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HYDROLOGICAL DATA REGISTERS OF THE WATER RESEARCH INSTITUTE

Juhani Henttonen, Väinö Malin & Matti Verta


The water Research Institute of the Finnish National Board of Waters has four data registers containing data from lakes, rivers and coastal sea areas. These are the registers of water quality, toxic substances, water levels and water discharges. In this paper the data collection systems, development of the registers, information stored in the registers, data processing systems and data utilization are discussed.

Index words: Data register, hydrology, water quality, toxic substances, water level, water discharge.

1. INTRODUCTION

The Water Research Institute of the National Board of Waters maintains four registers of hydrological data: the Water Quality Register (WQR), the Register of Toxic Substances (TSR), the Water Level Register (WLR) and the Discharge Register (DR). All these registers are separate and storage is on magnetic tapes except in the case of TSR, which uses mass-storage. The data from different registers may be combined.

In WQR are stored data obtained by the water authorities and by the laboratories carrying out the monitoring required by concessions and permits. These data are mainly physical and chemical data connected with water quality. In TSR, the results of analyses of sediments and water biota by water authorities and many other institutions are stored. Daily values of water levels and discharges are stored in WLR and DR. WQR and TSR are maintained by the water research office and WLR and DR by the hydrological office, both with the co-operation of the Finnish State Computer Center.

2. STATUS OF HYDROLOGICAL DATA COLLECTION SYSTEMS

The Water Research Office of the Water Research Institute is responsible for most of the national water quality monitoring programmes (Table 1). In practice, these are carried out by the water district offices. The objectives at the national level are research and planning, including co-ordination of regional management plans. The samples are analysed in the water district laboratories and in the research laboratory of the Institute in Helsinki.

The water district offices are responsible for the regional networks, consisting of about 1 000 stations under systematic monitoring in 1980. The programmes are planned by each water district office mainly for supervision purposes.

All industries and municipalities having permits to discharge into watercourses are required to maintain certain monitoring programmes. These programmes must be approved by the water administration, which also supervises the laboratories carrying out the monitoring. This kind of monitoring took place at about 2 800
stations in 1980.

An automated water quality monitoring system is at present operating at five river stations on the River Kymijoki. This system utilizes a central computing unit consisting of a PDP 11/35 computer located at the Helsinki offices of the National Board of Waters. The system was taken into service in September 1977. Two mobile stations, operating on the same principles and measuring the same parameters as the Kymijoki monitoring system, are also available.

The Hydrological Office of the Water Research Institute is responsible for the monitoring of hydrological parameters. About 1,000 observers situated around the country serve the hydrological office. The networks at the national level are presented in Table 2.

3. DEVELOPMENT OF HYDROLOGICAL DATA REGISTERS

In 1971 the National Board of Waters and the Finnish State Computer Center signed an agreement by which the Computer Center developed a computer system for storing monitoring data on water properties in the WQR. The programmes for maintaining the register became available in 1972. The oldest results stored in WQR are from the 1940's, while a fuller set of results exists from 1962 onwards. By January 1980 WQR contained data from 415,000 water samples from 27,400 different observation sites. Data from 45,000—50,000 samples are added to the WQR every year.

The planning of a register for storing data

| Table 1. The national monitoring programmes on water quality and water biota being conducted in 1980. |
|-------------------------------------------------|---------|--------|--------|-----------------------|
| Project                                        | Started | Number of stations | Observations per year | Notes                |
| Rivers                                         | 1962    | 187                        | 4                           | continuous           |
| Lakes                                          | 1965    | 165                        | 2                           | continuous           |
| Sea and coastal areas                          | 1965    | 111                        | 1—4                         | continuous           |
| Matter discharged by rivers to the Baltic Sea  | 1966    | 21                         | 4—12                        | continuous           |
| Small drainage basins                          | 1962    | 21                         | 5—12                        | continuous           |
| Precipitation                                  | 1973    | 38                         | 12                          | continuous           |
| Ground water                                   | 1973    | 54                         | 4—12                        | continuous           |
| Plankton research                              | 1963    | 400—670                    | 1                           | 1963, 1965           |
| Plankton research                              | 1961    | 180—370                    | 3                           | 1971, 1977           |
| DDT, PCB and heavy metal residues in fish      | 1978    | 89                         | every four years            |
| Deep-frozen water samples                      | 1974    | 1,500                      | last year 1979             |
| Deep-frozen fish                               | 1970    | 200                        | continuous                  |

| Table 2. Monitoring networks of the hydrological office in 1980. |
|-------------------------------------------------|---------|--------|--------|-----------------------|
| Parameter                                      | Started | Number of stations | Observations per year |
| Water level                                    | 1847    | 660                        | 365                     |
| Discharge                                      | 1862    | 390a                       | 365                     |
| Precipitation                                  | 1911    | 230                        | 365                     |
| Water content of snow cover                    | 1936    | 150                        | 4—8                     |
| Soil frost                                     | 1911    | 137                        | 18—26                   |
| Ground water                                   | 1962    | 103                        | 24—52                   |
| Ice thickness                                  | 1911    | 67                         | 9—12                    |
| Surface water temperature                      | 1911    | 50                         | 150—210                 |
| Pan evaporation                                | 1958    | 19                         | 130—150                 |
| Soil moisture                                  | 1973    | 54                         | 4                       |
| Deep water temperature                         | 1951    | 6                          | 24—36                   |
| Lake evaporation                               | 1971    | 4                          | 120—150                 |
| Air temperature                                | 1958    | 10                         | 365                     |
| Solar radiation                                | 1968    | 10                         | 365                     |

a Of these, 140 are electric power stations or regulation dams; elsewhere the discharge is determined with the aid of natural control or rating curves.
from the analysis of toxic substances in water biota and sediments was started in 1977. The programmes for handling this register were developed by the Finnish State Computer Center in 1978. The register has a format and a set of programmes similar to those of the WQR. In January 1980 the register contained data from 7 400 samples.

The development of the WLR and DR was started by the data branch of the Board of Civil Engineering at the end of the 1960's. In 1972 all recorded values of water level and discharge observations had been punched on cards and transferred to magnetic tapes. Since 1972 the Finnish State Computer Center has maintained the registers and has developed the programmes for their utilization. In January 1980 the WLR contained some ten million observations and the DR nearly four million.

4. INFORMATION STORED IN THE REGISTERS

In WQR and TSR one record (information from one sample) consists of data from sampling sites and from the samples themselves. The following data can be recorded for each sample:

- date
- administrative area
- institute
- co-ordinates
- river basin or sea area
- project
- 24 characters of alphabetical information (the name of the sampling site, literature references etc...)
- maximum depth at the site
- secchi disc transparency
- air temperature
- cloudiness
- wind direction and velocity
- ice and snow cover thickness
- sampling depth (only in WQR)
- specification of the sample (only in TSR)
- organ or part of the sample (only in TSR)
- reference matter (only in TSR)
- information on how the sample was stored (only in TSR)
- sex (only in TSR)
- the codes and the measured values of different variables

In WLR and DR one record contains the data for one year from one station. The record consists of the following data:

- river basin
- number of the observation station
- year
- monthly means
- daily observed values
- maximum and minimum values for the year
- date of freezing
- date of break-up of the ice cover

Two auxiliary registers are used in connection with WLR and DR. One contains the rating tables and the other information of the observation stations. The latter contains data concerning the station, such as the number and name of the river basin concerned, number and name of the station, its co-ordinates, drainage area, lake percentage, elevation of the zero-point etc. The data in the observation station register are primarily used for printing out table headings and for general information. The rating table register contains rating curves in tabular form to facilitate conversion of water stages into discharges.

5. DATA PROCESSING

The material to be fed into the registers is written on magnetic tapes at the National Board of Waters. The runs for updating and utilizing the registers take place at the Finnish State Computer Center with an IBM 370/168 computer system or a UNIVAC 1108 computer. Copies of the registers may also be run with the PDP 11/35 minicomputer of the National Board of Waters.

The computer programmes for the WQR and the TSR have been written in FAS language developed by the Finnish State Computer Center. The programmes for WLR and DR were first written in PL 1 and ASSEMBLER languages and later in FAS.

The data flows of WQR and TSR are presented in Fig. 1. When updating the registers the consistency of the sampling site data is checked. The analytical data are also compared with alarm limits. Simultaneously with the updating, the checking list and the list of all samples added to the registers are produced.

The data flow of the WLR and DR is presented in Fig. 2. Simultaneously with the updating,
6. DATA UTILIZATION

The information obtained for particular locations, including all data stored in the registers, is available through retrieval searches. The retrieved data may be listed on magnetic tape, microfiches or paper sheets etc.

After retrieval, specific data reports can be generated in the form of lists, statistical summaries, plots, loadings of cumulative mass flows etc. These can be accomplished by many library programmes as well as by a set of programmes developed especially for the registers.

A list containing information on the sites sampled for the WQR and both a list and a map (Fig. 3) showing the location of the sites analysed for toxic substances, are produced annually. The printing output of the lake monitoring is presented in Fig. 4 as an example of the reporting programmes.
Fig. 2. Data processing of the Water Level and Discharge Registers.
### YMPÄRISTÖMYRKKYREKISTERIN HAVAINTOALUELUETTELO 1980

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<th>VP</th>
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#### HAV.VUODET/YEARS OF SAMPLING

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<th>VESIKASVIT/WATER PLANTS</th>
<th>KALAT/FISH</th>
<th>NISÄKÄÄT/MAMMALS</th>
<th>LINNUT/BIRDS</th>
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#### HAV.VUODET/YEARS OF SAMPLING

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### Fig. 3. A map and a line printer output from the Water Quality and Toxic Substances Registers showing the number of samples analysed for toxic substances in two areas of one hundred square kilometers.
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<tr>
<th>Depth Layer</th>
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<th>Mean</th>
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<td>2.3</td>
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<td>12</td>
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<td>467</td>
<td>136</td>
<td>12</td>
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Fig. 4. A line printer output of a lake monitoring site consisting of extreme and mean values, standard deviations and three-year moving averages from the periods March 10 to April 10 in 1965–1977 (M = depth in meters, H = middle depth water layer).
The data stored in WLR and DR are published in condensed form in the Hydrological Yearbooks (in Publications of the Water Research Institute), containing the monthly means and the annual maxima and minima taken from the annual statistics. In addition, computer-calculated systematic analyses for the different observation stations have been published. These analyses (mean values and extremes, persistence and return times) have been published as copies in reduced scale of the computer line printer output complemented with diagrams (Figs. 5 and 6).

LOPPUTIIVISTELMÄ

Vesihallituksen koordinoimat veden laadun seu
ranna on yksityiskohtaisesti tutkitten vesistöjen
vesitoimistojen toiminta. Vesistöjen pyriään
vesistöjen, merialueiden ja
vesivirrkeiden yhteydessä
vaihtoehtoista
valvontaa

Vedenlaatu- ja ympäristömyrkykkyyrkistörekisterin
koordinoimisessa

Vedenlaatu- ja ympäristömyrkykkyyrkistörekisteriin
kerätään uransa-aikoina ulkoisen

Vedenkorkeus- ja virtaa

Vedenlaatu- ja ympäristömyrkykkyyrkistörekisteriin
kerätään uransa-aikoina ulkoisen

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tutkimusten tulos on

Vedenkorkeus- ja ympäristömyrkykkyyrkistörekisteriin
kerätään uransa-aikoina ulkoisen

Vedenkorkeus- ja virtaan

Vedenlaatu- ja ympäristömyrkykkyyrkistörekisteriin
kerätään uransa-aikoina ulkoisen

Vedenkorkeus- ja virtaan
Fig. 5. A line printer output showing extreme and mean values of daily water stage.
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