b949b958e9f5b)



Denmark

- In Denmark, tide tables and operational storm surge warnings are the responsibility of the Danish Meteorological Institute (DMI). The maintenance of tide gauges in Denmark is shared by different authorities. DMI is responsible for approximately 1/3 of the operational Danish tide gauges, but does also show real time observations for tide gauges maintained by other authorities.
  The collected data are used in several ways: primarily for safety of navigation, but they also represent an integral part of the national storm surge monitoring and prediction system.
  In 2018, DMI and KDI (Danish Coastal Authority) wrote together a manual on requirements for water level recorders.
  The manual is accessible here: https://kyst.dk/publikationer/oversvoemmelse/manual-for-marine-vandstandsmaalere/ (in Danish)

Tidal Developments

Measurements

- Denmark maintains a network of water level stations located across Denmark. The ownership of the tide gauge network is approximately distributed as follows:
  - 1/3: DMI (Danish Meteorological Institute).
  - 1/3: KDI (Danish Coastal Authority).
  - 1/3: local harbours.

- An overview of tide gauge ownership is available here: https://www.dmi.dk/dmis-vejrprodukter/vandstand/ then "Stationsliste og dataleverandører".
  The tide gauge network is composed of a mixture of modern water level recorders and old devices. Note, that at some locations, there is also a secondary recorder.
  Newly collected data are transferred from the stations to the DMI oceanographic database every ten minutes. The raw DMI water level data will be made freely available by the end of 2020.

Digital Tide Tables

- Tide tables are the responsibility of DMI. They are referenced to LAT, and their last edition was published in January 2020 with two year validity (2020 and 2021).
- Tide tables are freely available here: http://ocean.dmi.dk/tides/tides_dk.php

Website Predictions

- Online observations and forecasts are available in Danish and English on several web sites such as:
  - https://www.dmi.dk/maalinger-seneste-24-timer/ (in Danish, choose "vandstand" at the chart)
  - http://ocean.dmi.dk/anim/index.uk.php
  - http://ocean.dmi.dk/english/index.php -> "sea Level and Tides" -> various products
  - http://fcoo.dk/ (in English)

Developments GNSS Based Surveys

- The Danish Geodata Agency (DGA) in its role as a hydrographic office has responsibility for hydrographic surveys and charting in Denmark. The practical work of hydrographic surveys is done with personnel and ships from the Royal Danish Navy.
  GNSS augmentation service is used for hydrographic surveys. Specifically, VRS from GPSNET.dk and own base stations are related to EUREF89 (horizontally) and DVR90 (vertically). DGA is performing Ellipsoidally Referenced Surveys since 2000.

Belgium

- For the Belgian part of the North Sea:
  - Flemish Hydrography: tide gauge operations in ports and on fixed offshore measuring platforms, quality control on levelling and data, analysis of data and publishing of tide tables and reports.
  - For the tide gauges along the rivers: Flanders Hydraulics Research.
  - A process to create a more uniform output of all online products of the hydrographic office is currently taking place.

Tidal data (among other datasets) can be visualized and downloaded

- North Sea: https://meetnetvlaamsebanken.be/Measurement
- With a free login datasets can be downloaded, either by hand, or automated by API. https://api.meetnetvlaamsebanken.be/V2-help/
- River: https://www.waterinfo.be/
- Online version of tide tables are the equivalent of the printed tide tables. https://www.afdelingkust.be/nl/getij
- Updates of tidal predictions of HW and LW , including meteo influences are published: https://afdelingkust.be/nl/getij-oostende

Digital Tide Tables

- Digital tidal currents atlas is under development.
- A standalone version has reached the status of an “advanced Beta”, but the current vision on technology will include a redevelopment as a web based service.

Developments for GNSS Based surveys

- On the Belgian part of the North Sea the combination of a LAT-ellipsoid separation surface, full VRS RTK coverage and increasingly affordable satellite data links for receiving precise position corrections online, have resulted in increased efficiency for executing GNSS based bathymetric surveys.

Netherlands

Tidal Developments

Measurements

- In the Netherlands Rijkswaterstaat is responsible for the tidegauges on the coastline and at sea. NLHO only uses pressure tidegauges incidentally for surveys. Recently NLHO started with ADCP measurements but this is still in the test phase.

Digital Tide Tables

- NLHO produces digital tide publication NLTides, the software within this product is based on the UK Hydrographic Office's TotalTide program.
- NLTides provides the official tidal height predictions for all significant ports from Nieuwpoort in Belgium to List in Germany and tidal streams for the Southern North Sea, the Netherlands part of the Waddenzee, Scheldt, tidal river area and main port approaches. NLTides provides more ports than the paper HP33. NLTides uses the same prediction algorithms and Harmonic Constants for the Belgian and German ports as the Admiralty TotalTide program. The Netherlands ports are predicted using the Netherlands constants and algorithms as supplied by Rijkswaterstaat. Tidal heights are displayed clearly and concisely both in a graphical and tabular format. Tidal Stream rates are presented on a chart-based diagram. The tidal Stream rates are supplied by Rijkswaterstaat and the Port of Rotterdam.

Website predictions

- In the Netherlands Rijkswaterstaat is responsible for the website predictions (https://www.rijkswaterstaat.nl/water/waterdata-en-waterberichtgeving/waterdata/getij/index.aspx).

Useful links

- https://iho.int/mtg_docs/com_wg/IHOTC/IHOTC_Misc/TideGaugeInventory.pdf
- https://iho.int/en/miscellaneous-6 (actual Tides and Currents On-line Links).

Developments GNSS Based Surveys

- NLHO uses Ellipsoid Reference Surveying (ERS) since 2016. The used LAT is based on the Vertical Reference Frame for the Netherlands, Wadden Islands and Continental Shelf (NEVREF) from the University of Delft.

Norway

Tidal Developments: actual, expected, or considered from Norway:

Measurements

- All permanent water level gauges using stilling well with floats are now calibrated. Corrections for the dependency between the floats changing height in the water due to changing water level are added to the time series is real time.
- A technical specification for water level measurements is implemented.
- We are currently focusing on, and looking into the possibilities of crowdsourcing of water level data.
- As a part of the Common Reference Frame-project a permanent GNSS- antenna is installed at the water level gauge in Bergen.
- In Norway there are two ongoing initiatives:
    - Installation of three semi-permanent water level gauges east of Svalbard. Hostile conditions with drifting sea ice and no infrastructure makes this task challenging.
    - Densification of the permanent water level gauge- network. A comparison of different techniques for measuring water level is started.

Digital tide tables

- Digital tide tables are available free of charge, see https://www.kartverket.no/en/sehavniva/data-pa-se-havniva/Tide-Tables/ .
- The tide tables fulfil the IHO resolution on digital tide tables.

Website predictions

- Tidal predictions for any time and (almost) any place along the Norwegian coast is available in the webpage https://www.kartverket.no/en/sehavniva/
- Everything is free of charge.
- A tool for visualization of future sea level rise in maps is given here https://www.kartverket.no/en/sehavniva/visualize-sea-level/

Tidal API

- All data and information used for the webpages are available through an API, http://api.sehavniva.no/tideapi_en.html. This includes water level observations, tidal predictions, tidal constituents, models for sea level rise etc.

Discussion and sharing of experience on the role as water level authority in each country:

- In Norway, the Norwegian Hydrographic Service is responsible for water level measurements, management of water level data and information, tidal predictions and reference levels in the sea. Until now there exists no formal authority on these subjects, but it is considered whether Norwegian Hydrographic Service should work towards becoming that or not. This is not decided yet.

Developments GNSS Based Surveys (WP18-02)

- For offshore surveys GNSS is used together with the Danish altimetry derived Mean Sea Surface (DTU_18), and Z0 calculated from the output of an hydrodynamic model (ROMS4k).
- For inshore surveying, reduction to chart datum is done with water level measurements.
- There is an ongoing activity where the aim is to prepare for ellipsoidally referenced surveying in the coastal zone as well. This activity includes improving the GNSS positions (by using a close integration between the GNSS-antennas and the inertial motion sensor), improve the understanding of the different ellipsoids and the relation between them, choosing what permanent earth tide deformation to use, adjustments of the processing tools (Caris) and development of a ellipsoidally referenced LAT surface.

Iceland

The recent TWG meeting in Reykjavík revealed that the status of tide related matters such as who is the responsible authority, validation of data, calibrations and checks from tide gauges that are used in Iceland need further attention. It is planned that government organizations in Iceland will meet and have a discussion about these matters.

Measurements

- ICG is not responsible for tide measurements or it's govern, Tidal observation are provided by third parties usually by port authorities. Only one long term tide gauge is in operation, in the old harbor Reykjavik.
- For surveys ICG sets up short term tide gauges at locations of choice.

Tide Tables

ICG is the responsible for publishing tide table which are computed based on known constituents and published in hard copy. They list 5 harbors and all other harbors in Iceland can be estimated from those.

Website predictions

- Link to a company that runs many tide gauges for harbors: http://mogt.is/
- Direct link to the old harbor in Reykjavík:
  - http://vedur.mogt.is/harbor/index.php?action=Stations&harborid=1&stationid=1004
- The Icelandic Road and Coastal Administration (IRCA):
  - http://www.vegagerdin.is/vs/Today.aspx?la=is
  - http://www.vegagerdin.is/vs/Stations.aspx?st=3&la=en

Developments GNSS Based Surveys

Up to now surveys have been done with best GNSS position and EGNOS available and recent years VRS correction signal with good accuracy for horizontal and vertical although for vertical reference tide gauges have been used. For next survey season we will aim for ellipsoidal referenced survey and are in preparation and research phase for that do to unknown factors with the available vertical offset models and their accuracy.

Germany

Discussion and sharing of experience on the role as water level authority in each country:

The German tide gauge network is operated by different authorities of the German States and by the Federal Waterways and Shipping Administration (WSV). On the federal level, tasks regarding sea level are carried out by different agencies. Examples of these task include: Tides, water level predictions for the North Sea and Baltic Sea according to the Federal Maritime Responsibilities Act (Federal Maritime and Hydrographic Agency, BSH); administration and operation of federal water ways (WSV); consultancy and expert information on scientific and engineering topics (Federal Institute of Hydrology, BfG; Federal Waterways Engineering and Research Institute, BAW).

Website predictions

New BSH website in 2018
Home page: www.bsh.de
Tidal predictions: www.bsh.de/gezeiten
Water level forecast (German North Sea coast): www.bsh.de/wasserstand-nordsee

Predictions for the next 7 seven days are currently available on the website. Digital tidal data for one year can be ordered.

Explain and reduce differences in reference surfaces at the international borders (WP16-04, WP18-01)

Ronald Kuilman (NL) gave a presentation of the 1 percent norm (LAT difference divided by depth). In 2016 (TWG21) there was unanimous agreement that a rate of 1 percent or less was acceptable for the TWG members. In 2017 (TWG22) the TWG members decided to redefine the norm because of the fact that the rate of 1 percent was arbitrarily chosen.
During TWG23 there was a discussion about how to redefine the 1% percent norm. NL proposed to define a new proposal for the norm (connected to S-44) before the end of the year. See action point 23/01. After the norm has been redefined the differences matrix will be updated again.

The TWG members decided to replace action items AP 21/01 → 21/08 for a general action item AP 23/02 (Investigate all LAT differences at the borders and overlapping parts of surfaces using the redefined norm).

Input Andreas Boesch about results comparison DE-NL LAT surfaces.

Input Johan Verstraeten about results comparison BE-NL LAT surfaces.

Developments GNSS Based Surveys (WP18-02)

This subject was covered in the "Discussion and shearing of experience on the role as water level authority in each country", see above.

Draft report of the NSHC-TWG for the 34th NSHC conference (~~26-27 March 2020 Reykjavik~~) *(rescheduled: April 27-28, 2021)*

The draft report will be made by IS and sent to the members.

Review of Work Plan Points

The group reviewed the Work Plan Points as can be found in ANNEX E.

16/04	remains open
18/01	remains open
18/02	remains open (amended)
22/01	remains open

Review of Action Points

The group reviewed the Action Points as can be found in ANNEX C.

18/01	remains open
19/03	remains open - chair will contact Chris Jones
20/04	Closed
21/01	Closed
21/02	Closed
21/03	Closed
21/04	Closed
21/05	Closed
21/06	Closed
21/07	Closed
21/08	Closed
22/01	remains open
22/02	remains open
22/03	remains open
22/04	Closed
22/05	amended, remains open
23/01	new (amended 22/04)
23/02	new
18/01	remains open
19/03	remains open - chair will contact Chris Jones
22/01	remains open
22/02	remains open
22/03	remains open
22/05	amended, remains open
23/01	new (amended 22/04)
23/02	new

Date and Venue of the 24th NSHC TWG

The 24th NSHC TWG meeting should be held in Sweden at least 6 weeks prior to the NSHC meeting.

Closing Remarks

The chair, Árni Þór Vésteinsson (ICE), thanked everyone for their attendance and contribution to the meeting and wished everyone a safe journey home.

ANNEX A Member List

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ANNEX B: Agenda

Wednesday February 5th 2020

09:00 – 09:30	Opening, welcome Introduction Round	Chair All
09:30 – 10:30	✓ Adoption of the Agenda ✓ Adoption of the Minutes of the 22nd NSHC TWG Meeting ✓ Status of the Action Points from the 22nd NSHC TWG Meeting ✓ Adoption of draft of the Minutes of the NSHC33	All
10:30 - 10:45	Coffee break	
10:45 - 11:15	Presentation on the draft for a new German LAT/chart-datum-surface, including a comparison with the Dutch LAT-surface for the regions where both surfaces overlap.	DE Andreas Boesch
11:15 - 11:45	Presentation of the work in the Baltic Sea concerning harmonized tide gauge datum and chart datum. BSHC Chart Datum Working Group (CDWG).	SE Thomas Hammarklint
11:45 - 12:15	Presentation of findings, results and recommendations from the Common reference frame project carried out in Norway. Functionality in a new tool for visualizing sea level in maps.	NO Aksel Voldsund
12:15 - 13:00	Lunch	
13:00 – 13:30	The Icelandic Road and Coastal Administration. A National Tidal Observation Network, presentation	IS G. Orri Gröndal
13:30 – 14:00	The Icelandic Meteorological Office, presentation	IS Halldór Björnsson
14:00 – 14:40	Adaption of multivariate extreme value modelling for extreme coastal flood events – presentation of master's thesis.	IS Bryndís Tryggvadóttir
14:40 - 15:00	Coffee break	
15:00 – 16:00	Discussion and sharing of experience on the role as water level authority in each country.	All
18:30	Dinner – Ristorante Caruso Harbour by the Old Harbour Marina Ægisgarður 2, 101 Reykjavík	

Thursday February 6th 2020

09:00 - 09:05	Opening	Chair
09:05 - 09:30	Tidal Developments: actual, expected, or considered ✓ Measurements ✓ Digital Tide Tables ✓ Website Predictions	All
09:30 - 10:00	Explain and reduce differences in reference surfaces at the international boundaries. (WP16-04, WP18-01)	All
10:00 - 10:30	Developments GNSS Based Surveys (WP18-02)	All

10:30 - 10:40	Coffee break	
10:40 - 11:00	Merging land and sea data into a seamless chart - presentation	NL Ronald Kuilman
11:00 – 11:20	IHO Tides, Water Levels & Currents Working Group (TWCWG): Status & Update	UK Chris Jones
11:20 - 11:25	Draft report of the NSHC-TWG for the 34th NSHC conference (26-27 March 2020 Reykjavik)	All
11:25 -11:30	Any Other Business	All
11:30 - 12:00	Review of Action Points	All
12:00 - 12:15	Date and Venue of the 24th NSHC TWG and Closing Remarks	All Chair
12:15 – 13:00	Lunch	

ANNEX C: Updated Work Plan and Action Points of the 23rd NSHC TWG Meeting

Item Number (TWG/Item)	Objective (Why/Priority)	Task Description (What/How)	HO Involved	Status
WP 16/04	Enable GNSS-based tidal reduction and the connection with the vertical datum on land	Follow developments on geoid, MSL and LAT computations for the North Sea area	All	Permanent, see also WP18/01
WP 18/01	Improve North Sea wide realization of reference surfaces	Explain and reduce differences in reference surfaces at the international boundaries	All	Permanent
WP 18/02	Improve methodologies for ERS	Exchange between HO's on operational methodologies for ellipsoidal referenced surveying for GNSS based surveys	All	Permanent
WP 22/01	Ensure common European LAT surface adoption.	Follow the developments of European initiatives on new LAT surfaces.	All	Permanent

Item Number (TWG/Item)	Objective (Why/Priority)	Task Description (What/How)	HO Involved	Status	Corresponding Work Plan Item
AP 18/01	Explain differences in realizations of LAT	Exchange on bilateral basis between involved HO's to investigate further the origin of observed differences at the boundaries between national reference surfaces	All	Permanent	WP 18/01
AP 19/03	Make an overview over existing separation and hydrodynamic models, including metadata	Each member state sends the information to UKHO	All, UK	TWG24?	WP 18/01

AP 20/04	Gain insight the connection between EVRS and chart datum	Create overview of connection between EVRS and Chart Datum	NL, All	Closed	WP 16/04
AP 21/01	Investigate the differences at the BE-FR border between national LAT reference surfaces	Investigate all LAT differences at the border of more than 1 percent (LAT difference/depth)	BE, FR	Closed	WP 18/01
AP 21/02	Investigate the differences at the BE-NL border between national LAT reference surfaces	Investigate all LAT differences at the border of more than 1 percent (LAT difference/depth)	BE, NL	Closed	WP 18/01
AP 21/03	Investigate the differences at the DK-DE border between national LAT reference surfaces	Investigate all LAT differences at the border of more than 1 percent (LAT difference/depth)	DK, DE	Closed	WP 18/01
AP 21/04	Investigate the differences at the DK-NO border between national LAT reference surfaces	Investigate all LAT differences at the border of more than 1 percent (LAT difference/depth)	DK, NO	Closed	WP 18/01
AP 21/05	Investigate the differences at the FR-UK border between national LAT reference surfaces	Investigate all LAT differences at the border of more than 1 percent (LAT difference/depth)	FR-UK	Closed	WP 18/01

AP 21/06	Investigate the differences at the DE, NL border between national LAT reference surfaces	Investigate all LAT differences at the border of more than 1 percent (LAT difference/depth)	DE, NL	Closed	WP 18/01
AP 21/07	Investigate the differences at the NO, UK border between national LAT reference surfaces	Investigate all LAT differences at the border of more than 1 percent (LAT difference/depth)	NO, UK	Closed	WP 18/01
AP 21/08	Investigate the differences at the NO, SE border between national LAT reference surfaces	Investigate all LAT differences at the border of more than 1 percent (LAT difference/depth)	NO, SE	Closed	WP 18/01
AP 22/01	Investigate the differences in national LAT reference surfaces at all borders.	Each member state should supply information on how their LAT surface was built to NL who will analyse this information and compare the surfaces.	NL, All	Permanent	WP 18/01
AP 22/02	Investigate the differences in national LAT reference surfaces at all borders.	Each member state should supply all LAT updates to NL who will update the LAT differences matrix accordingly.	NL, All	Permanent	WP 18/01
AP 22/03	Investigate the differences in national LAT reference surfaces at all borders.	Make error estimates in LAT surfaces.	All	Permanent	WP 18/01
AP 22/04	Explain the differences in national LAT reference surfaces at all borders.	Decide how the arbitrary 1% norm should be redefined to something practical before the next TWG meeting and make an according proposition to NSHC for acceptance.	All	Closed	WP 18/01

AP 22/05	Ensure common European LAT surface adoption.	Follow the developments of European initiatives e.g. EMODnet on new LAT	All	Permanent	WP 22/01
AP 23/01	Define new proposals for the norm connected to S-44 by the next meeting TWG24.	Decide how the arbitrary 1% norm should be redefined to be linked to something practical.	NL	Dec 2020	WP 18/01
AP 23/02	Investigate all LAT differences at the borders and overlapping parts of surfaces using the redefined norm.	Investigate the differences at all MS borders (and overlapping parts of surfaces) between national LAT reference surfaces.	All	Permanent	WP 22/01