SLOVENSKI STANDARD
SIST-TP CEN/TR 17798:2022

01-junij-2022

Optimalno načrtovanje hidrometričnih omrežij

Optimal design of hydrometric networks

Hydrometrisches Datenetz und Optimierung

Conception optimale des réseaux hydrométriques

Ta slovenski standard je istoveten z: CEN/TR 17798:2022

ICS:

07.060	Geologija. Meteorologija. Hidrologija	Geology. Meteorology. Hydrology

SIST-TP CEN/TR 17798:2022 **en,fr,de**

TECHNICAL REPORT

RAPPORT TECHNIQUE

TECHNISCHER BERICHT

CEN/TR 17798

April 2022

ICS 07.060

English Version

Optimal design of hydrometric networks

Conception optimale des réseaux hydrométriques

Hydrometrisches Datenetz und Optimierung

This Technical Report was approved by CEN on 27 March 2022. It has been drawn up by the Technical Committee CEN/TC 318.

CEN members are the national standards bodies of Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Republic of North Macedonia, Romania, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and United Kingdom.

EUROPEAN COMMITTEE FOR STANDARDIZATION
COMITÉ EUROPÉEN DE NORMALISATION
EUROPÄISCHES KOMITEE FÜR NORMUNG

CEN-CENELEC Management Centre: Rue de la Science 23, B-1040 Brussels

Ref. No. CEN/TR 17798:2022 E

Contents

Page

European foreword

This document (CEN/TR 17798:2022) has been prepared by Technical Committee CEN/TC 318 “Hydrometry”, the secretariat of which is held by BSI.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN shall not be held responsible for identifying any or all such patent rights.

Any feedback and questions on this document should be directed to the users’ national standards body. A complete listing of these bodies can be found on the CEN website.

1 Scope

This document provides guidance to assist with the planning and design of hydrometric networks, to ensure a better understanding of the water cycle and that any data are observed and collated in an effective and appropriate manner. This document is intended for use when:

- a new network is being planned and designed;
- the nature, value and extent of an existing network is being reviewed;
- a redundant network is being decommissioned or modified.

This is to ensure that the impacts of these changes are considered objectively, and all changes are adequately monitored and recorded.

Even though this document covers network design principles in general it focuses mainly on river (streamflow) monitoring networks.

This document covers all aspects that are considered pertinent to the design of hydrometric networks. The guidance is intended to be used to inform the decision-making process employed by the network's owners and operators. The objective nature of the review will ensure that all influential factors, both beneficial and otherwise, are considered. This will ensure that primary and potential alternative uses of the network are considered. It will also ensure compliance with any extant environmental legislation.

The intended audience for this document may include:

- Government, Non-Government Organizations (NGOs), agencies and other organisations which are responsible for designing and developing hydrometric networks that provide data to support a public service.
- Research and academic institutions that aim to develop a better understanding of the natural and human influences on the hydrological cycle.
- Developers of the built environment seeking to comply with environmental legislation that requires them to monitor those parts of the natural hydrological cycle that have been, or will be, impacted by their activities.
- Any individual seeking a better understanding of the water cycle for private and personal reasons.

2 Normative references

There are no normative references in this document.

3 Terms and definitions

No terms and definitions are listed in this document.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- IEC Electropedia: available at https://www.electropedia.org/
- ISO Online browsing platform: available at https://www.iso.org/obp

4 Nomenclature

4.1 Categories

There are three categories of terms and nomenclature:

- those relating to the geophysical and hydraulic nature of the river basin;
- those relating to the need for data and information about the flow regime in the catchment;
- those relating to the processing and provision of the data and information.

4.2 Geophysical and other restraints originating from the river basin

1) *Patterns of runoff and snow melt*: where rainfall and snow melt occur in the catchment, producing variations in runoff, including the long-term trends

2) *Winter conditions*: where permanent or semi-permanent snow fields exist in mountainous and polar regions

3) *Patterns of evapotranspiration*: where rainfall totals are low and where effective rainfall can be negligible due to high losses through evapotranspiration

4) *Catchment morphology*: the river pattern and nature of the catchment and its effect on average and extreme values of discharge, stage (or river level), plant growth, temperature, water salinity and turbidity

5) *Accessibility of the catchment*: particularly in remote areas and wilderness where road and transport routes have not been developed

6) *Environmental constraints*: limitations on access due to environmental restrictions such as working near or in SSSIs (Sites of Special Scientific Interest), Ramsar sites, World Heritage Sites, or more generally at or near sites where protected fauna and flora are found

7) *Legislative constraints*: limitations on working due to temporary or permanent rulings, Acts, Orders or Licences

4.3 The need for data and information

1) *Existing and potential uses of the catchment*: uses include water resource management, water resource planning, strategic environmental assessments, drought contingency planning, flood forecasting and warning, development of navigation

2) *Hydrometric parameter management*: maintained water level or stage, discharge regulation, sediment management, water quality and water pollution management

3) *Required data availability and data accuracy*: requirements of data in terms of temporal and special availability and accuracy

4) *Available budget*: justifiable and agreed expenditure on developing and managing the network

4.4 Technical and economic considerations due to data capture, data processing and data archival

1) *Existing related networks and established requirements*: what hydrometric networks and databases already exist, and what the original purpose for their development was

2) *Length and quality of established data records*: what periods of time do these databases cover and how accurate and representative they are

3) *Use of temporary networks to inform the design of specific engineering schemes*: are there any existing or abandoned temporary networks that were established for a specific survey for which useful data exist on archive

4) *Use of a permanent measuring site or structure*: the existence of a measuring site that has a usable flow record relevant to the current need

5) *Choice of flow measuring method*: whether to install a flow measuring structure to measure flow with potentially greater accuracy of measurement, or the use of less expensive and potentially less accurate open channel flow measuring techniques

6) *Capital cost of the hydrometric network*: the cost of construction and development of the network e.g. design costs, civil engineering costs, mechanical and electrical costs, technological costs

7) *Revenue cost*: the ongoing cost of operating and maintaining a permanent network. In the case of a survey for a specific project, this would be the budget allocated for the operation of the network over the duration of the project. This may have been capitalized when the project was established

8) *Data management requirements to be considered at design stage*: how best to operate the network given all logistical, technological and practical constraints of data capture, data processing and data archival, over the expected life of the network

9) *Use of surrogate gauged catchments to characterize ungauged catchments*: the availability of data from adjacent and similar catchments to provide the required information. This can avoid the cost of a new network, but may incur reduced accuracy of data and information.

5 Strategic considerations

5.1 The need for hydrometric data

The good and effective management of water and its availability in a catchment is dependent on reliable hydrometric measurements. The quality of these data is very dependent on the selection of the monitoring sites and the measurement techniques deployed. These data can serve a number of purposes that include but are not limited to:

a) water supply – assessment of current and future water availability, design and operation of water supply schemes;

b) flood management – design and operation of flood mitigation schemes, flood forecasting;

c) drought monitoring, drought forecasting and drought management;

d) effluent discharge and pollution control, and the dilution of effluents;

e) monitoring of abstraction licences and discharge consents;

f) conservation and environmental protection, fisheries management, maintenance of compensation flows, environmental impacts of major water related developments;

g) hydro-electric power production (HEP) management, assessment of the potential for HEP;

h) navigation and recreation;

i) hydrological research activities including monitoring the impacts of climate change.

Many gauging stations serve more than one purpose and the data from a site can be used for a number of different purposes. It is essential that all the potential uses and relative value of hydrometric data are considered when designing, reviewing and assessing networks.

5.2 Network requirements

A hydrometric measuring network is a system of monitoring stations that observe the major parameters of the water cycle within a river basin. These may include river flow gauging stations, precipitation gauges and groundwater observation boreholes. These monitoring stations provide the data needed for the planning, design and management of the water resources of the river system. The data need to enable accurate estimation of the principal characteristics of the hydrological regime of the river basin and the impacts of any significant human interventions. The network requirement is greatly influenced by a number of factors, including:

1) the precipitation pattern in the basin catchment;

2) drainage characteristics of the river basin;

3) the other physical characteristics of the catchment;

4) the purposes for which the data are required;

5) existing and potential uses of the river basin;

6) the availability of financial, skilled staff and other resources.

The selection of hydrological observation sites forming the basic network will be dependent on the above. The main objective of hydrometric network design is to obtain the maximum amount of useful, hydrological information for a given investment of time and money.

Hydrometric networks need to have the following characteristics:

a) be fit for the purposes they are intended;

b) be practical and if possible, relatively easy to implement and maintain;

c) be manageable in terms of whole life cost i.e. be possible to determine and hence optimize, the balance between initial capital outlay and ongoing revenue expenditure of developing and running the network;

d) be sustainable with as low a carbon footprint as can be achieved. This is of paramount importance.

5.3 Existing and potential users of the catchment data

In order to define the purposes and objectives of the Hydrometric network it is essential to have clearly defined the existing and potential data users. All existing and potential users of Hydrometric data have to be identified. The formation of the Hydrological Data Users Groups (HDUG) is a way of facilitating this, and these have been established by some countries and organizations. Each member of the HDUG needs to be consulted to establish their data requirements, both in terms of location and frequency. For example, on a large river which responds slowly to rainfall events a 15-min recording frequency may be adequate. However, on smaller, urban catchments where the prime purpose of the data might be for the design of flood protection works, then a 5-min frequency of streamflow measurement might be required.

There is a tendency for the organization, department or group responsible for data collection to concentrate on activities within their own sphere of interest. However, it is essential when revising or re-designing the network that all existing and potential users of data are identified. This may require forward projection of future needs. To assist with this process, it is important to study the basin(s) under consideration in detail to identify the following factors which could influence the network design:

- proposed water resources development locations;
- major river diversions and off-takes or basin transfers;
- existing and potential Hydro-electric power facilities;
- areas earmarked for industrial development;
- areas of water supply shortages;
- waste disposal sites and areas of contaminated land;
- areas earmarked for de-forestation or re-forestation;
- conservation areas and areas of ecological interest;
- physical characteristics - changes in topography, geology, soils.

5.4 Water resources utilization and demand for water

The effective development of the water resources of a river catchment is heavily dependent on the availability of flow data at key points within the catchment. Without this information the design of infrastructure that utilizes and deploys the resource, and the procedures that are put in place to manage the resource, will have the potential for misuse and the system will be at risk of failure, especially during periods when droughts reduce the natural base flow in the watercourses. Furthermore, at these times, serious environmental damage to the river can occur due to over abstraction of water from the rivers.

Typically, the utilization of the water resource of the river system consists of:

- the construction of impounding reservoirs and abstraction facilities to provide potable water for public water supply;
- the construction of impounding reservoirs and abstraction facilities for hydro-electric power generation, or cooling water at non-HEP power stations;
- abstraction facilities for other industrial use;
- abstraction facilities for the irrigation of food crops and food processing;
- river regulation to maintain adequate water depth in navigable channels.

Any of the above activities has an impact on the flow regime of a river, but where an impounding reservoir is built to support this abstraction the impact on river flow can be significant. In all cases, the change to the natural flow regime must be quantified. This is because the health of the river, and the biodiversity that it supports, rely on an adequate range of flow over the seasons of the year. For example, the maintenance of low-flow is essential to support the very basic ecology of the river, especially during hot seasons when high river water temperature can prove damaging or even lethal to water based fauna and flora. However, the occurrence of mid- and high-range flows is of equal importance as these conditions help sustain and refresh faunal habitats and floral variety throughout the watercourse margin. Additionally, where a watercourse receives discharges of treated effluent, adequate dilution of the effluent is essential to prevent the damaging effects of chemical pollution and high biological oxygen demand.

The safe and reliable development of the water resources in a region is therefore heavily dependent on the availability of good quality flow data. This information needs to be in the form of daily mean discharge at specific key locations along the river network. Moreover, to enable the determination of the likelihood of occurrence of specific flow ranges during critical periods, the flow record needs to be of sufficient length to enable key statistics on the flow distribution to be determined.

The length of the flow record needs to be greater than 10 years and include at least one period when low flows occur. For example, Severn Trent Water, a utility has a flow database that has daily mean flow at critical points on its resource rivers, that covers the period January 1920 to present. This period contains three double season droughts during the years of 1933-4, 1975-6, 1995-6, and several severe single season droughts, e.g. 1959. Environmental managers and legislators also use similar databases to model the impacts of low flows to determine the minimum acceptable flow in a river system. This is sometimes known variously as the 'environmental flow factor', the 95 % exceedance flow' or 'hands-off' flow. Critically, this will include the period of time when the flow is below this minimum flow threshold. As an example, the minimum flow at a point on a river might be considered to be a set value. Whilst an isolated day or two when the flow drops below this level might not give too much concern, a prolonged period i.e. 7 to 14 days or longer, might prove seriously detrimental to the river's ecology. This measure therefore helps determine the water available for abstraction without the risk of detriment to the riverine ecology.

All these aspects of the development of a river's resource and its safe use therefore rely on an adequate hydrometric network that monitors flows in the catchments, and provides a sufficient length of record to allow meaningful statistical analyses to be made. Nevertheless, there are catchments, particularly in the developing World, where no data exist, yet there is a need to develop the natural water resources of the river system.

5.5 National and international needs

Stable long-term hydrometric networks providing data to national and international initiatives are essential to meet many of the applications outlined in 5.1 and other requirements. National and international initiatives hold or connect data collected by many different network operators. Through the collation, integration and sharing of such data, it is often possible to generate more information about the hydrology of an area/country/region which otherwise cannot be determined by considering local data alone.

Where data are, or could be, contributing to such large-scale archives it is important that their requirements are taken into consideration when designing or reviewing hydrometric networks. For example, large-scale initiatives often prioritize data from monitoring sites which are established for a long period of time to give information about the long-term hydrological variability of a particular location.