

DEFINITIONS OF TERMS USED FOR DESCRIBING AND CALCULATING THE TIDAL PHENOMENA IN THE SEA

by

DR. H. RAUSCHELBACH, OF THE DEUTSCHE SEEWARTE, Hamburg.
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INTRODUCTION.

The phenomenon of tides, which brings out a large number of properties which vary very much according to localities and thus introduce the greatest difficulties into the scientific understanding thereof, has from earliest times incited not only those who live on the coast, but also many of those who live inland, to study the origin of this most striking movement of the sea. Consequently, a multitude of terms used to describe the various peculiarities of this phenomenon have been introduced both in foreign countries and into the German vocabulary. Not only do the same expressions not always have the same meaning for peoples speaking the same language, but even the same terms are not always used in the same sense by coastal and inland peoples.

It is principally in German literature that great irregularities in the use of terms have appeared in popular works and also in scientific discussions, and even in treatises and in manuals. This condition of affairs is due to: 1) terms borrowed from foreign languages have been translated variously by different authors instead of translating them by a term already in use according to their real significance, 2) these terms have undergone a change of meaning with time, and 3) the authors of articles in manuals on tides, who are frequently not familiar with tidal subjects, use older manuals as sources of information without taking into account the progress which has been made since they were written. The want of unity in the designations may easily be such that the same expressions are used by various authors, or even by the same author in different places, with quite different meanings, or a certain expression may be rendered by several different words to which, in other places, an entirely different signification may be attributed.

Thus, for example, the term *Flut*, which properly means the rising of the water, is used by PREY (1) for *Hochwasser*, for *Gezeiten* and for *Tidenhub*; conversely, the term *Tidenhub* is expressed either by the words *Flut*, *Fluthöhe*, *Gezeitenhub*, *Höhe der Flut* or *Hubhöhe*; and among others are found *Springflut* for *Springtidenhub*, *Niedrigwasser der Springflut* for *Springniedrigwasser* and *Pegel* for *Nullpunkt des Pegels*.

GUTENBERG (2) uses the word *Flut* either in the sense of *Hochwasser* or in that of *Gezeit*, and the word *Ebbe* for *Niedrigwasser*. By *Fluthöhe*, he means either *Hochwasserhöhe* or *Tidenhub*, or even the *Wasserstand* at any moment; for *Tidenhub*, besides this designation and the word *Fluthöhe*, he uses the word *Hubhöhe*. He uses the term *Springflut* for *Springhochwasserhöhe* and *Hafenzeit* for *Mondflutintervall*; *Flutstundenlinien* are, according to him, *Linien gleicher Hafenzeit*.

In the same way that PREY and GUTENBERG use the word *Flut* instead of *Hochwasser*, and the expressions *Fluthöhe*, *Gezeitenhub* or *Hubhöhe* instead of *Tidenhub*, so HOPFNER (3) uses them also. PREY and HOPFNER also designate falsely the phenomenon of the *tägliche Ungleichheit* as *halbmonatliche Ungleichheit*.

These examples, taken from treatises and manuals of the last ten years, will suffice to show how great confusion may be introduced in the minds of the readers of these books insofar as the meanings of the terms relating to tidal phenomena are concerned,

(1) A. PREY, *Anwendung der Methoden der Erdmessung auf geophysische Probleme*, IV. Theorie der Gezeiten. *Naturwissenschaftliche Monographien und Lehrbücher*, 4. Band, *Einführung in die Geophysik*, I. Teil, pp. 86 to 130, Berlin 1922.

(2) B. GUTENBERG, *Wasserwellen und Gezeiten*. *Lehrbuch der Geophysik*. Abschnitt VIII, pp. 308 to 353, Berlin 1929.

(3) F. HOPFNER, *Die Gezeiten der Meere*. *Handbuch der Experimentalphysik* by W. WIEN & F. HARMS, Band 25, II. Teil. *Geophysik*, II. Teil, *Physik des festen Erdkörpers und des Meeres*, pp. 687 to 801, Leipzig 1931.

seeing that the authors themselves have no clear idea as to the meanings of the expressions which they use.

In order to lay down clear definitions of the terms concerning tidal phenomena, at any rate for official use, some thirty years ago (29th August, 1904) the Staatssekretär of the Reichs-Marine-Amt issued a decree fixing standard terms for the phenomena and values which enter into the subject of tides. This decree, which is entitled the "*Zusammenstellung einheitlicher Bezeichnungen für die Vertikal-Ausmessungen der Gezeiten*", was published in the *Annalen d. Hydr.* 1904, pp. 449 to 451. After this date, the terms thus fixed only were to be employed in the publications and other works of the Deutsche Seewarte.

As these terms required to be complemented and modified, a new decree of the Staatssekretär of the Reichs-Marine-Amt, dated 17th October, 1913, was published in the *Annalen d. Hydr.* 1913, pp. 553 to 555, under the title "*Zusammenstellung der in der Kaiserlichen Marine anzuwendenden Bezeichnungen und Erklärungen betreffend die Tiden-Erscheinungen*". The designations were drawn up in accordance with the proposals of the Imperial Observatory (Wilhelmshaven) and of the Deutsche Seewarte. This list was reproduced also in the *Gezeitentafeln für das Jahr 1915* and in the succeeding editions of this work; it was corrected and amplified as the years went by. Except in the publications of the German Navy and in the Tide Tables, these terms have not, so far, been uniformly used, even in the publications of the Deutsche Seewarte.

The relatively few terms which are given in the above-mentioned lists are not even sufficient to represent completely the simple phenomena of the tides which occur in the waters of the North Atlantic, and thus it is even less possible, under these circumstances, to describe satisfactorily the complex phenomena of tides over vast areas in the Indian and Pacific Oceans by means of these designations. This explains the need which has been felt for some years for a list of the usual terms used, or of those which have to be employed in connection with tides drawn up on a wider basis.

The comments and the definitions given below have been inspired by the author's collaboration in the establishment of a list of terms concerning tidal phenomena in the German language for a vocabulary which is now being prepared by the International Hydrographic Bureau of Monaco, and which contains terms connected with tides in various languages. (1)

In order to draw particular attention to those terms employed in foreign languages, the construction of which is similar to those used in the German language, or which convey the same idea, or which, though constructed in a similar manner, are used in a sense different from that of the German, the tidal terms used in English, French, Italian and Dutch have been added to the German technical expressions given below. As in the English terms there is frequently a difference between the idiomatic expressions used in Great Britain and in the United States, throughout the article a distinction will be made between the British terms (which will be distinguished by the abbreviation *Br.*) and the American terms (before which the abbreviation *Am.* will be inserted). French terms will be preceded by the abbreviation *Fr.*, Italian terms by *It.* and Dutch terms by *Nd.*

1ST PART. — DESIGNATIONS USED FOR THE DESCRIPTION OF TIDES.

The expression *Gezeitenerscheinungen* — *Br.*: tidal phenomena; *Fr.*: phénomènes des marées; *It.*: fenomeni di marea; *Nd.*: getij-verschijnselen — is used generally to designate the forms of the movement of very large gaseous, liquid or solid masses produced by astronomical causes and re-occurring (2) at definite intervals of time. Though these intervals of time need not necessarily be of the same length, they should, however, if they vary, follow some fixed law. In accordance with this conception, for some three and a half centuries *Gezeiten* — *Br.*: tides; *Fr.*: marées; *It.*: maree; *Nd.*: getijden — have been understood to mean particularly the repetition which occurs twice a day at most places, and in numerous others either rarely, sometimes or frequently, or even always, once a day, of the *Steigen und Fallen* — *Br.*: the rising and falling (of the level of the sea); *Fr.*: l'élevation et l'abaissement (du niveau de la mer); *It.*: l'innalzamento e l'abbassamento (del livello); *Nd.*: het stijgen en dalen (van den waterspiegel) — of the

(1) The first part of this vocabulary containing the more important tidal terms in general use in English and French has appeared meanwhile. It is entitled: Vocabulary concerning Tides, Special Publication No 28, International Hydrographic Bureau, Monaco, 1932.

(2) The prefix "Ge" calls special attention to the idea of repetition in the word *Gezeiten*.

liquid masses of the ocean or of large inland lakes, consequent on the attraction of the moon and the sun on the aqueous envelope of the earth as it turns on its axis.

The short or long period oscillations in the height of the surface of the ocean engendered by a daily variation in land and sea winds, by the annual return of prevailing winds, of precipitations, evaporations or other meteorological influences, cannot consequently be properly designated as tides even though they are indissolubly connected with the rise and fall of the true astronomical tides and are calculated at the same time as these. Abnormal rises of water at any place which are attributed to earthquakes or sea-quakes, to storms or other causes which do not obey a law entailing a re-occurrence cannot, however, be considered as tidal phenomena, though they are quite incorrectly called *Flutwellen*, *Springfluten*, *Sturmfluten*, etc.

Concurrently with the rise and fall of the level of the sea in most places there is a lateral or horizontal reciprocating movement of the mass of water to which the name of *Gezeitenstrom* — *Br.*: tidal stream, stream; *Am.*: tidal current, current; *Fr.*: *courant de marée*; *It.*: *corrente di marea*; *Nd.*: *getijstroom* — is given. Between the two movements i.e., the vertical rise and fall of tides and the horizontal reciprocating movement of the tidal streams, there is, at a certain place, a close relation, seeing that these two movements are part of one and the same phenomenon and are engendered by the lunar and solar forces which produce the tide in correlation with the rotation of the earth.

In the following pages the definitions relating to the different expressions which occur in the theory of tides as concerns tides of the ocean only are distinguished by italics.

1. *Gezeitenscheinungen* — *Br.*: tidal phenomena; *Fr.*: *phénomènes des marées*; *It.*: *fenomeni di marea*; *Nd.*: *getij-verschijselen* — are the forms of the movements of the great masses of water under the effect of the attractive forces of the moon and of the sun in correlation with the rotation of the earth about its axis. They include the vertical movements corresponding to the position of the moon and of the sun with reference to the earth, the periodical rise and fall of the water and the corresponding horizontal movements, i.e., the periodical reciprocating movement of the water.

2. *Gezeiten* — *Br.*: tides; *Fr.*: *marées*; *It.*: *maree*; *Nd.*: *getijden* — are the vertical parts of the tidal phenomenon or the alternating rise and fall of the aqueous masses caused mainly by lunar and solar attraction in correlation with the rotation of the earth about its axis.

3. *Gezeitenströme* — *Br.*: tidal streams; *Am.*: tidal currents; *Fr.*: *courants de marée*; *It.*: *correnti di marea*; *Nd.*: *getijstroomen* — are the horizontal parts of the tidal phenomenon or the alternating flow in opposite directions of the water mass concomitant with the tides.

The word *Gezeitenscheinung* includes also the idea of *Gezeiten* and *Gezeitenströme*. In order to make matters clear it is necessary that a definite distinction be made between these two ideas, and all the more so in that the connection between the tides and tidal streams is neither simple nor everywhere the same. For instance, it may happen that, at certain places, a strong tidal stream occurs in connection with a tide of average rise and fall, whereas in another place the same rise and fall is accompanied by a weak tidal stream. The relation between the times of the commencement of the rise and of the fall and the times of the initiation of tidal streams differs considerably from one place to another.

As a general rule an *isolated* tide is designated by the Low German word *Tide* — *Br.*: *tide*; *Fr.*: *marée*; *It.*: *una marea*; *Nd.*: *getij* — (It should be noted here that in the harmonic analysis and synopsis of tides, the word *Tiden* is taken also to mean the different *Teilwellen* — *Br.*: *constituents*; *Am.*: *components*; *Fr.*: *composantes*; *It.*: *onde parziali*, *componenti*; *Nd.*: *partieele getijden* — of which the tides are composed).

The isolated tide is represented graphically in the form of a curve of sea levels which commences at a minimum value of the water level and returns to another minimum value after having passed through a maximum value. In opposition to such a *Tidenkurve* — *Br.*: *tidal curve*, *tidal diagram*; *Am.*: *tide curve*; *Fr.*: *courbe type de marée*; *It.*: *un'onda di marea*, *una oscillazione di marea*; *Nd.*: *getijhromme* — which reproduces the observed or calculated aspect of the rise and fall of a single isolated tide or of some definite isolated tide, the word *Gezeitenkurve* — *Br.*: *tidal curve*, *tidal diagram*; *Am.*: *marigram*, *tidal diagram*; *Fr.*: *courbe de marée*; *It.*: *curva di marea*, *mareogramma*; *Nd.*: *getijlijn* — is taken to mean the graphic representation of the observed or pre-calculated alternating aspect of a large number of tides.

During a rising tide the water level rises until it reaches a maximum level or until

the *Hochwasser* — Br.: *high water*; Fr.: *la pleine mer*; It.: *alta marea*; Nd.: *hoogwater* — occurs, thereafter the water falls again until it reaches a minimum level or until the *Niedrigwasser* — Br.: *low water*; Fr.: *la basse mer*; It.: *bassa marea*; Nd.: *laagwater* — occurs. *Hochwasser* and *Niedrigwasser* (1) are the two principal phases of the tide and are often jointly designated by *Gezeiten*.

In ordinary language, the words *Hochwasser* and *Niedrigwasser* may also signify a measure of height as well as an epoch. When the meaning does not directly appear from the context, *Hochwasser* should be replaced either by *Hochwasserstand* — Br.: *high water stand*, but: *the height of high water (above datum)*; Fr.: *la hauteur de la pleine mer (au-dessus du zéro)*; It.: *quota dell'alta marea (sul piano di riferimento)*; Nd.: *hoogwaterstand (boven het vergelijkingsvlak)* — or by *Hochwasserzeit* — Br.: *the time of high water*; Fr.: *l'heure de la pleine mer*; It.: *ora dell'alta marea*; Nd.: *het uur van hoogwater, tijd van hoogwater* — and in the same way *Niedrigwasser* either by *Niedrigwasserstand* — Br.: *not: low water stand*, but: *the height of low water (above datum)*; Fr.: *la hauteur de la basse mer (au-dessus du zéro)*; It.: *quota della bassa marea (sul piano di riferimento)*; Nd.: *laagwaterstand (boven het vergelijkingsvlak)* — or by *Niedrigwasserzeit* — Br.: *the time of low water*; Fr.: *l'heure de la basse mer*; It.: *ora della bassa marea*; Nd.: *het uur van laagwater, tijd van laagwater*.

It is necessary to insist particularly here on the fact that the expressions *high water* and *low water* do not imply any idea of a level of a determined altitude which may be connected to a given *Nullebene* — Br.: *plane of reference, datum*; Fr.: *plan de référence, zéro*; It.: *piano di riferimento*; Nd.: *vergelijkingsvlak* —, for there is a large number of places at which the low water of one day is actually higher than the high water of another day or where the high water of one day does not reach the altitude of the low water of another. Whatever may be the height of the level of the water, there is a high water when the rise of the water stops and the water is about to go down; in the same way there is a low water when the fall ceases and the rise is just about to begin.

Based on the above, the following new definitions may be given:

4. *Tide* — Br.: *tide*; Fr.: *marée*; It.: *marea*; Nd.: *getij* — is an isolated *Gezeit* or *Gezeitenwelle* — Br.: *wave*; Fr.: *onde*; It.: *un'onda di marea*; Nd.: *golf* — which generally necessitates a closer explanation and which extends from one low water until the following low water.

5. *Tidenkurve* — Br.: *tidal curve, tidal diagram*; Am.: *tide curve*; Fr.: *courbe type de marée*; It.: *una oscillazione di marea*; Nd.: *getijkromme* — is a graphic representation of the rise and fall of the water in which the hours are given by the abscissae and the levels of the water by the ordinates and which for any given tide or definite curve of water level commences with a low water and extends to the following low water, passing through a high water.

6. *Gezeitenkurve* — Br.: *tidal curve, tidal diagram*; Am.: *marigram, tidal diagram*; Fr.: *courbe de marée*; It.: *curva di marea, mareogramma*; Nd.: *getijlijn* — is a curve which shows the variations of the level of the water for a number of tides and which has been obtained either by means of a recording instrument or by a tide predicting machine.

7. *Hochwasser, H.W.* — Br.: *high water, H.W.*; Fr.: *la pleine mer, P.M.*; It.: *alta marea, A.M.*; Nd.: *hoogwater, H.W.* — is the highest level of a tide as it passes from the rise to the fall or it is the instant at which this highest level is reached.

8. *Hochwasserzeit, H.W.Z.* — Br.: *the time of high water*; Fr.: *l'heure de la pleine mer*; It.: *ora dell'alta marea*; Nd.: *het uur van hoogwater, tijd van hoogwater* — is the instant at which high water occurs.

9. *Hochwasserstand* — Br.: *the height of high water (above datum)*; Fr.: *la hauteur de la pleine mer (au-dessus du zéro)*; It.: *quota dell'alta marea (sul piano di riferimento)*; Nd.: *hoogwaterstand (boven het vergelijkingsvlak)* — is the height of the water measured above or below a given plane of reference (datum) at the moment of high water.

10. *Niedrigwasser, N.W.* — Br.: *low water, L.W.*; Fr.: *la basse mer, B.M.*; It.:

(1) The Landesanstalt für Gewässerkunde und Hauptnivelements of Berlin uses the equally incorrect expressions *Tidehochwasser* and *Tideniedrigwasser* instead of the terms *Hochwasser* and *Niedrigwasser*. The addition of *Tide* or rather *Tiden* is superfluous seeing that both navigators and coastal people have no doubt whatever as to what should be understood by *Hochwasser* or *Niedrigwasser*; nor is it customary to use such additions in English and in Dutch.

bassa marea, B.M.; Nd.: laagwater, L.W. — is the lowest level between two tides as they pass from the fall to the rise or it is the instant at which this lowest level of the water is reached.

11. *Niedrigwasserzeit*, N.W.Z. — Br.: the time of low water; Fr.: l'heure de la basse mer; It.: ora della bassa marea; Nd.: het uur van laagwater, tijd van laagwater — is the instant at which low water occurs.

12. *Niedrigwasserstand* — Br.: the height of low water (above datum); Fr.: la hauteur de la basse mer (au-dessus du zéro); It.: quota della bassa marea (sul piano di riferimento); Nd.: laagwaterstand (boven het vergelijkingsvlak) — is the height of the water measured above or below a given plane of reference (datum) at the moment of low water.

It is in but few places that the tidal curve at the moment of high or low water is of such a shape that the exact moment of the occurrence of this phenomenon may be determined with accuracy. In most places, for some minutes before or after high or low water, it is scarcely possible to observe any vertical movement of the water. In some places the movement at the moment of high or of low water is barely perceptible even over quite a long period, whereas in certain other places a prolonged stand at the same level of the water may occur both between high water and low water and between low water and high water. As, in such cases, the tide remains stationary during a certain interval of time, the duration of this stand at the same level is designated by *Stillstand der Gezeit* — Br.: the stand of the tide; Fr.: l'étale de la marée; It.: la stanca; Nd.: stilstand van het getij — during high water by *Stillstand des Hochwassers* — Br.: high water stand; Fr.: étale de pleine mer; It.: stanca di alta marea; Nd.: duur van hoogwater — and during low water *Stillstand des Niedrigwassers* — Br.: low water stand; Fr.: étale de basse mer; It.: stanca di bassa marea; Nd.: duur van laagwater —. However, as the stand of the tide, or of high or of low water, is subject to considerable variations, no very great importance is generally attributed to it in giving a description of tides.

On the other hand, the stand at high water or low water is of importance in the determination of the time of high water or low water from tidal curves. When the rising portion and the falling portion of the tidal curve are of regular aspect near high and low water, the time of high and low water may be considered to be the time which corresponds to the middle of the stand. But when the two parts of the tidal curve are not symmetrical in the vicinity of high and low water, it is well to draw horizontal tangents to the tidal curve and then to determine the exact points of contact. One method for determining the point of contact with greater accuracy than can be done by eye is to draw a certain number of chords parallel to the tangent and to divide these in half; the dividing points will be found to lie on a curve which cuts the tidal curve at the point of contact of the tangent, i.e., at the time of high or low water.

13. *Stillstand der Gezeit* — Br.: the stand of the tide; Fr.: l'étale de la marée; It.: la stanca; Nd.: stilstand van het getij — is the interval during the movement of a tide during which no appreciable change in the level of the water occurs.

14. *Stillstand des Hochwassers* — Br.: high water stand; Fr.: étale de pleine mer; It.: stanca di alta marea; Nd.: duur van hoogwater — is the interval of time at high water during which the level of the water does not noticeably vary.

15. *Stillstand des Niedrigwassers* — Br.: low water stand; Fr.: étale de basse mer; It.: stanca di bassa marea; Nd.: duur van laagwater — is the interval of time at low water during which the level of the water does not noticeably vary.

The phenomenon of alternating rise and fall of the surface of the sea may be expressed either by the word *Gezeiten* or by the short expressions *Flut* — Br. not: flood, but: the rising tide; Fr. not: le flot, but: la marée montante, le flux, le montant; It.: il flusso; Nd.: vloed — and *Ebbe* — Br. not: ebb, but: the falling tide, Fr. not: le jusant, but: la marée descendante, le reflux, le perdant; It.: il riflusso; Nd.: eb —. In agreement with the definition of the word *Gezeiten* neither the horizontal movement of the liquid masses in reciprocating streams nor instants, as opposed to *Gezeiten*, should be designated by *Flut* and *Ebbe* (1). *Flut*, therefore, does not signify either high water or

(1) In unofficial calendars etc., data relative to tides are often to be found with the superscription *Flut* and *Ebbe*. In this case *Flut* has been used instead of *Eintritt der Flut* for the sake of brevity; this term consequently means *Niedrigwasser*. The word *Ebbe* is likewise inserted instead of *Eintritt der Ebbe*, and signifies *Hochwasser*. The indifferent use of the expressions *Flut* or *Hochwasser* and *Ebbe* or *Niedrigwasser* in many books should be suppressed in all circumstances.

low water and in the same way *Ebbe* does not mean either low water or high water.

The *Dauer des Steigens* or the *Flutdauer* — *Br.*: the duration of rise; *Fr.*: la durée de la montée; *It.*: la durata del flusso; *Nd.*: de duur van de stijging, de duur van den vloed — and the *Dauer des Fallens* or the *Ebbdauer* — *Br.*: the duration of fall; *Fr.*: la durée de la baisse; *It.*: la durata del riflusso; *Nd.*: de duur van de daling, de duur van de eb — indicate, as the expressions clearly show, the intervals of time during which the water rises or falls.

16. *Flut* — *Br.*: the rising tide; *Fr.*: la marée montante, le flux, le montant; *It.*: il flusso; *Nd.*: vloed — is the actual rising of the water from low water to the next high water.

17. *Ebbe* — *Br.*: the falling tide; *Fr.*: la marée descendante, le reflux, le perdant; *It.*: il riflusso; *Nd.*: eb — is the actual falling of the water from high water to the next low water.

18. *Dauer des Steigens* or *Flutdauer*, S.D. — *Br.*: the duration of rise; *Fr.*: la durée de la montée; *It.*: la durata del flusso; *Nd.*: de duur van de stijging, de duur van den vloed — is the interval of time between a low water and the next high water.

19. *Dauer des Fallens* or *Ebbdauer*, F.D. — *Br.*: the duration of fall; *Fr.*: la durée de la baisse; *It.*: la durata del riflusso; *Nd.*: de duur van de daling, de duur van de eb — is the interval of time between a high water and the following low water.

To describe a *Stand* of the water — *Br.*: sea level, the level of the sea; *Fr.*: le niveau de la mer; *It.*: il livello del mare; *Nd.*: waterstand — at any given moment, or at high water or low water, the term *Wasserstand* has been used above in opposition to the word *Höhe*, the use of which should be limited to water levels which are referred to a certain plane of reference. Whereas by *Wasserstand* — *Br.*: the height of the tide (above datum); *Fr.*: la hauteur du niveau (au-dessus du zéro); *It.*: quota del mare (sul piano di riferimento); *Nd.*: waterstand (boven het vergelijkingsvlak) — the elevation of the surface of the sea above any selected or given datum or else the fall of the water below such datum should be understood, the expression *Höhe* — *Br.*: height; *Fr.*: hauteur; *It.*: altezza; *Nd.*: hoogte — should be employed whenever it is necessary to express the altitude of the surface of the sea above a plane called *Kartennull* — *Br.*: chart datum; *Fr.*: zéro de la carte; *It.*: zero della carta, livello di riduzione degli scandagli; *Nd.*: reductievlak van de kaart — i.e., above the plane to which the depths given on charts are referred.

The use of the expression *Höhe* in the sense of elevation of the surface of the sea above chart datum is justified by the use of the same word to designate the elevation of a point on land above the plane of reference adopted for hypsometrical purposes, e.g., *über Normall-Null* — *Br.*: ordnance datum; *Fr.*: zéro du nivellement général; *It.*: zero della livellazione, zero dell'I.G.M.; *Nd.*: Normaal Amsterdamsch Peil, N.A.P. — The above designation has a corollary that:

The depth of the water at any given moment at a given place is equal to the data as to depth given on the chart increased by the height of the tide.

This rule, which has been applied for a long time in foreign countries, leads to the following definitions, but it should be specially noted, in this connection, that in British countries it is the custom to use the term *the rise* instead of the expression *the height of high water*.

20. *Kartennull*, K.N. — *Br.*: chart datum; *Fr.*: zéro de la carte; *It.*: zero della carta, livello di riduzione degli scandagli; *Nd.*: het reductievlak (van de kaart) — is the plane of reference to which all data as to depths on charts are referred.

Kartennull usually does not coincide with *Normal-Null* (N.N.).

21. *Höhe (der Gezeit)* — *Br.*: the height (of the tide); *Fr.*: la hauteur (de la marée); *It.*: l'altezza (della marea); *Nd.*: de hoogte (van het getij), getijhoogte — is the height of the water above or below the datum of the chart at any given moment.

22. *Hochwasserhöhe*, H.W.H. — *Br.*: the rise (of the tide), the height of high water; *Am.*: high water, the height of high water; *Fr.*: la hauteur de la pleine mer; *It.*: altezza dell'alta marea; *Nd.*: rijzing, de hoogte van hoogwater — is the height of the water above the datum of the chart at high water.

23. *Niedrigwasserhöhe*, N.W.H. — *Br.*: the height of low water; *Am.*: low water, the height of low water; *Fr.*: la hauteur de la basse mer; *It.*: altezza della bassa marea; *Nd.*: de hoogte van laagwater — is the height of the water above or below the datum of the chart at low water.

Consequently, it is possible to read off at any moment the heights of the tide and during the stand of the tide, the heights of high and low water on a tide-recording apparatus, the zero of which coincides with the datum of the chart, for example, on Harbour Tide Poles. If the zero does not coincide with the chart datum but with some other plane of reference, e.g., with the ordnance datum, the *Wasserstände* and, during the stand of the tide, the *Hoch-* or *Niedrigwasserstände* may be read off.

Since 1904 (1), to designate the *Wasserstandsunterschied* or the difference of altitude between high water and low water, the word *Tidenhub* — *Br.*: range; *Fr.*: amplitude, *marnage*; *It.*: *ampiezza della marea*; *Nd.*: *tijverschil* — has been used and this term is employed particularly to express the mean of the values of the vertical movements of the surface of the sea during a tide from one low water to the next high water and thence to the following low water. For the amplitude itself, on the other hand, since 1913 either the word *Tidenstieg* (when the vertical movement is from low water to high water), or the word *Tidenfall* (when it is desired to express the amount which the water has fallen between high and low water) are used.

24. *Tidenstieg*, T.S., is the amount that the water rises during the rising tide or the difference between the *Hochwasserstand* and the preceding *Niedrigwasserstand* or the difference between the *Hochwasserhöhe* and the preceding *Niedrigwasserhöhe*.

25. *Tidenfall*, T.F., is amount of the fall of the water during the falling tide or the difference between the *Hochwasserstand* and the following *Niedrigwasserstand* or the difference between the *Hochwasserhöhe* and the following *Niedrigwasserhöhe*.

26. *Tidenhub*, T.H. — *Br.*: range; *Fr.*: amplitude, *marnage*; *I.*: *ampiezza della marea*; *Nd.*: *tijverschil* — is the arithmetic mean between the *Tidenstieg* and the *Tidenfall* of a tide.



(1) In old works, the expressions *Flut*, *Fluthöhe*, *Fluthub*, *Flutwechsel*, *Gezeitenhub*, *Grösse des Fluthubs*, *Höhe der Flut*, *Höhe der Gezeit*, *Hub*, *Hubhöhe* are used.