TWCWG Survey - harmonic analysis

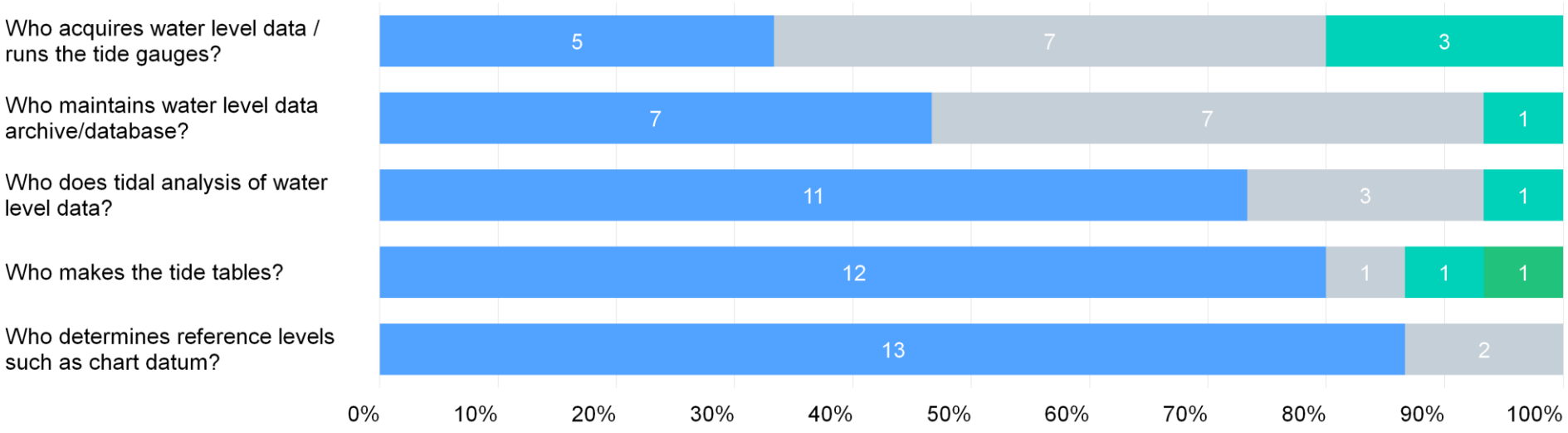
Part 1: General information

TWCWG Survey - harmonic analysis

15 organisations/countries participated in this survey

Australia (AHO), Brazil (CHM), Chile (SHOA), France (SHOM), Germany (BSH), New Zealand (LINZ), Norway (NHS), Peru (DHN), Republic of Korea (KHOA), South Africa (SAN HO), Spain (IHM), Sweden (SMA), The Netherlands (NLHO), United Kingdom (UKHO), United States (NOAA)

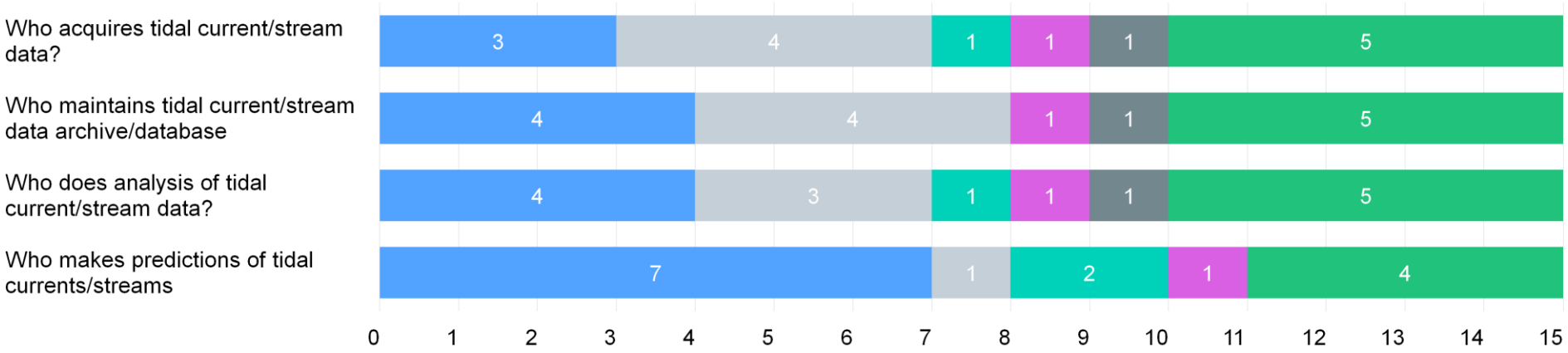
How is water level data handled in your country?



Observations

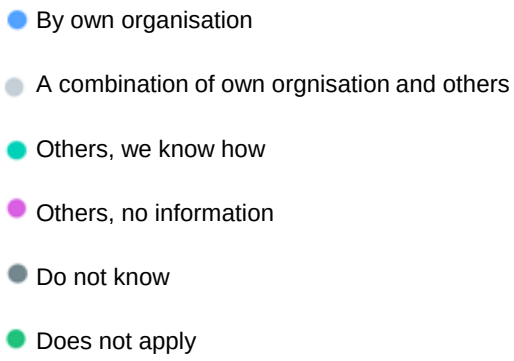
Total **15**

How is tidal current/stream data handled in your country?



Observations

Total **15**



Additional comments on how water level data is handled in your country

The open answers provided

The determination of reference levels is done in cooperation between the Tide gauge operators and the Land Survey Organization. The determination of chart datum is done by Swedish Maritime Administration (SMA). No tide table is produced in Sweden, thou water level predictions and warnings for high and low water level conditions is issued by the Swedish Meteorological and Hydrological Institute (SMHI). Mainly SMA does tidal analysis for the stations in Skagerrak, Kattegatt and Öresund. Baltic Sea is treated as a non-tidal area. The chart datum is the zero-level in the National Height System RH 2000 (Baltic Sea Chart Datum 2000), close to the Mean Sea Level (MSL).

My answer is expressly focused on marine water level because if I answer to the question -Who determines reference levels such as chart datum- , it'll be under the responsibility of Shom for marine area, but for rivers, several organisms are doing it (Ex: port authority on rivers, IGN, national geographic institute, …).

In the Netherlands the Department of Waterways and Public Works is responsible for collecting and analyzing the water level data. They are also responsible for the tide gauges. The Department of Waterways and Public Works publishes the tide tables (website and hardcopy). The NLHO publishes also the tide tables (hardcopy and digital (USB)).For the Caribbean Islands of the Netherlands NLHO is responsible for collecting the water level data. A contractor (Deltares) analyzes this data with Delft3D software.

NOAA runs the tide gauge network but we will take in water level data from other organization if there is a need to do it. All tide predictions and tidal datums come from our office.

Most tide gauges are run by port companies, local councils or a crown research institute. LINZ regularly obtains the water level data, but recognises that the organisation running the gauge still owns the data.

Tide gauges are operated by the Waterways and Shipping Administration in Germany (WSV). Raw data are available at pegelonline.wsv.de

Australian Hydrographic Office makes the Official Tide Tables to meet SOLAS carriage requirements. Some of our states do their own for the general public.

Additional comments on how tidal current/stream data is handled in you country

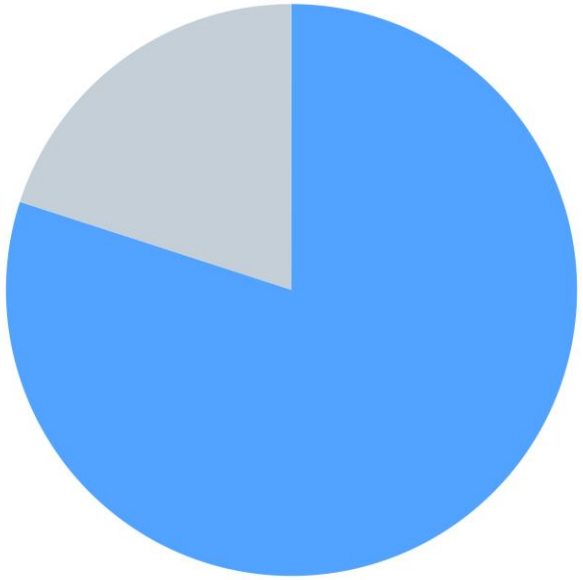
The open answers provided

The Swedish Meteorological and Hydrological Institute (SMHI) produces predictions for currents.
The Department of Waterways and Public Works and the NLHO collect and archive the data. The Department of Waterways and Public Works and a contractor (Deltares) analyze the data. The Department of Waterways and Public Works publishes current/stream data on their website. The NLHO publishes stream atlases (hardcopy and digital).
Previously some work was done by the NHS, but at the moment this activity is stopped (because of lack of ressources).
Tidal Stream is inappreciable around South Africa in relation t the Agulhas and Benguela currents speeds.
We currently don't analyze tidal currents, but we are interested in learning some methods and software.
No ongoing tidal current/stream data collection in New Zealand. Tide stream predictions are generated for two locations based on algorithms developed following a survey of the streams using ADCP technology.
In the past, tidal stream analyses had been calculated mainly based on the harmonic method. Nowadays, mainly numerical models are used for prediction.

Part 2: Analyzing water level data

TWCWG Survey - harmonic analysis

What method is used for analyzing water level data?

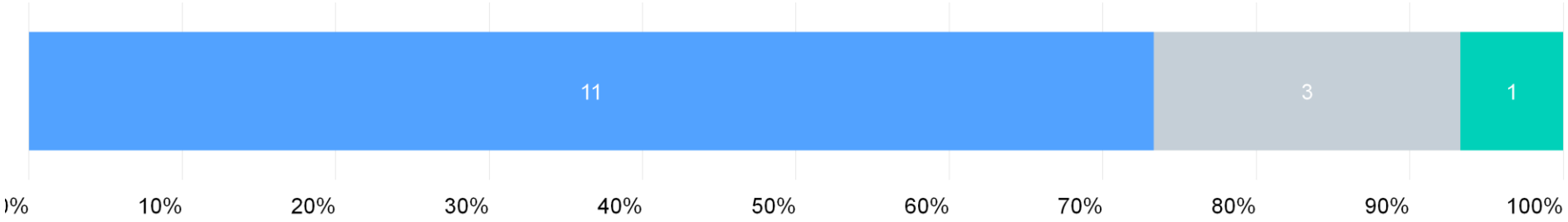


Observations	
Total	**15**
Harmonic analysis	80.0%
Other, please specify:	20.0%

Harmonic Representation of Inequalities for one. The other two use harmonic analysis in some cases, but also other methods depending on the data.

Who does tidal analysis of water level data in your country?

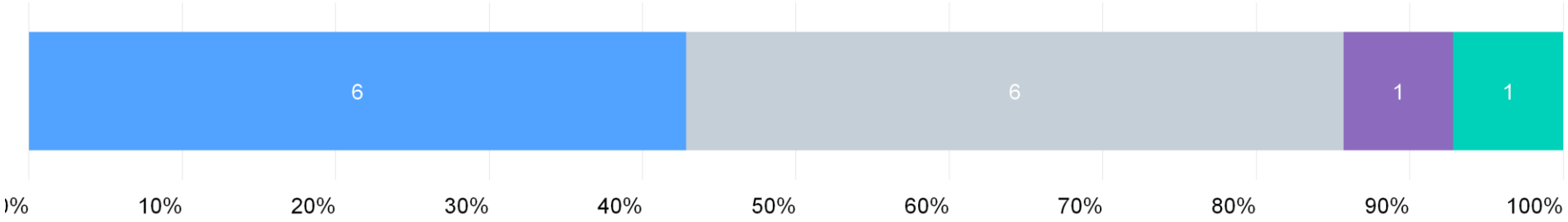
Most of the replies do the analysis themselfs, a few in combination with others. Only one country does not do it themselfs, and no one uses contractors.



Observations

Total	**15**
own organisation	11
Combination of own organisation and others	3
Contractors	0
Others - we know how	1
Others - no information	0
Do not know	0
Does not apply	0

How do you select the set of harmonic constituents to use to calculate tidal predictions

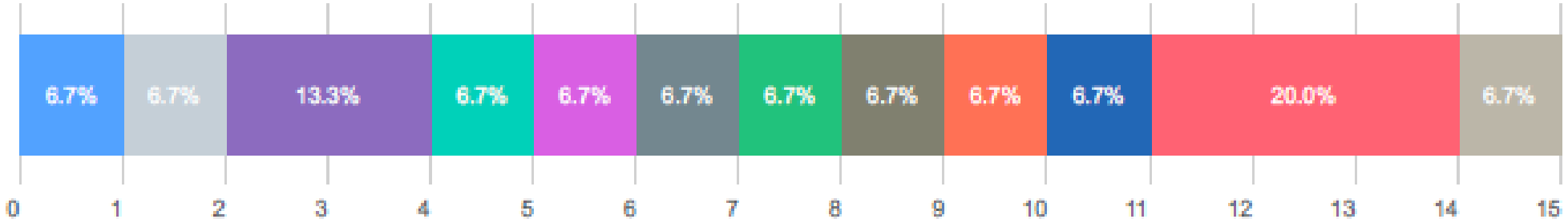


Observations

Total	**14**
Pre-defined set	6
Include if significant (based on signal-to-noise ration or equivalent)	6
Other	1
Do not know	1

Do you use inferred constituents and/or other methods for decontamination of constituents for short data series?

The majority uses inferred constituents to some extend



Observations

Total	**15**
Could you precise please?	6.7%
For locations with only short time series, predictions from nearby tide gauges with sufficient data are transfered	6.7%
inferred constituents	13.3%
inferred constituents for short data series	6.7%
No	6.7%
No, we don't	6.7%
other (Department of Waterways and Public Works analyzes the data)	6.7%
Use inferred constituents for short datasets, the number of inferred constituents dependednt on length of data.	6.7%
we use long data series	6.7%
Will use Sa & SSA derived from a separate analysis	6.7%
YES	20.0%
Yes, but depending on the end-user	6.7%

How do you deal with long-period tidal constituents (Sa, Ssa, Mf, Msf..)

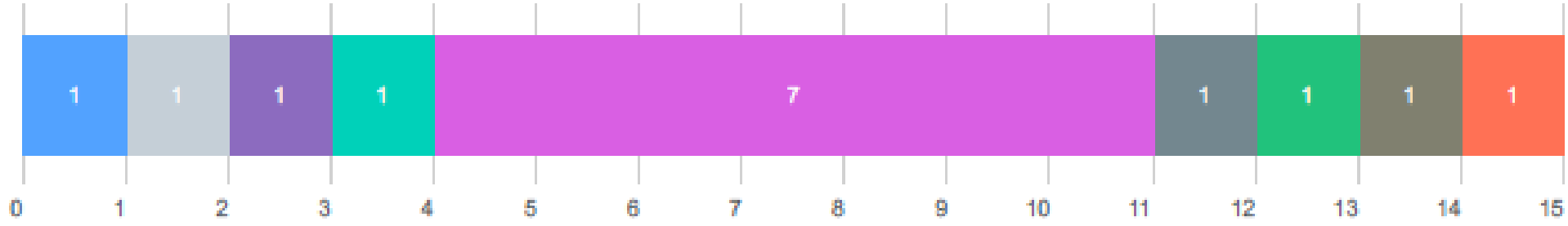
Most common to find these by separate anlysis or include them based on analysis of long series. Only a few discard them.

All answers are shown.

- Yes
- other (Department of Waterways and Public Works analyzes the data)
- Sa is included, the others are generally discarded.
- There are included in the predictions
- These are considered as input data for predictions
- Use a separate analysis
- Identified in a 'standard analysis' if the length of ovbservation is sufficient in order to resolve them
- Included if significant
- Not included
- Harmonic Representation of Inequalities uses only long-period tidal constituents (currently 39)
- Long term period harmonic analysis
- They are included based on analysis of the longest set of data.

What is the time spacing of data (hourly, 10 minutes etc)

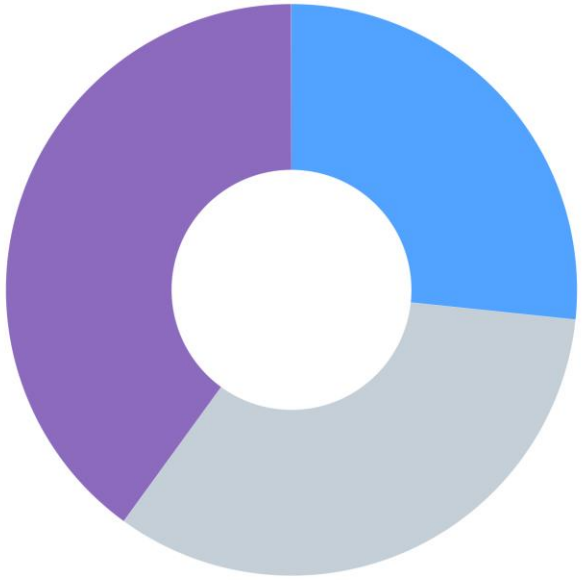
The majority use hourly data (8/15). The rest varies from 1 minute data to 10 minute data.



Observations

Total	**15**
10 min	1
10 min (previously hourly)	1
Filtered hourly data (obtained from 5 or 10 minutes raw data)	1
for tide tables at present: times and heights of high and low waters; in development: full curve predictions based on 1 minute data	1
Hourly	7
other (Department of Waterways and Public Works analyzes the data)	1
Several cases: 1', 5', 10'	1
varies from 6 mins upto 10 mins	1
Varies; most frequently 10 minute intervals, but can be any time interval.	1

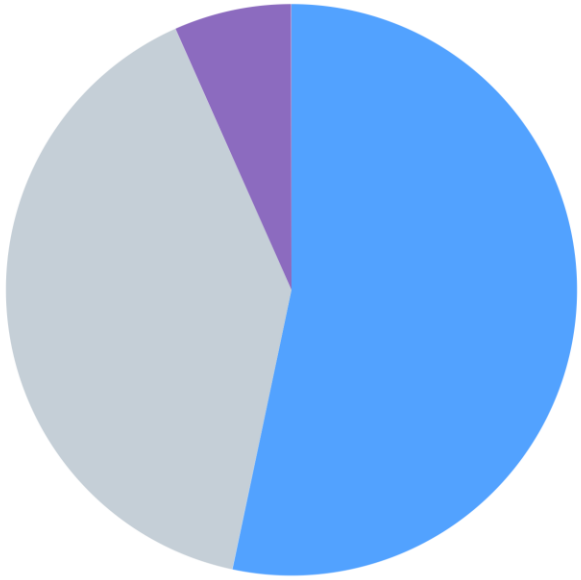
Do you analyse multiple years or year-by-year?



Observations

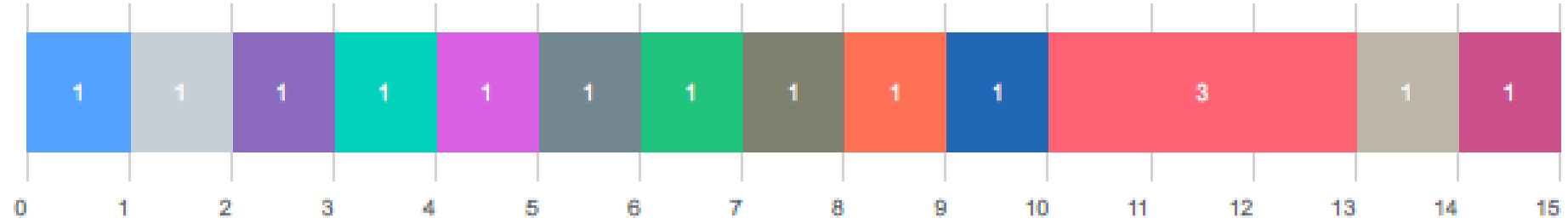
Total			**15**
Multiple years	26.7%	Other	40.0%
One year at a time	33.3%	Do not know	0.0%

Do you accept short data gaps or fill them?



Observations	
Total	**15**
Accept	53.3%
Fill	40.0%
Do not know	6.7%

How do you handle big data gaps? (using all available data or analyzing each part separate etc)



Observations	
Total	**15**
Accept them	1
analyzing each part separate if the gap is bigger than 3 days	1
Do not know	1
Fill gaps	1
Generally we are using all available data, but might have to analyze each part separately if the gap is really big.	1
no gaps are allowed	1
Not fill more than 15 days gaps	1
Separate analysis	1
Use all available data	1
use all available data including gaps	1
Using all available data	3
we analyze each part separate	1
Will look at botha a combined data analysis and seperate analysis.	1

Additional information about the analysis

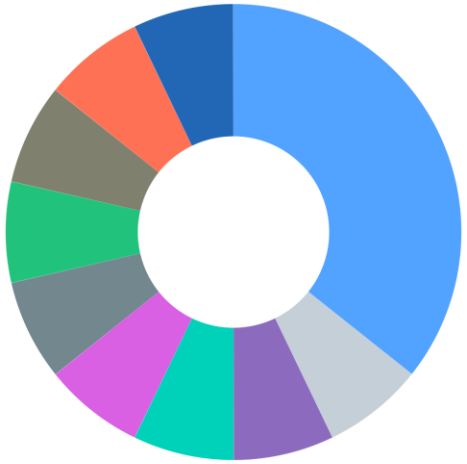
The open answers provided:

annual analysis for official national prediction; multiple years for long term tidal studies et dev.t studies.
other (Department of Waterways and Public Works analyzes the data)
The constituents for the permanent tide gauges was analyzed year-by-year (or a little more than a year). For analysis performed now, we analyze multiple years.
we anaylise year by year as well as multiple years to update our constituents
Gaps up to three days are filled
We analyse multiple years (up to 12 years) and also year by year depending on the data
Would like to be able to analyse multiple years and looking at Mike Foreman's versatile_tidana software to do this.

Part 3: Tide tables and reference levels

TWCWG Survey - harmonic analysis

What type of tidal predictions are published (High/low water, hourly, etc)

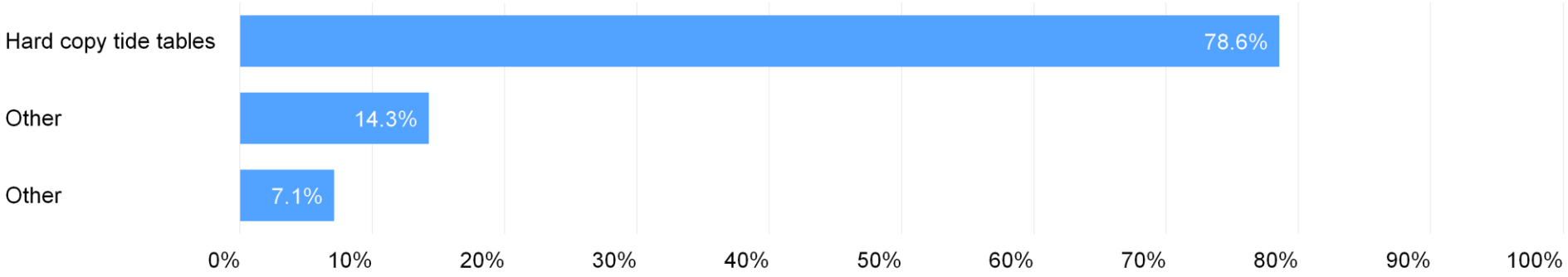


Observations

Total **14**

high/low water	5	hard copy adn websites are high/low only. Digital software allows, 10 min up to 60 mins equal spaced predictions and high/low.	1	High/Low with moon phases + hourly	1
Hard copy only provides high/low waters, website provides time series in 6, 15, or 30 minute interval	1	high/low water(all sites), hourly(major ports)	1	hight/low water	1
High low tidal prediction and hourly tidal prediction	1	High/low water, hourly, tidal curve, LAT	1	Paper: High/Low Water and Hourly (for some locations). Tidal Stream Max flood and ebb and Times of Slack Water. Digital predictions allows for various time intervals.	1
High/low in the pdf, high/low, hourly and 10 minutes on the website/API.	1				

Where is the official tide tables published?



Observations

Total **14**

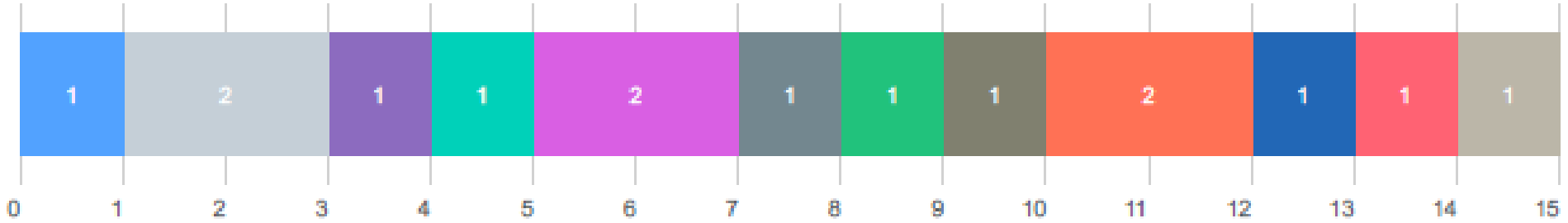
Do you publish tide tables elsewhere, and if so, where?

Most also publish tide tables on websites

in our Web site by password.
Shom Web site : https://maree.shom.fr/
Digital (USB), Hard copy timetables
Published on our website and through an API (application programming interface)
website
SAN HO Website
Yes. DHN's website
publish both hard copy and website
Admiralty Digital Publication "TotalTide" - see https://www.admiralty.co.uk/digital-services/admiralty-digital-publications/admiralty-totaltide. Online "EasyTide" - see http://www.ukho.gov.uk/easytide/EasyTide/index.aspx; Tidal API -see https://www.admiralty.co.uk/digital-services/data-solutions/uk-tidal-api
NO
Website
www.bsh.de/gezeiten (7 days in advance)
Official website
Hard copy, digital software, Government websites

How frequent do you update constituents for sites with a permanent tide gauge?

This differs: Half updates constituents annually while 1/4 rarely updates them.



Observations

Total	**15**
Almost not change	1
Annually	2
annually	1
Every 10 years	1
every year	2
Once every five years	1
other (Department of Waterways and Public Works analyzes the data)	1
Our Bureau of Meteorology, does annual analysis of our standard ports	1
Rarely	2
We have recently update all the tidal waves for our sites with our new software with all available data	1
when new tide gauges data are received with a minimum of 1 year time sery	1
yearly	1

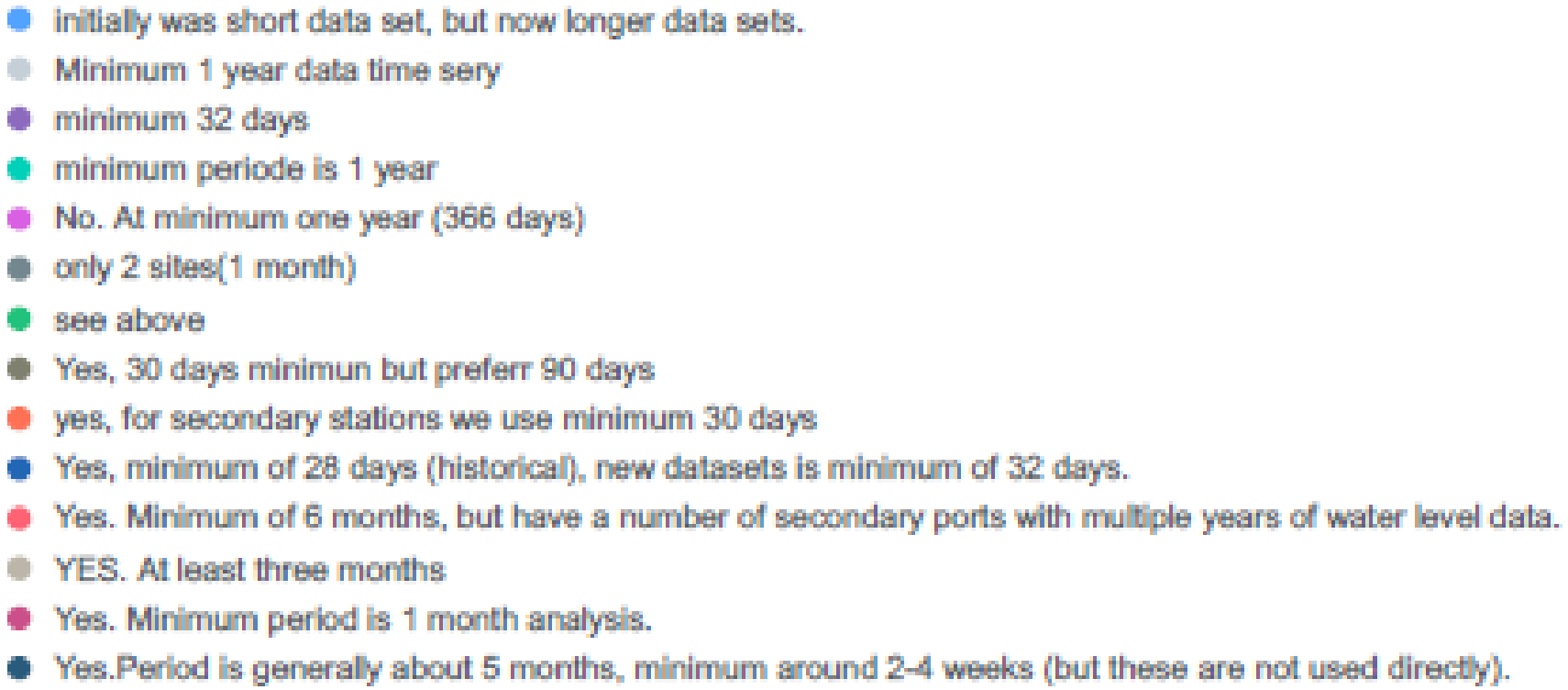
How many years of data is typical used for the analysis which official tide tables are based on?

This ranges from 1 to 20 years, as the open answers show

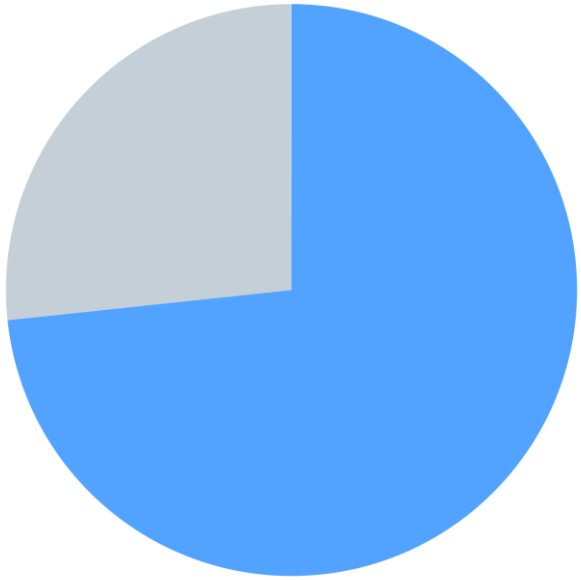
if it is possible, we use more than one year
20
other (Department of Waterways and Public Works analyzes the data)
Generally between 5 and 10 years
one year
approxomately 40 years at present
A nodal cycle
one to five years for permanent stations. Short term data sets (30 days) can be used
A minimum of 1 year analysis; but many more years are preferable.
At least one year
19 years, but several sites have yet to accumulate acceptable data of this duration.
19 years
369 days
we have a few locatiosn less than 12 months, but our preferences is 12montsh +. Most locations have 20yrs +

Do you do tidal predictions based on short data sets? What is the usual and minimum period of data used?

Minimum of one year for some, but most have 1 month as minimum



Do you calculate HAT and LAT



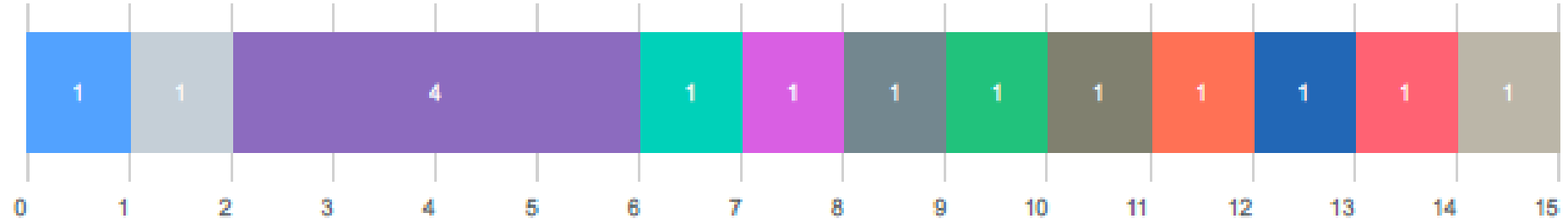
Observations	
Total	**15**
Yes	73.3%
No	26.7%

If yes, please specify how you calculate LAT (and HAT)

Most common (8/12) to use 19 years of predictions, some for the same 19 years as the anlysis is done. Two countries uses models.

- based on 19 years predictions fo rthe above mentioned epoch.
- From tidal predictions over 40 years (1980-2019)
- Highest and Lowest levels to occur in a 18.6 [19] year set of predictions.
- Lowest (highest) value when considering 19 years of predictions
- Maximum (HAT) and mininum value (LAT) obtained from the high/low water prediction in the 1990-2008 period
- Minimum (and maximum) water levels computed over a 19 year period using a 'master' set of constituents.
- See Bathyelli method TWCWG3-6.10.4-SurfRef_Project-FRA.pdf (https://www.iho.int/mtg_docs/com_wg/IHOTC/TWCWG3/TWCWG3.htm)
- Tidal analysis of 19 years of water level data followed by tidal synthesis of the same 19 years based on analysis result (harmonic representation of inequalities)
- TU-Delft calculated LAT (NEVREF project)
- unknown (preprogrammed into the in house software before my appointment at SANHO.)
- Use the same 19 year period as tidal datums
- We calculate the LAT by doing a forecast for 19 year

What do you use as Chart Datum



Observations

Total	**15**
A.L.L.W	1
in UK, "approximately the level of Lowest Astronomical Tide [LAT]"	1
LAT	4
LAT - epoch 1992 - 2011	1
LAT + security margin (0, 20 or 30 cm)	1
LAT or the local minimum level	1
Mean Sea Level for topography and Mean Low Water Ordinary Springs for bathymetry	1
MLLW	1
MLWS	1
North Sea: LAT (except estuaries), Baltic Sea: BSCD2000	1
RH 2000 or Baltic Sea Chart Datum 2000	1
Zero hydrographic	1

Additional information about tide tables and tidal predictions

Open answers shown

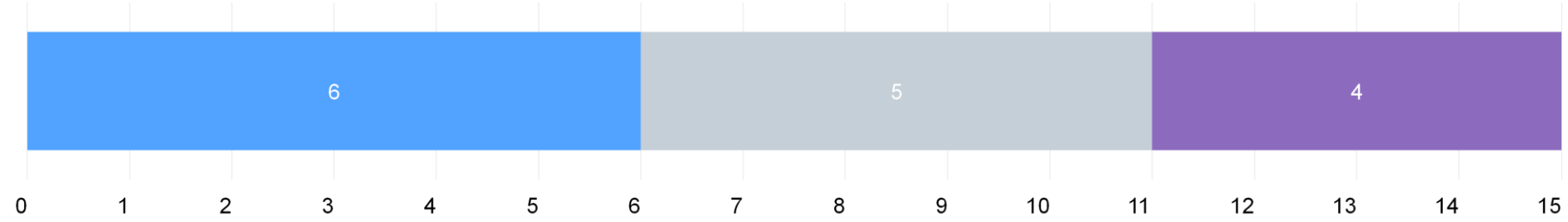
- The official tide tables are published as a pdf on the website
- also publish times of sunrise/set and moonrise/set in the Toide Tables
- See https://www.admiralty.co.uk/publications/publications-and-reference-guides/admiralty-tide-tables
- We also published the official tide tables on Intranet

Part 4: Software for analyzing water level data

TWCWG Survey - harmonic analysis

Is the software used developed in-house, open software or commercial?

Software developed in-house and use of open software are most common. Commercial product corresponds to those using Matlab



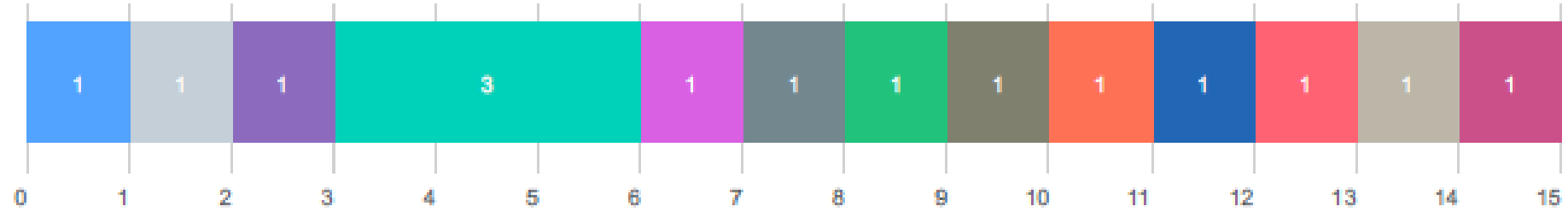
Observations

Total **15**

Developed in-house	6	Commercial product	4	Do not know	0
Open software	5	Other	0		

Programming language

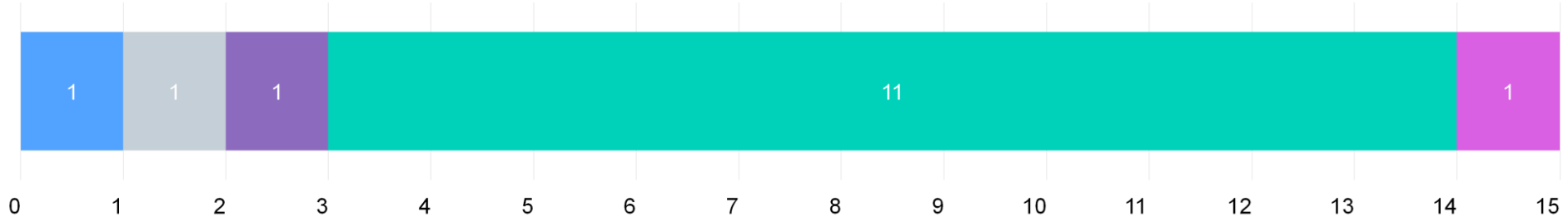
Fortran mentioned by 10, Matlab mentioned by 4. The other languages mentioned are Phyton, R, Java, C++.



Observations	
Total	**15**
-	1
C++	1
F90	1
Fortran	3
FORTRAN 77	1
Fotran	1
Matlab	1
MATLAB, FORTRAN	1
n/a	1
origianl FORTRAN, now converted to JAVA	1
proprietary programming language developed by MathWorks (MATLAB)	1
Python, Fortran	1
R Language, Matlab	1

Is this software used for predictions?

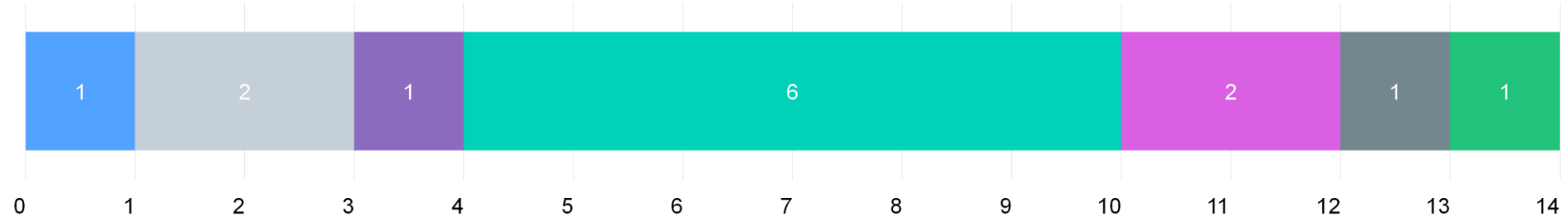
The majority uses the same software for predictions.



Observations

Total	**15**
MAS for official french tidal prediction	1
No, another fortran routine developed at the same time.	1
No. We use in-house software to generate predictions using the results generated by TASK.	1
Yes	11
YES, BOTH.	1

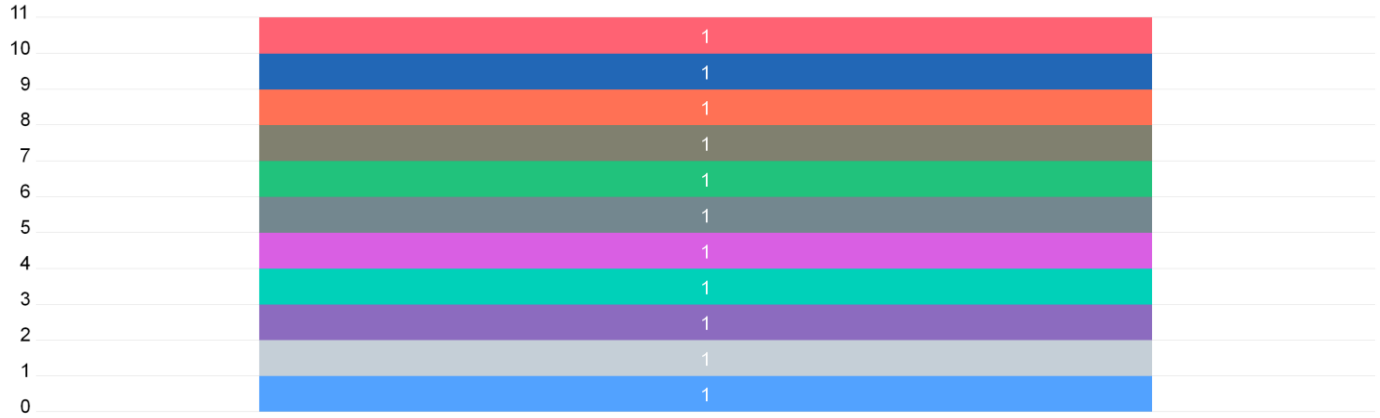
Operating system(s):



Observations

Total					**14**
-	1	WINDOWS	6	Windows, Linux	1
Linux	2	Windows 10	2		
Unix/Linux	1	Windows 7 currently	1		

Software source

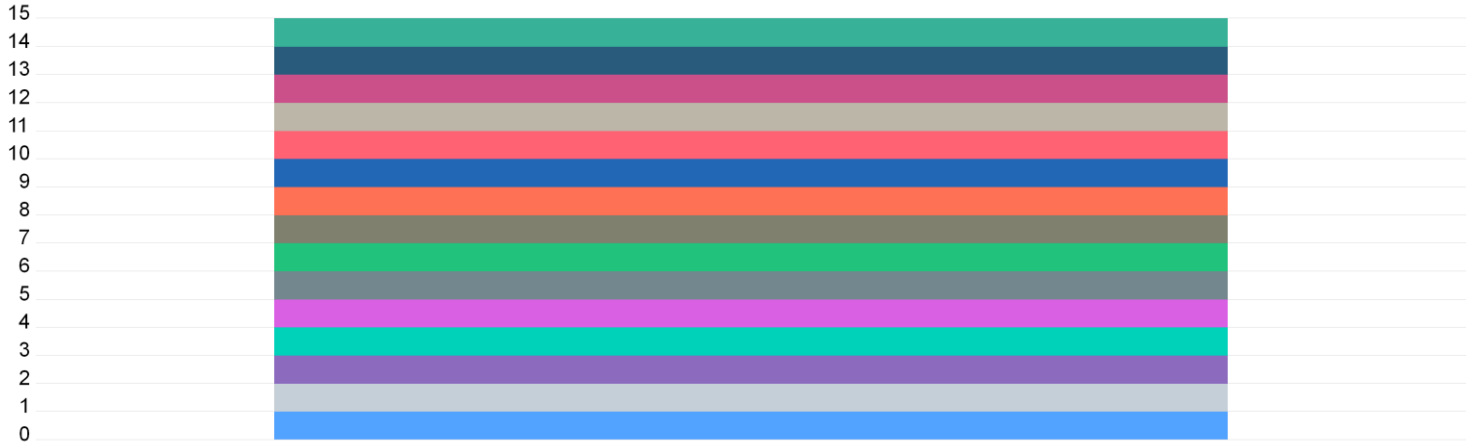


Observations

Total **11**

- Alec Stephenson y Patrick Caldwell 1
- BSH 1
- Deltares 1
- Foreman (IOS) 1
- Mathworks 1
- MATLAB 1
- Mike Foreman - Institute of Ocean Sciences, Canada 1
- National Oceanography Centre (NOC), 6 Brownlow St, Liverpool, L3 5DA Telephone: +44 (0)151 795 4800 Fax +44 (0)151 795 4801 e-mail: dataproducts@noc.ac.uk 1
- Originially developed by Scripps Inst. in the 1960's 1
- Proudman Oceanographic Laboratory 1
- Source Shom for Mas. Separatly and for HYCOM: It's a consortium is a multi-institutional effort sponsored by the National Ocean Partnership Program 1

Software name



Observations

Total	**15**
Delft3D-Tide	1
IOS Tidal Package	1
LSQHA	1
Mas and Hycom in its version used at Shom (for HYCOM source & info : https://www.hycom.org)	1
Matlab	1
Modified Foreman Tide Package	1
n/a	1
PACMARE	1
PROGRAMA DE MAREAS	1
SLPR2 and MATLAB (Specific toolboxes T_TIDE and U_TIDE)	1
TASK 2000	1
Tidal Analysis Software Kit (TASK) - Windows Edition v2.0.0	1
Tidal Office	1
Tide	1
TideHarmonics, NMPR2, T_tide	1

Additional information about the software

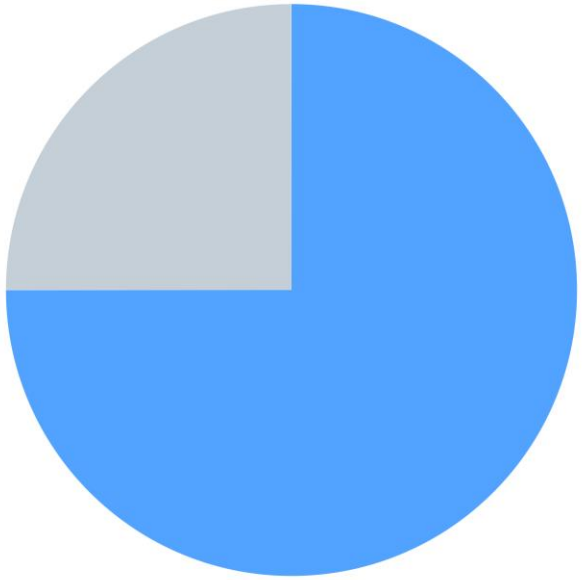
Open answers as shown

These software are used to data quality control, predictions and forecast,
Own written code, the toolbox for tides in Matlab is not used
Simulations of multi-dimensional hydrodynamics flows (incl. sediments)
software developed by Brazilian Admiral Alberto dos Santos Franco
analysis and prediction software with approximately 25 specialised outputs
Versions 0.1-1, 3.0 y 1.1
Originally developed in Fortran 4 has been updated to Fortran 95. Uses least squares methodology.
see https://noc.ac.uk/business/marine-data-products/tidal-analysis
LINZ developed a front-end interface for interacting with the software and uses a SQL Server database to store water level data, constituent sets and tidal levels by tide station location.
Modified for Southern hemisphere

Part 5: Analyzing tidal currents/stream data

TWCWG Survey - harmonic analysis

What method is used for analyzing tidal currents/stream data

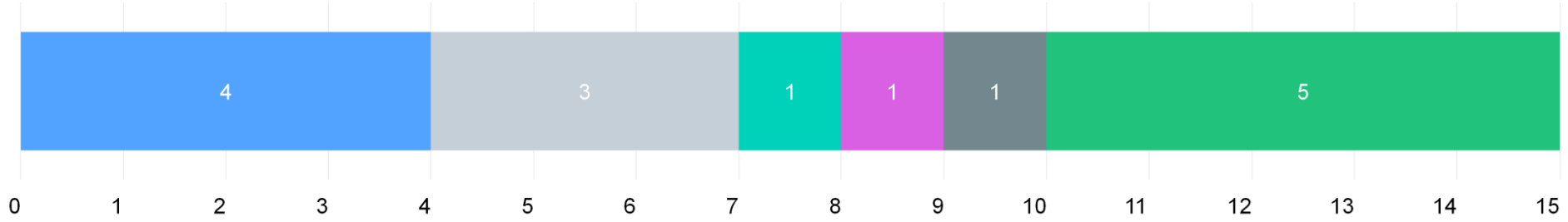


Observations	
Total	**8**
Harmonic analysis	6
Other, please specify	2

Harmonic analysis or non-harmonic depending on the use/data

Who does the analysis of tidal current/stream in your country?

Blue is own organisation and grey in combination with others. Green are those not doing tidal current/stream.

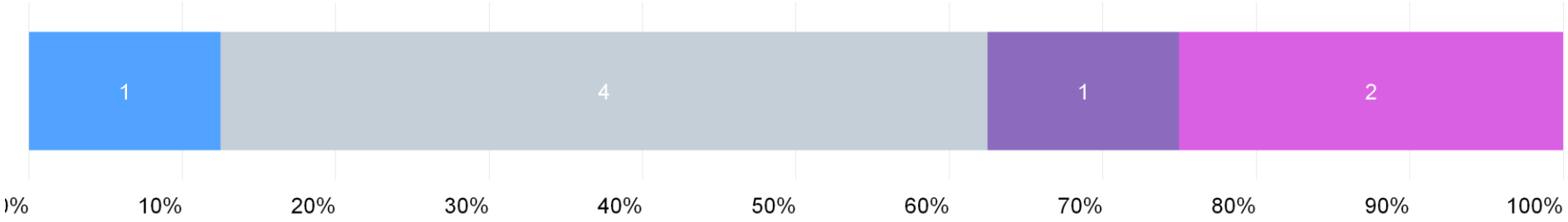


Observations

Total **15**

own organisation	4	Others - we know how	1	Does not apply	5
Combination of own organisation and others	3	Others - no information	1		
Contractors	0	Do not know	1		

Do you use inferred constituents



Observations

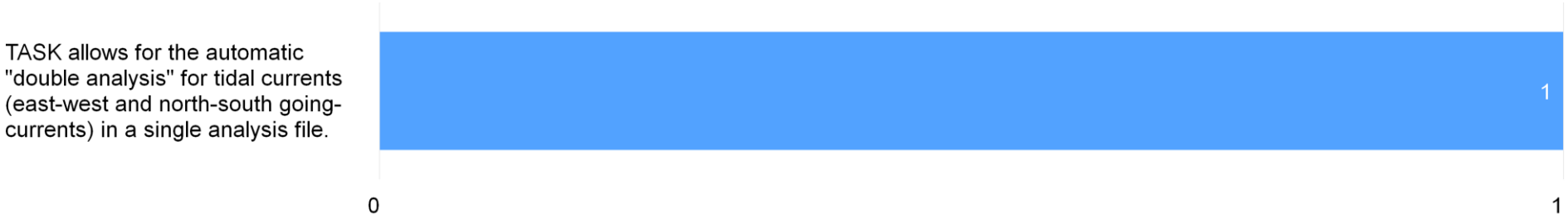
Total **8**

Yes, most often	1	No, never	1	Do not know	2
If possible, but normally not	4	Other	0		

How long series do you normally use?

From the open answers

Additional information about the analysis

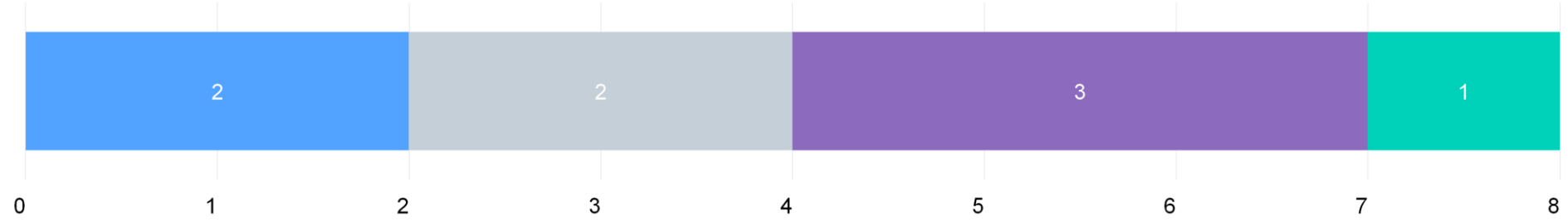


Observations	
Total	**1**

Part 6: Software for analyzing tidal currents

TWCWG Survey - harmonic analysis

Is the software used developed in-house, open software or commercial?



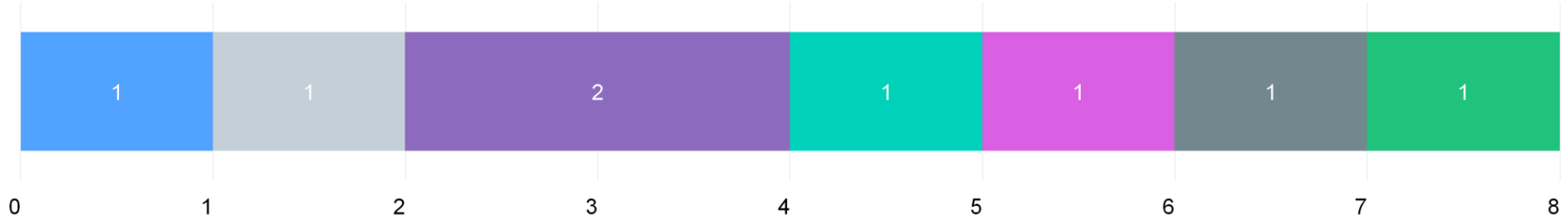
Observations

Total	**8**

Developed in-house	2	Commercial product	3
Open software	2	Other / Do not know	1

Programming language (if relevant/known):

Fortran is most common (5/8)

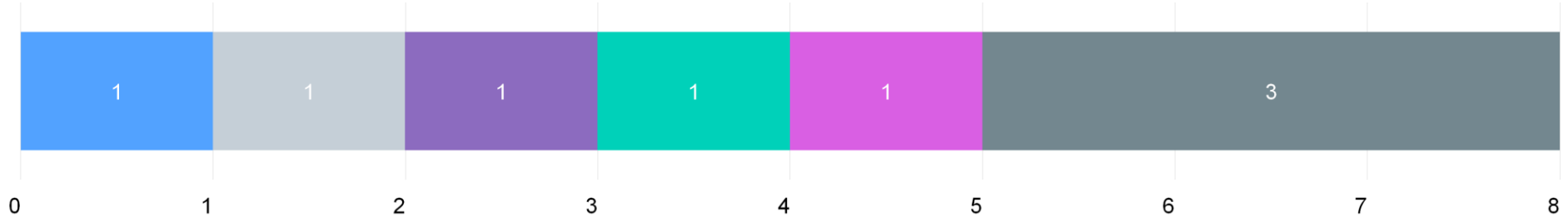


Observations

Total	**8**
Do not know	1
F90	1
FORTRAN	2
FORTRAN - now converted to JAVA	1
Fotran	1
n/a	1
proprietary programming language developed by MathWorks.	1

Is this software used for predictions?

More than half uses a different software/separte rutine fortidal currents/stream predictions.



Observations

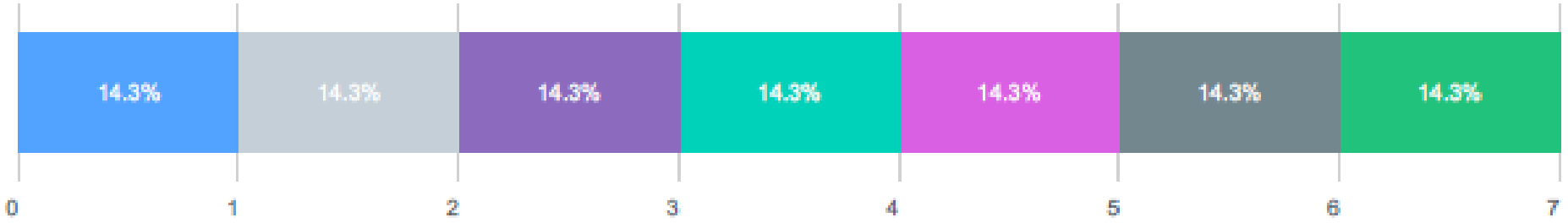
Total	**8**
it is a Coastal Flood forecasting System for the Netherlands	1
MAs for official tidal prediction	1
no	1
No, separate FORTRAN routine	1
No. In-house software used to generate the predictions using the results of TASK.	1
Yes	3

Operating system(s):

Observations

Total	**8**
Do not know	1
Linux	1
Unix/Linix	1
Windows	3
Windows 10	2

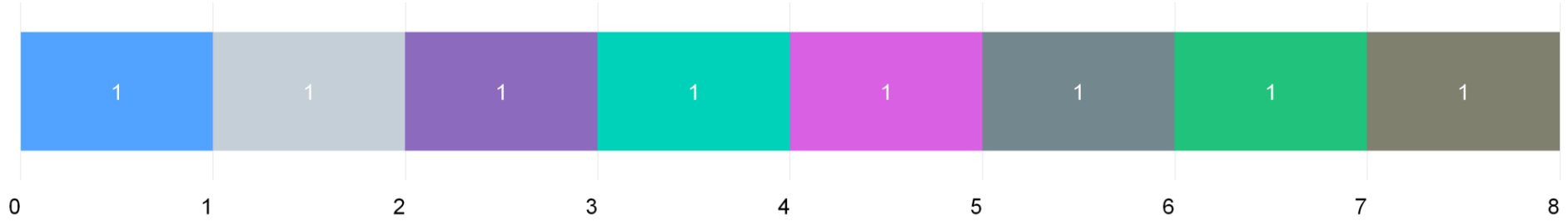
Software source:



Observations

Total	**7**
IOS Canada	14.3%
Matroos database	14.3%
National Oceanography Centre (NOC), 6 Brownlow St, Liverpool, L3 5DA Telephone: +44 (0)151 795 4800 Fax: +44 (0)151 795 4801 e-mail: dataproducts@noc.ac.uk	14.3%
POL/PSMSL	14.3%
Proudman Oceanographic Laboratory	14.3%
Scripts Inst. from 1960's	14.3%
Src for MAS : Shom (French hydrographic Center) . Src for HYCOM : https://www.hycom.org/	14.3%

Software name:



Observations

Total	**8**
Dutch Continental Shelf Model v6	1
Foreman Tidal stream analysis package	1
LSQHA	1
MAS for some cases, Hycom for other cases	1
MATLAB (U_TIDE TOOLBOX)	1
TASK-2000	1
Tidal Analysis Software Kit (TASK)	1
Tidal Analysis Software Kit (TASK) v2.0.0	1

Additional information about the software for analyzin tidal currents/stream

Open answers provided:

Developed by Deltares

Essentially same software used for both Tides and Currents

See https://noc.ac.uk/business/marine-data-products/tidal-analysis

FINAL QUESTION: ADDITIONAL COMMENTS

TWCWG Survey - harmonic analysis

Is there any other information you want to share reagarding analysis of water level data and/or tidal currents/stream data, or do you have other comments?

Open answers provided:

1. For the time being, we do not produce any tide-tables for Swedish harbors. The tide in Swedish waters are weak and the maximum tidal range, during spring tide, is about 0,60 meters on the Swedish west-coast. For sea level predictions, we use data from a hydrodynamic model (a 3D NEMO-model, run by SMHI). Even thou, we are doing some harmonic analysis of our water level data for other purposes. For that, we have developed our own tool (S_Tide) for the harmonic analysis. The code is written in MATLAB, without the use of any toolbox, such as t_tide. Our results will now be compared with results from other tools, developed by UKHO, NOAA and others (task in TWCWG). We are following the TWCWG Standard constituent list. For the tidal analysis, we use hourly observation values (1980-2019) from our own tide gauges, SMHI and others. The data is freely available through Copernicus Marine Service, EMODNET Physics and SMHIs Open data service. We have developed our own tools for the harmonic analysis. Probably, due to the unique conditions at every port makes it hard to use exactly the same number of harmonic constituents for all stations etc. For example, we usually exclude the long-term constituents in Swedish waters, because they correlates (too) well with the meteorological variations.

Is there any other information you want to share reagarding analysis of water level data and/or tidal currents/stream data, or do you have other comments?

Open answers provided:

2. Survey question -Do you accept short data gaps or fill them? - It depends on the local dynamics and the gap length. In some "strong" dynamics (with strong water level slopes, non linearity, for example) the data gap length position tolerance is stricter. On average, water level gap tolerance is between 3 hours and 12 hours in strong semi diurnal tidal regime.

3. No, thanks.

4. Tidal Current Harmonic Analysis can accept gaps in the data if the data set is longer than 30 days.

5. As most water level data is obtained from tide gauges run by other organisations getting them to undertake good, regular calibration checks is one of our biggest problems. As the uses of this data expands to other applications, calibration information is becoming more important than ever. Would like to develop a capability to analyse tide current/steam data collected during the course of hydrographic surveys.

THANK YOU FOR CONTRIBUTING TO THE SURVEY

TWCWG Survey - harmonic analysis