

# **The Position of Hydrography in a System of Sciences – A Comprehensive Definition and Systematic Subdivision of the Discipline**

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**Key words:** hydrography, definition, lexicography, terminology theory, term, concept, system of sciences, philosophy of science

## **SUMMARY**

What is hydrography? – Experts shouldn't have problems to answer this question. However, when they are asked to write down their definition, the difficulties begin. Looking at the recently published definition of the IHO one can see the trouble it makes to define the concept comprehensively. In this definition from the year 2009, a modern understanding of the concept of hydrography is expressed. However, it does not meet the requirements on a definition the lexicographers have. The majority of the definitions that have been written by hydrographers have this flaw. But professional lexicographers don't do better. The definitions of hydrography formulated by them, as they are presented in dictionaries and encyclopaedias, don't describe the concept that hydrographers have of their discipline. The published definitions therefore have either formal shortcomings or mistakes in terms of content.

The aim of this study was to define the concept of hydrography comprehensively and vividly and in compliance with the formal lexicographic criteria. First, the terms 'Hydrographie' and 'hydrography' were examined with linguistic (and semiotic) methods in German-British comparison. Over the decades, the German term 'Hydrographie' has acquired 18 different meanings. One of the 18 concepts denominated with the same (homonymous) term represents hydrography in the sense of a science. It is precisely this concept of hydrography that then was differentiated from other concepts with the help of an investigation according to the philosophy of science and with terminological proceedings. After an extensive evaluation of hydrographic literature, it was finally possible to sharpen the concept of hydrography and to insert it into a conceptual system. From the position in the conceptual system then the position of hydrography in the system of sciences could be derived.

One finding of the study is that there is a unified international and intercultural understanding of the concept of hydrography among experts. This understanding is captured in a new and comprehensive definition. An essential feature of this definition is the systematic process-oriented subdivision of the discipline and a clear naming of the object of investigation to illustrate the hydrographic activities. The definition does not describe the lowest common denominator, or a consensus, but the broadest concept. With this it is possible that each hydrographer can find himself in the definition, even if his own hydrographic work has a smaller scope. With the presentation of this globally valid understanding of the concept this work helps to enable an unambiguous technical language communication across national borders. At the same time it allows an effective communication to non-specialists.

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## 1. INTRODUCTION

The concept of hydrography is subject to constant change. The science continues to develop, its methods develop further, the view on the object of investigation changes, the objective is formulated differently. Someone who uses the term ‘hydrography’ today means most likely something different than he did 20 years ago when he used this term too. Perhaps he is even aware of it.

But actually, is there a guarantee that speakers and listeners have the same concept of hydrography? That the two parties share the same idea of hydrography? Unfortunately, no.

Why is that? Why could technical communication fail?

The main reason is that the concept of hydrography is indeed defined – for example, in general language encyclopaedias, technical dictionaries and standards –, but that these definitions do not always express the same thing, they are even contradictory in main aspects. It is certainly the fact that it is not mentioned in conversation, to which definition one refers (which implies, too, that this definition is known). But it could also be because the definitions – especially if they have been written by experts in hydrography – do not meet the requirements that lexicographers have on a definition. To make matters worse, very few definitions are clear and vivid. Finally, it plays a role that the term ‘hydrography’ does not only denote the scientific discipline, but the term can take at least ten more different common meanings. Therefore there is the need to present an up-to-date definition.

## 2. LINGUISTIC PRINCIPLES

For the understanding of this study it is necessary to distinguish between *concept* and *term* as the terminologists do.

An object is not directly named. Only once one has an understanding of the object, thus has an idea of how the object is constructed and how it can be used, one can define the concept and name the object with a term (cf. Duden 2006, p. 1146). One and the same object can be named with different (synonymous) terms

While a term, a linguistic expression, is what one can write, read, or hear, the concept is a thinking unit, an idea that is connected with a term (cf. Schmitt 2008, p. 40). So one can hear or read terms, repeat them even without understanding them; in this case one has no idea, no concept of these terms. Now, if two parties do not combine the same concepts with the terms that they use, significant communication problems can result, perhaps without noticing them at first.

When exploring a concept also its term must be examined, i.e., its string. What message does the string ‘hydrography’ communicate to one who encounters the term for the first time?

Semiotics provides answers to this question.

Language is a system of signs. The individual signs transmit information. Semiotics deals with the signs as a means of communication. It examines the signs as to their use and interpretation. The term 'hydrography' is a sign, too. With a semiotic investigation it is possible to explore which ideas – associations and connotations – are linked to this sign. Findings from this semiotic analysis must be included in the definition. However, all other terms that are used in the definition, must be examined for their suitability. Only terms that express clearly what is meant, are allowed to be used.

In order to define a concept correctly, it is necessary to distinguish it from other concepts. Terminologists therefore create a conceptual system and determine the position of a concept within this conceptual system. This procedure is also suitable to find the position of hydrography in a system of sciences. For this purpose it is necessary to determine the exact relationship between hydrography and other sciences, like hydrology and oceanography, geography and cartography, bathymetry and meteorology.

### 3. DEMANDS ON A DEFINITION

According to a German DIN standard of terminology theory, “a definition describes a concept by linguistic means” (DIN 2342, 2004, transl.). As in a mathematical equation, with a definition there is the attempt to establish a clear link between concept and term. On the left side of the equation there is “the concept expressed by the term, the definiendum (which is to be defined)”; on the right side there is “the (substantial) description of the concept, the definiens (which is used to define something)” (Schaeder 2007, chap. 5.3, transl.).

There are different types of definitions. The main variants are the content definition, the scope definition and the inventory definition (cf. *ibid.*, chap. 5.4).

In a *content definition* a concept is defined by the indication of its hypernym and by stating the specific (distinctive) features.

With a *scope definition* a concept is defined by the complete list of its hyponyms (on the same subdivision level). Three scope definitions can be distinguished: Listing all hyponyms on the same level; listing individual concepts; specifying the rules, how the list may be obtained.

An *inventory definition* defines a concept by listing the hyponyms (on different subdivision levels).

It is desirable to use common language for a definition, so that it can be understood what is expressed by a term (cf. Schierholz 2003, p. 12). In addition, auxiliaries may be used which – contrary to the DIN definition – are allowed to be of non-linguistic nature, such as pictures, drawings, symbols or formulas (cf. Schaeder 2007, chap. 5.5).

Despite the knowledge of the fundamental demands on various definitions, one would still run the risk of making mistakes. There are five typical different types of poor definitions (according to Schaeder 2007, chap. 6).

In a *circular definition* the definiendum is used in whole or in part as definiens.

A *too broad definition* lacks either qualifying characteristics, or the qualifying characteristics also apply to objects that are to be excluded with this definition.

A *too narrow definition* has qualifying characteristics which exclude objects that are part of the concept which is to be defined.

In a *negative definition* the definiens is a negation of the definiendum in whole or in part.

In a *redundancy-afflicted definition* characteristics are explicated, explained by examples or repeated in concept ladders.

#### 4. ONE TERM – ELEVEN CONCEPTS

After an extensive consultation of German and English encyclopaedias and general language dictionaries as well as after a wide-ranging literature review – also of non-hydrographic literature – eleven now common concepts were identified, all denominated with the (homonymous) term ‘hydrography’.

In addition, some obsolete meanings were found, and concepts that are falsely denominated by the term. A total of 18 different concepts were identified.

In a technical language dictionary eleven current meanings could be included.

**hydro•gra•phy** -ies, | hī'drāgrəfē | noun,

**1** no pl., science of surveying of bodies of water and waters-related information;

**2** no pl., **a)** depth measurement of waters (esp. of oceans), bathymetry; **b)** surveying of bodies of water;

**3** no pl., **a)** descriptive hydrology; **b)** characteristic features of bodies of water, descriptive set of waters-related data and information;

**4** no pl., (register of the) totality of the waters in an area, waters index;

**5** no pl., **a)** map element; **b)** cartographic depiction of waters;

**6** shape of the bottom of a water, topography covered by water, morphology;

**7 a)** no pl., art technique; **b)** artwork.

#### 5. KNOWN DEFINITIONS

At this point only hydrography in the first meaning is of interest. For this concept it is important to find an appropriate definition. Therefore known definitions that have been written by experts, are presented and discussed.

##### 5.1 Definition produced by the IHO

In 1994 the International Hydrographic Organization (IHO) has published a definition of hydrography in the fifth edition of the *Hydrographic Dictionary*.

“That branch of applied science which deals with the measurement and description of the physical features of the navigable portion of the EARTH’s surface and adjoining coastal

areas, with special reference to their use for the purpose of NAVIGATION” (IHO 1994, p. 108).

According to former opinion navigable surface waters were the object of investigation of hydrography. If we would not notice the addition “adjoining coastal areas”, we might think that also navigable lakes and rivers belong to these waters. But the term ‘coastal’ (belonging to the coast) reveals the sole reference to the sea. It is all about the seas and the adjacent coastal zones (‘coastal areas’) – not including the shorelines of lakes and rivers. The emphasis is on the use of hydrography for navigation.

In the same technical dictionary also the term ‘hydrographic survey’ is listed (under the lemma ‘survey: hydrographic’):

“A SURVEY having for its principal purpose the determination of DATA relating to bodies of water. A hydrographic survey may consist of the determination of one or several of the following classes of DATA: DEPTH of water; configuration and NATURE OF THE BOTTOM; directions and force of CURRENTS; HEIGHTS and TIMES of TIDES and water stages; and location of topographic features and fixed objects for survey and navigation purposes” (IHO 1994, p. 237).

This definition is remarkable because it fleshes out the abstract formulation of “measurement and description of the physical features” from the first definition. Suddenly, one can imagine something and has a picture in mind.

For some years the *Hydrographic Dictionary* has not only been available in conventional output format (as a printed book or as a PDF document), but it is also accessible online via a database. There is still no newer version of this technical dictionary, the definition of ‘hydrography’, however, is updated in the database since January 2010. It is the definition that has been approved on June 2, 2009 at the 4th Extraordinary International Hydrographic Conference in Monaco:

“Hydrography is the branch of applied sciences which deals with the measurement and description of the physical features of oceans, seas, coastal areas, lakes and rivers, as well as with the prediction of their change over time, for the primary purpose of safety of navigation and in support of all other marine activities, including economic development, security and defence, scientific research, and environmental protection” (IHO 2010; cf. IHO 2009, p. 38).

Both definitions have an equal or similar wording. One can literally feel the efforts for development and how someone has tried hard at the wording. While the definition from the year 1994 refers solely to the navigable part of the sea (keyword: “adjoining coastal areas”), nowadays all major bodies of water are included. But also other extensions have been added. In previous times only the actual condition of waters was described according to the metrological detection of the physical properties, today also the change over time plays a role. According to the definition it is not about the comparison between a previous state and the current state, but it is about the prediction of a future state. But the special importance for

navigation is still emphasised – “for the primary purpose”. In an incomplete list – “including” – also other purposes are mentioned.

In the period between 1994 and 2009 a further definition circulated which was slightly modified and expanded compared with the first one and which is still cited today (e.g., slightly wrong, in Wikipedia 2010):

“Hydrography is that branch of applied sciences which deals with the measurement and description of the features of the sea and coastal areas for the primary purpose of navigation and all other marine purposes and activities including (inter alia) offshore activities, research, protection of the marine environment and prediction services” (IHO 2009, p. 38 and p. 153).

According to this definition hydrography exclusively deals with the sea and coastal areas. But anyhow hydrography was not anymore exclusively there for navigation, but was also required for other purposes, which were listed only as examples. A good example to understand the further development of the definition are the prediction services. While beforehand the predictions only belong to the additional purposes – “other marine purposes” – and were called in the last place, they are much more put into focus in the recent definition. Nowadays hydrography not only serves for the purpose of predictions, but in the mean time the predictions are part of hydrography.

Prior to the 4th Extraordinary International Hydrographic Conference in Monaco this second definition was the basis for the third, the newly proposed definition. A working group of the IHO, the IHO Strategic Plan Working Group (ISPWG), had decided to improve the existing definition. The working group submitted a proposal which differed only in one detail from that definition accepted later. The phrase “prediction of their change over time” was preceded by the phrase “prediction of their evolution” (cf. IHO 2009, p. 153). This rewording was a result of a consultation with the Committee on the Hydrographic Dictionary (CHD). The proposal found in this way was submitted to the IHO Member States for approval. The final version of the definition was forwarded to the chairman of the Hydrographic Dictionary Working Group (HDWG) to include it in the *Hydrographic Dictionary* (cf. *ibid.*, p. 153).

## 5.2 Definition produced by the UN

In December 1977 a group of experts of the United Nations (UN) has discussed a definition of hydrography (cf. UN 1978, p. 67). This definition published in 1978 in English gained wide recognition and is still cited today. It is therefore worthwhile to have a closer look at this old definition

“Hydrography may be defined as the science of measuring and depicting those parameters that are necessary to describe the precise nature and configuration of the sea-bed, its geographical relationship to the landmass, and the characteristics and dynamics of the sea. The parameters encompass bathymetry, geology, geophysics, tides, currents, waves and certain other physical properties of sea water” (UN 1978, p. 67).

In Germany, the influence of this definition holds to this day. It all started when Peter Andree presented his German translation of this definition in 1984 on the 16th DVW-seminar (and first German Hydrographic Conference) “Introduction to Hydrography”. He translated the second sentence very freely, went away from the original text, restructured the sentence and expanded the statement. Only the first sentence is presented here:

“Die Hydrographie ist die Wissenschaft von der Messung und Beschreibung jener Parameter, die zur Darstellung der genauen Beschaffenheit und Gestalt der Sohle von Ozeanen, Meeren und anderen Gezeitengewässern, ihrer geographischen Beziehungen zum Landkörper sowie der charakteristischen Eigenschaften und Kräftespiele der Gewässer notwendig sind” (Andree 1984, p. 3).

A formulation that is obviously strongly related to Andree’s translation can be found, for example, on the web sites of the German Hydrographic Society (DHyG), or on Wikipedia.

“Die Hydrographie ist ‘die Wissenschaft und Praxis der Messung und Darstellung der Parameter, die notwendig sind, um die Beschaffenheit und Gestalt des Bodens der Gewässer, ihre Beziehung zum festen Land und den Zustand und die Dynamik der Gewässer zu beschreiben’” (DHyG 2006; identical Wikipedia 2010).

Both sources explicitly refer to the definition from the year 1978. In fact, it should say that it is a modification of the UN definition. Because details are different. Most important regarding to the content is the expansion to all waters. Striking is also the fact that ‘science’ (‘Wissenschaft’) is completed with ‘practice’ (‘Praxis’) – it also could have been a ‘practical science’ or an ‘applied science’ (like in the IHO definition).

The German sentence also includes grammatical mistakes. It is not clear what is meant with the phrase “Beschaffenheit und Gestalt des Bodens der Gewässer” (nature and configuration of the bottom of waters). There could be two meanings: first, the nature of the bottom (i.e., the material) and the configuration of the bottom (i.e., the shape). Secondly, the nature of the waters and the shape of the bottom.

And also the phrase “ihre Beziehungen zum festen Land” (their relationships to the mainland) is used incorrectly because it does not refer to the waters as it is intended (and as it is in the English original), but the phrase refers to the parameters.

The sentence is only purportedly designed accurately; mainly it is formulated very abstractly. Therefore, there are doubts that everyone understands it right away. Above all, a non-specialist might have difficulties.

Most important is the fact that the definiens of exactly this formulation reappears in the draft standard *DIN 18709-3* from the year 2007 (DIN 18709-3, 2007, p. 4). It is to state that the definition published by the UN in 1978 for first time has made its way into the DIN standard from 2007 with some genetic reproductions. The evolution cannot be denied.

When people talk about the UN definition of 1978, usually only the first two sentences are taken into account (sometimes even only the first sentence is quoted). But the explanations go further. Overall, the chapter “What is Hydrography?” is divided into three paragraphs (§§ 11–

13). The two previously quoted sentences are from § 11; two more sentences follow. But even more interesting is the entire § 12, in which is shown that hydrography can be divided into three areas:

“In general, there are three aspects of hydrography: coastal, off-shore, and oceanic. Coastal hydrography is concerned with the development of ports and harbours, coastal erosion problems, the utilization of harbour and coastal conservation services and, especially, the safety of navigation in coastal waters. Off-shore hydrography is concerned with (a) the provision of hydrographic data as an extension of the coastal zone normally encompassing the continental shelf, (b) the development of mineral deposits, including hydrocarbons, and (c) provision of data for fisheries management. Oceanic hydrography is concerned with the acquisition of hydrographic data in the deep ocean areas for the depiction of sea-floor geomorphology. Hydrographic data collection is inevitably a slow and systematic process, as well as being expensive, and applies in varying degrees to the three aspects described above” (UN 1978, p. 68).

Eventually, in these sentences the object of investigation is clarified and somewhat illustrated. According to this explanation, firstly, hydrography is concerned with coastal waters, secondly, with off-shore waters, and thirdly, with the deep sea. The waters of the mainland remain entirely unmentioned.

The definition of 1978 has proven to be long-lasting, but the UN have written a new one. In a more recent publication – in a *Training Manual* from 2006 – the following new definition is printed:

“Hydrography is the discipline dedicated to describe the precise nature and configuration of the sea-bed, its geographical relationship [to] the land mass and the characteristics and dynamics of the sea.

It is the total set of spatial data and information and the applied science of its acquisition, maintaining and processing, necessary to describe the topographical, physical and dynamic nature of the hydrosphere and its borders to the solid earth, and the associated facilities and structures” (UN 2006, p. III-2).

Fundamental things have changed in this definition. Hydrography is no longer just simply the “science of measuring and depicting”, but at first a “discipline” that turned to an “applied science of its acquisition, maintaining and processing” in the next paragraph. But ‘hydrography’ is not only regarded as a scientific discipline, but the term also denotes “the total set of spatial data and information”.

It is nothing new that the term ‘hydrography’ has several meanings. At this point one can also not be surprised about the new meaning and its intention. But nevertheless it has to be noted that hydrography does not refer to “the total set of spatial data and information”, but only to ‘the total set of *aquatic* data and information’.

A real violation of lexicographical principles, however, is that there are two definiens in only one definition. This is a disaster in respect to terminology theory and mathematics. Because it expresses that hydrography is both a first object and a second object at the same

time. But the first object is not equal to the second object. This contradiction cannot be resolved logically, but in fact it exists. It is therefore a purely descriptive double definition.

### 5.3 Definition produced by the NOAA

The National Oceanic and Atmospheric Administration (NOAA) provides a somewhat different view on hydrography in the fourth edition of the *Hydrographic Manual*. Unlike the IHO or the UN the NOAA subsumes hydrography not generally under the applied sciences:

“Hydrography is that branch of physical oceanography dealing with the measurement and definition of the configuration of the bottoms and adjacent land areas of oceans, lakes, rivers, harbors, and other water forms on Earth. Hydrographic surveying in the strict sense is defined merely as the surveying of a water area; however, in modern usage it may include a wide variety of other objectives such as measurements of tides, currents, gravity, Earth magnetism, and determinations of the physical and chemical properties of water” (Umbach 1976/1982, p. 1-3).

It is unfamiliar and it does not meet the expectations according to the previous studies that hydrography is presented here as a “branch of physical oceanography”. Such an assignment remains an exception. According to general understanding oceanography deals with the oceans and the sea – the name says it all. All the more arbitrary seems the assignment of hydrography to oceanography, because only a few words later also the lakes, rivers and other bodies of water are mentioned.

As puzzled and illogical the assignment to oceanography is, as advanced is the opinion expressed in 1976 to take into account all waters. At that time, the IHO and the UN were far from such a way of consideration. However, this view has not been reflected in each NOAA publication.

It is due to a balancing act that almost everyone involved can find himself in this formulation – although it does not meet the strict criteria of a definition. Only the conceptual distinction between a “strict sense” and a “modern usage” of the term makes that possible. But that is exactly the main point of criticism: It might be historically well founded and quite common in science to differentiate in such a way. From a terminological point of view, however, it must be realised that it is dealt with two different concepts. Two concepts, however, also require two separate definitions. A mixture is not permitted.

Positive is the illustrative list of parameters to be measured, which explicitly includes the “chemical properties” in this definition.

### 5.4 Definition produced by Horst Hecht

Horst Hecht, Director of the Department “Nautical Hydrography” at the Federal Maritime and Hydrographic Agency (BSH) until 2008, held a presentation on “The Digital Hydrographic Office – Challenges and Prospects of Hydrography in the Evolving Geographic Information

Infrastructure” at the U.S. Hydrographic Conference in May 2001 (Hecht 2001). In view of the emerging information age Hecht considered it as necessary to revise the definition of hydrography.

Knowing the definition in the *Hydrographic Dictionary*, in which the relevance for navigation is explicitly expressed, Hecht noted that the “navigation-related services” without doubt “will remain a core business for Hydrographic Offices” (ibid., p. 8). At the same time he raised the question whether hydrographic offices do not have to face other demands in the long term. In view of the technological developments – more accurate positioning and improved communications and computer techniques make data collection and processing more efficient – Hecht predicted the opening of new markets. The exploration of the continental shelf – keywords are offshore technology, fish farms and wind energy – “requires extensive knowledge of the sea floor and the dynamics of the water body, and even its biology” (ibid., p. 8).

Even the UN definition of 1978 is not good enough. It states that hydrography is the science »of measuring and depicting«. Hecht is bothered by the term ‘depicting’. According to Hecht this term only refers to the cartographic representation, what was nearly the only way in 1978 to make the data available to the users. Therefore, Hecht suggested to replace “measuring and depicting” by “measuring and processing”. This is also similar to the United Nations Convention on the Law of the Sea (article 277), where it says: “acquisition and processing of marine scientific and technological data and information” (UNCLOS 1982, p. 128). For Hecht this reference to the “data and information” seemed to be much more suitable to describe the core of hydrography today and in future – not least because the maintenance of databases and the keeping of information systems is becoming increasingly important. Due to the multiple possibilities of use in many cases databases are more important as the products derived from them. Anyway there is a clearly discernible trend towards digital data that can be searched on the Internet. Hecht therefore recognises: “Hydrographic information is the true asset owned by HOs” (Hecht 2001, p. 9). He went even further, by putting the intention linked to a “Global Spatial Data Infrastructure” in the following words: “Accurate and up-to-date, high resolution geographic information will be readily available from anywhere on the globe (land, sea) and for any purpose” (ibid., p. 11). Today, when “The Digital Earth” (ibid., p. 9) already exists as a virtual image of the planet and has found a prominent representation with Google Earth, we are apparently on the right track.

Although representative of the BSH, the German Hydrographic Office, and thus responsible for the sea, Hecht also directed his gaze on the land and on inland waters. Consequently, he criticised the traditional limitation of hydrography to the “marine hydrosphere”. Also inland waters such as rivers and lakes should have been considered. Because no significant differences exist regarding the data on waters, or in terms of techniques and methods by which the data are gathered. Therefore the regard to “the hydrosphere in general” would be more reasonable. These considerations were the basis for the following approach for a new definition:

“Hydrography is the total set of spatial data and information, and the applied science of its acquisition, maintaining and processing, necessary to describe the topographical, physical

and dynamical nature of the hydrosphere and its borders to the solid earth, and the associated facilities and structures” (Hecht 2001, p. 9).

In his clear-sighted and visionary contribution Hecht draw an unattained and progressive image of hydrography. This fact probably was the reason for including this definition verbatim (except for one tiny change) in the *Training Manual* of the UN four years later (UN 2006, p. III-2).

Hecht’s definition has been quoted and commented by several authors. Obviously, especially David Monahan liked it very much. Already in 2003 he dealt with it in a speech to the centenary of GEBCO (Monahan 2003, p. 3). At the U.S. Hydrographic Conference in 2005 he saw a lot of changes that have affected hydrography in recent times. On the one hand he named – without explicitly making this distinction – technical changes that have affected data collection, on the other hand he named changes that affect the distribution of data and information. Charts are no longer hand-drawn, but computer-generated, and the Internet has considerable influence on the communication and information channels. Geographic information is available on the Internet. Monahan’s conclusion: “As we all are very well aware, the role of Hydrography continuously changes” (Monahan et al. 2005, p. 5.). He subsequently mentioned Hecht’s proposal for a new definition.

But then something unexpected happened. He added the widely unknown subdivision of the UN from the year 1978 to this modern definition with the explanation: “It is normal to subdivide this ‘total set’ into sub categories” (ibid., p. 5). Useful is the subdivision in “Coastal hydrography”, “Off-shore hydrography” and “Oceanic hydrography” (ibid, pp. 5–6).

Probably, this approach deliberately ignores the fact that hydrography has expanded to all waters a long time ago. This focused view is understandable since the actual topic of the lecture was the GEBCO Training Program of the Nippon Foundation. As is generally known the General Bathymetric Chart of the Oceans (GEBCO) shows only the ocean floor. The remarkable thing is Monahan’s request for a subdivision, obviously to better work out the object of investigation.

## 5.5 Critical analysis of the definitions

The criticism of the examined definitions refers to both the content and the form.

In the project to define hydrography as a science a content definition, a scope definition and an inventory definition might be used in combination.

A content definition would be suitable to indicate to what kind of science hydrography belongs. Most of the definitions do not take this assignment according to philosophy of science into consideration. Only the NOAA assigned hydrography to oceanography (Umbach 1976/1982, p. 1-3).

A scope definition would be suitable to indicate which bodies of water are being investigated by hydrography. For this, all hyponyms of the same subdivision level are listed, for example, oceans, rivers and lakes. If other waters are to be included, it would be advisable to choose the common hypernym. ‘Waters’ – respectively ‘Gewässer’ (as in DHyG 2006) –, or ‘hydrosphere’ (as in Hecht 2001, p. 9), however, would be too general, because they

include the groundwater. ‘Tidal waters’ – respectively ‘Gezeitengewässer’ (as in the expanded translation of the UN definition of 1978, e.g., Andree 1984, p. 3) would be too restrictive, however, because only with a lot of subtleness also coastal river sections and larger lakes are taken into account in which tide has a measurable impact on the water level. ‘Surface waters’ or ‘all standing and running waters’ would be more reasonable. In fact, usually an inventory definition is done by listing hyponyms of different subdivision levels, for example, “oceans, seas, coastal areas, lakes and rivers” (IHO 2009, p. 38), where the “coastal areas” step out of line.

An inventory definition would be suitable to indicate the different kinds of data collected by hydrography. Since you cannot list all the kinds of data, and not all data are equally relevant, it would be just the right thing to have a list that focuses on a key selection. However, there are different opinions: They range from simple “physical features” (IHO 2009, p. 38) up to data “necessary to describe the topographical, physical and dynamical nature” (Hecht 2001, p. 9) up to “chemical properties” (Umbach 1976/1982, p. 1-3). In particular, one cannot understand the term ‘physical’ in this context without further explanation.

It would be quite appropriate to list the various physical parameters gathered in an inventory definition – even at the risk to distribute redundant information if it was already given at another place. Since the new definition of hydrography should stand on its own and should be understandable without further explanation, a possible redundancy must be accepted.

An inventory definition would also be suitable to indicate the goals of hydrography, its purposes and the areas it is useful for. In its infancy, this is done in the IHO definition which states: “in support of all other marine activities, including economic development, security and defence, scientific research, and environmental protection” (IHO 2009, p. 38). In this case, however, the inventory definition was not successful because the expression ‘all other marine activities’ is too general and only specified by little more concrete terms. On the contrary, these are only keywords that are hardly suited to illustrate the inventory. What is the contribution of hydrography to economic development? What exactly has hydrography to do with security and defence? What does the scientific research consists of? And how does hydrography protect the environment? – All these questions are not answered by the definition, on the contrary, the definition raises further questions.

The attempt to get all interests under one roof by using hypernyms which are broad, keyword-like and vague, is not supposed to be successful. By such an approach the intention to come to a more concrete definition is thwarted. A more elegant solution is therefore needed.

Selected examples shall illustrate the criticism on the discussed definitions. Typical errors were made.

A definition is too narrow if only the sea is named as the object of investigation; a definition is too broad if all the waters are called, including the groundwater which is not examined by hydrography. A subsequent reduction like “all waters, except the groundwater” would lead to a negative definition. A definition is also too narrow if the examination of the chemical properties of the water is not mentioned, or if hydrography is presented only as a service for navigation. A definition is too broad if the ‘acquisition of physical parameters’ is

mentioned in a too general way. Much more can be suspected or understood under ‘physical parameters’ than it is intended. The attempt to identify only the relevant subset of the physical parameters by talking about the ‘acquisition of hydrographic parameters’, which at the same time would be a distinction to the oceanographic parameters, would cause a circular definition. It is both too narrow and too broad if hydrography is presented as a part of the applied sciences, and it only seems to be a clarification. It is too narrow because it excludes the theoretical shares which are without any doubt included in hydrography. It is too broad because the applied sciences are a broad field, and the discipline has to be specified.

In addition to these formal lexicographic errors we have also discovered substantive gaps. For example, in some definitions the cartographic representation is not even mentioned. In the IHO definition it is only to be guessed from the term ‘depicting’ (IHO 2009, p. 38), in Hecht’s definition in which the term ‘processing’ is used it is not longer recognisable (Hecht 2001, p. 9; UN 2006, p. III-2). In 2009 the IHO considered the temporal component for the first time, by mentioning the prediction of the physical properties of the waters. This probably refers to the predictable tidal water level changes, but also to the foreseeable short-term water level changes through the influence of the weather. The epistemologically interesting comparison of several states over time, as it is expressed, for example, in the change of the ground relief by the migration of ripples remains unmentioned. By observing the states in regular time intervals a statement about a future state can be derived by extrapolation with a certain probability.

In summary, it is to say that aspects missing in some definitions are contained in other definitions. All definitions taken together make up a largely complete picture.

## 6. CLARITY BY SUBDIVISION

David Monahan has recognised it correctly: with his efforts to subdivide the totality of hydrography, he wanted to illustrate the definition of Horst Hecht. Since with a concise definition of hydrography not all has been said by a long shot. A systematic subdivision makes sense. This is also in keeping with a scope definition, in which all hyponyms are listed. A better idea is obtained only when one considers the system (systematic structure) of a subject. Only the subdivision makes a scientifically accurate – and therefore necessarily abstract – definition clear and vivid. There are three main reasons for a systematic subdivision (cf. Kohlstock 1997, pp. 172–173):

- Non-specialists – such as prospective students – will get a framework which makes clear the coherent whole of hydrography to them, regardless of individual keyword-like focuses as they are about to find in a timetable of lectures, which mostly lists specialists disciplines.
- Relatives of the field – such as representatives of adjacent specialist fields – develop a better understanding of hydrography by getting shown the purpose-driven target and by this they acknowledge the necessity of the activities.
- Professional members wide their perspective and, despite their specialisation in professional life, do not lose the insight into the connections, so they avoid considering questions in isolation and acquire instead interdisciplinary insights.

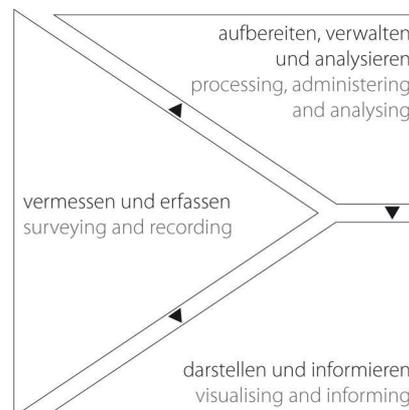
There are different ways to subdivide a science. Kohlstock has investigated the suitability of a subdivision according to areas of activity, branches, application aspects and specialised disciplines (cf. *ibid.*, pp. 151–152). Instead, Buschmann suggests subdivisions into branches, according to means of knowledge and objects of investigation (cf. Buschmann 2001, p. 287). Not all types are suitable. The aim must be to develop an equally complete, clear and vivid subdivision. Therefore a subdivision into different areas of activity could be used. But also a subdivision into process steps is promising. But particularly clear could be a subdivision according to the object of investigation.

A definition is clear and vivid, however, only if one uses vivid language and terms that are connected with clear images. All abstract terms must be avoided. And also terms that are not understandable without using a dictionary.

## 7. A NEW DEFINITION

Hydrography is a branch of the science of surveying and geoinformation. It investigates the surface waters of the earth and collects the related data and information. Its goal is to expand the knowledge of waters in order to use them responsibly and safely and to protect the habitat. The practical engineering and geoscientific work is divided into three main fields of activity:

1. Surveying of waters, and recording of aquatic data;
2. Processing of the data, administering the data in information systems, and analysing the total set of data;
3. Visualising the waters on charts and in information systems, and informing about the waters.

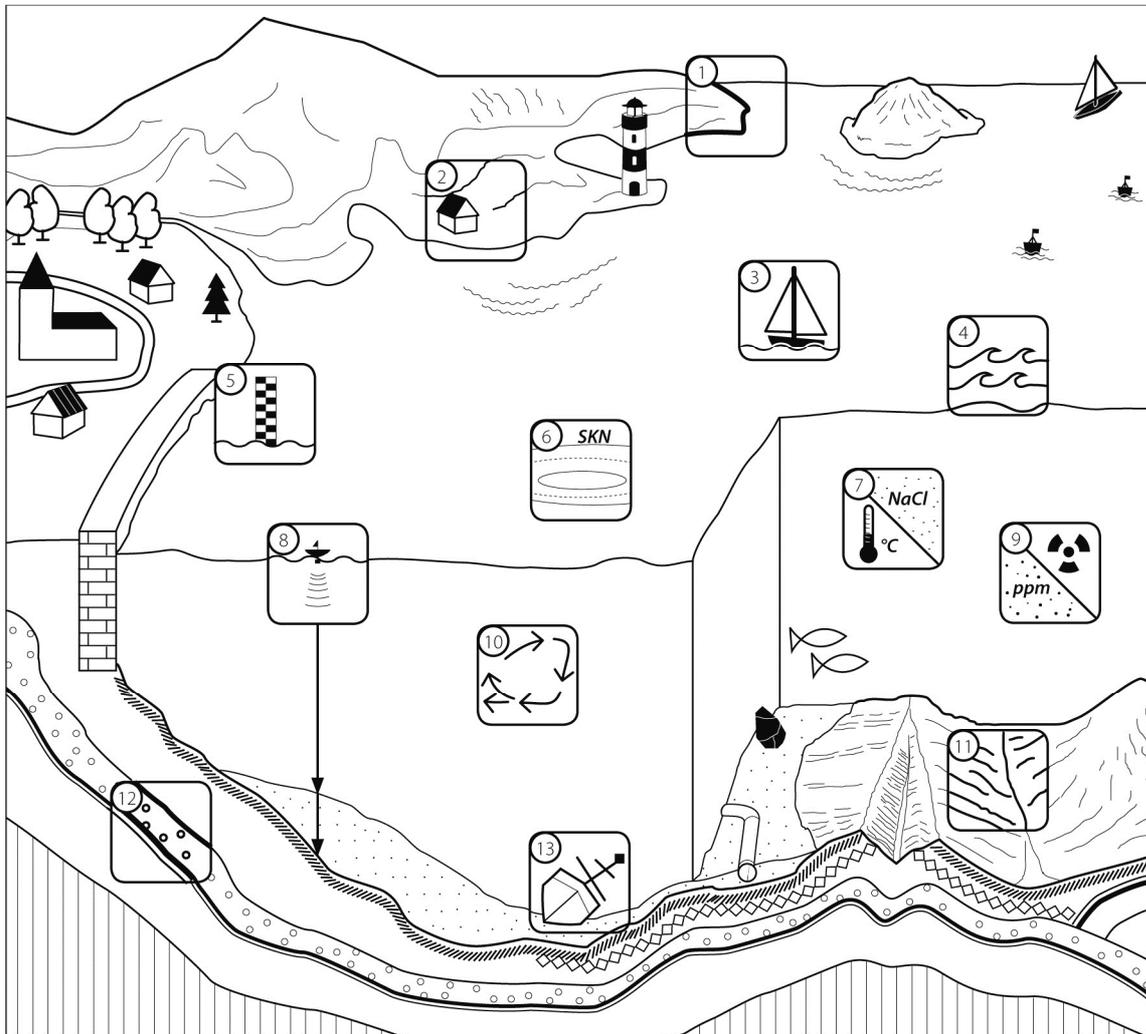


After the examination of a surface water hydrography provides information about its current state and about past and future changes.

It makes statements about:

- the water depths in relation to a reference horizon,
- the positions of shoals,
- the positions of magnetic anomalies,
- the shape and structure of the bottom,
- the material composition of the bottom,

- the structure of the deeper soil layers,
- the location of deposits,
- the uniform change of the water level (tides),
- the short-term and long-term change of the water level (storm surge, sea level rise),
- the height profile of the water surface (orthometric height),
- the characteristics of waves,
- the characteristics of currents,
- individual parameters of the water column (temperature, salinity),
- the structure of the water body,
- the water quality (particle concentration, radioactivity),
- the natural and artificial objects in and on the waters,
- the traffic situation on the waters,
- the course of the water's limit,
- the course of boundaries within the waters,
- the nature of the adjacent land strip (coastal zone resp. shoreline).



Object of investigation of hydrography

1. Course of the water's limit
2. Nature of the adjacent land strip (coastal zone resp. shoreline)
3. Traffic situation on waters
4. Characteristics of waves
5. Water level
6. Height profile of the water's surface (orthometric height)
7. Individual parameters of the water column (temperature, salinity)
8. Water depths
9. Water quality (particle concentration, radioactivity)
10. Characteristics of currents
11. Nature of the bottom
12. Structure of the deeper soil layers
13. Natural and artificial objects in and on the waters

## 8. RÉSUMÉ

Many scientists like to use the term 'hydrography', but in fact they all mean something different. Often, a scientist delineates a concept in another way than his colleagues. As a consequence, with the denomination 'hydrography' for this concept everybody wants to create a different conception by the audience. But this is not clear when they all use the same term. In technical communication, it is therefore necessary to make clear in which sense the term is used.

Starting from a clear definition of hydrography, which meets all criteria for a definition, it is then easier for a scientist or another person using the language to make clear in what sense he uses the term 'hydrography'. For this he simply needs to work out the difference between the definition and his own understanding of the concept.

Another reason for a proper definition is the intercultural aspect. For example, when hydrography shall be exported to other countries in the context of development assistance and capacity building. In these countries hydrography is still unknown and there are therefore no terms in national languages for it. In such a case, a definition makes it possible to evoke a clear idea – and to create a new term in another language in a further step. Even to make it clear to a layman what hydrography is in his own language, a definition is very helpful.

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Lars Schiller graduated in Surveying Engineering from the University of Applied Sciences Hamburg in 2002. Since 2008 he has been working as a technical writer at a full service company for technical documentation where he is responsible for terminology management. At present he is studying M.Sc. Hydrography at the HafenCity University, Hamburg. In February 2012 he presented his master thesis about the position of hydrography in a system of sciences.

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Hans Werner Schenke graduated in Geodesy from the University of Hannover in 1977. His doctoral thesis in 1984 was about accuracy assessment of high precision coordinates derived from TRANSIT Doppler-Satellite measurements in the three-dimensional geodetic testnet Harz-Mountains. Since 1983 he has been Head of the Geodetic and Bathymetric Lab at the Alfred Wegener Institute in Bremerhaven and responsible for scientific bathymetry and geodetic programmes in polar regions. He is member of several international Committees for ocean mapping and undersea feature naming. Since 1999 he has been lecturer for GIS Hydrography at the Leibniz University Hannover and received an honorary professorship there in 2011.

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