

Seanet - Data Interface Group - Measuring Network Flemish Banks Hydro-Meteo-System for the North Sea

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The Ministry of the Flemish Community, Coast and Harbours Service, has built up a hydro-meteo data collection network for the North Sea. The installation of this network was necessary to provide information for the storm-surge warning service, to monitor the traffic in the important chipping channel leading to the port of Zeebrugge and the Western Scheldt, to monitor the North Sea activities of the Ministry of the Flemish Community and to create a data-bank for the Belgian part of the North Sea.

1. INTRODUCTION

In 1975, at the time of the expansion of the harbour of Zeebrugge (Northern part of the Belgian coast) and of the execution of protection works for the coast, it became obvious that there was a need for :

- statistical information of the hydro-meteo parameters for the determination of the project criteria ;
- on-line information relative to the data concerning sea conditions for works execution ;
- information to be used as input for mathematical models (diffraction, refraction, a.s.o.).

Additional information was needed along the navigation channels towards the harbour of Zeebrugge and the Western Scheldt Mouth. Indeed, a specific guaranteed depth is required to insure safe passage along these navigation channels, which are characterised by a tide differential of 4 meters covering a 12 hours time span ; ships' passage is then allowed within a tide range. It is thus required to guide and optimise navigation :

- to make maximal use of the available depth (combination of tide and ebb) so that waiting time of ships be reduced to a minimum ;
- to make optimal use of the available depth to limit the channel dredging.

The "*Measuring Network Flemish Banks*" was created in response to the above aims. At the beginning the Network consisted of two measuring systems :

- a mini Hydro-Meteo system which gathered wave data and meteorological information on the coast (winds, temperatures, insolation ...) ;
- a network of measuring piles made up of several piles placed at specific locations at sea, which enabled collection of hydro-meteo information.

Those measuring systems were, for historical reasons, set up independently from one another, and this made it necessary to integrate them in one global monitoring system.

Concurrently, the data provided by those systems had to be completed by data from the foreign measuring networks and, moreover, it was necessary to have prediction data at hand.

For this reason the Department Environment and Infrastructure, Administration for Water-infrastructure and Maritime Affairs, Coastal Harbours Service, gave the Joint-Venture HAECON - C.E.I. the assignment to set up a global monitoring system :

Hydro-Meteo-System for the North Sea.

2. FUNCTION(S) OF THE HYDRO-METEO SYSTEM

The function of the Hydro-Meteo System is determined by :

- the goals of the Hydro-Meteo System ;
- the System's users ;
- the services to provide for with the system.

2.1. Goals of the hydro-meteo system

1. Gathering of the actual hydrographic and meteorologic information along the Flemish coast and on the Belgian Continental Platform, and, more specifically along the navigation channels. Collection is insured by the Local Acquisition Centres (LACs) ;
2. On-line handling of the data acquired by the LACs and their storing in a central data bank, together with information received from foreign measuring networks ;
3. Data exchange with the national and international instances (Royal [Belgian] Meteorological Institute, [Dutch] State "Waterstaat", Thames Barrier, Bracknell, Reading) which dispose of actual and predicted hydro-meteo (forecasts) data for the North Sea ;
4. Acquisition of the predicted hydro-meteo information using mathematical models ;
5. Dissemination of the actual and/or predicted hydro-meteo data to the Hydro-Meteo System users.

2.2. Users of the hydro-meteo system

Users of the Hydro-Meteo System are grouped as "internal" and "external" users. Internal users are the services which are responsible for the functioning, use and maintenance of the system and include :

- the Coastal Harbours Service responsible for the functioning, management and maintenance of the system ;
- the forecast and information system responsible for the use of the Hydro-Meteo Systems data to produce prediction (forecast) data, work carried out by meteorologists.

Users who request from and/or feed information to the Hydro-Meteo System and which do not belong to the group of the Internal Users, are external users. They are :

- the nautical authorities of Zeebrugge and Flushing ;
- the Royal [Belgian] Meteorological Institute ;
- the Management Unit of the Mathematical Model ;
- the Dutch measuring networks (State "Waterstaat", North Sea Directorate, ...) ;
- the British Measuring Networks (National Meteorological Office Bracknell, Thames Barrier) ;
- the Scheldt radar (Extended in-land Radar Chain UWRK) ;
- private instances (Construction Companies, Study bureau, Beasac ...) ;
- future as yet unspecified user.

2.3. Services(s) provided by the hydro-meteo system

The service intended to be provided by the Hydro-Meteo System may be subdivided in:

- maritime traffic ;
- prevention ;
- information providing ;
- data exchange with other measuring nets.

2.3.1. Maritime traffic

The services to provide are :

- management of the maritime traffic in the navigation channels ;
- insuring safe passage, to wit availability of the actual and predicted hydrologic and meteorologic conditions, especially those along the navigation channels ;
- reduction of ships' waiting times, viz. optimisation of harbour's traffic ;
- optimal use of the available water depth in order to optimise in turn dredging operations.

2.3.2. Prevention

The services to provide are :

- warning for possible heavy wave attack along the axis of the Zeebrugge locks (to provide protection of the locks' doors).
- storm forecasts (e.g. removal in-time of strand cabins and other material so as to prevent damage, such as in De Haan) ;
- storm flood warning ;
- dangerous currents in harbours accesses ;

2.3.3. Information role

Service providing concerning information supplying encompasses :

- placing at disposal of Hydro-Meteo System data in relation to studies, assessments, expert testimonies, ... ;
- help tool to plan work at sea or on the coast ;
- carrying out of special activities at sea, such as:
 - * the handling of the *Mont Louis* wreck ;
 - * the handling of the *Herald of Free Enterprise* wreck.

2.3.4. Exchange of data

The Hydro-Meteo System is coupled with other measuring networks and it makes its information available to external instances such as :

- the Dutch Measuring Network (Middelburg), with a continuous reciprocal data exchange ;
- the Belgian Royal Meteorological Institute, for :
 - * requests from the Hydro-Meteo System of the mathematical model data of the *European Centre for Medium Range Weather Forecasts (ECMWF)* at Reading and the National Meteorological Office Bracknell ;
 - * requests from the [Belgian] Royal Meteorological Institute of the sea-sited and Flemish coast located sensors data ;
- the Management Unit of Mathematical Models for input of models, control of the models' forecast and models calibration.

3. BUILT-UP OF THE HYDRO-METEO SYSTEM

3.1. Introduction

The basic components of the Hydro-Meteo System are illustrated on *fig. 1*. They are :

- Local Acquisition Centres ;
- Connections with the external measuring networks ;
- Mathematical Models Computer System ;
- Central Collection- and Processing Service ;
- Forecast and Information Service.

3.2. Local acquisition centres

The Local Acquisition Centres, LACs, are responsible for the local collection of data from the sensors placed on the Belgian Continental Platform and along the Flemish Coast.

LACs process data on-line, transforming that the collected raw values into parameter values such as wave height, wave period, wind velocity, air temperature, visibility, etc.

The sensor grid of the Flemish Banks Measuring Network consists of :

- seven measuring platforms (MOW₀, MOW₅, MOW₇) with different sensors to measure wave parameters, wind, temperature and air parameters at sea, current parameters, visibility, etc. ...
- a number of wave buoys of the following type :
 - WAVERIDER [one-dimensional spectrum $e(f)$]
 - WAVEC [two-dimensional spectrum $E(f, \theta)$]
- telemetric sea level meters in the harbours of Nieuwpoort, Ostend and Zeebrugge ;
- current meter at the entrance of the Port of Zeebrugge ;
- a meteorological station on the Flemish Coast at Zeebrugge (Locks building) that measures parameters relative to wind, temperature, barometric pressure, precipitation, insolation,

The measuring sensors at sea send their information by a radiosender to the LACs.

Receivers are located in the LACs which pick up the data. Due to geographical position of the sensors, there are three acquisition Centres, so that all information may be received.

These are :

- Residence De Mast (*Fig. 2*) to collect wave buoys information from the WAVERIDER and WAVEC buoys ;
- the Oceanographic and Meteorological Station (*Fig. 3*) to collect the MOW₅ measuring pole data, sensors placed along the Flemish Coast and wave buoys of the WAVERIDER and WAVEC types ;
- the Measuring Poles Network (*Fig. 4*) to collect the data relayed by the measuring poles MOW₀...MOW₄ and MOW₇.

Every local acquisition station is equipped with a mini-computer whereon the following functions are implemented :

- controlling of the data-acquisition equipment for the sampling of the sensors' signals ;
- storage of the raw data ;
- on-line processing of raw data to parameter values and storage in a local data file.

The Local Acquisition Centres function separately and independently one from the other.

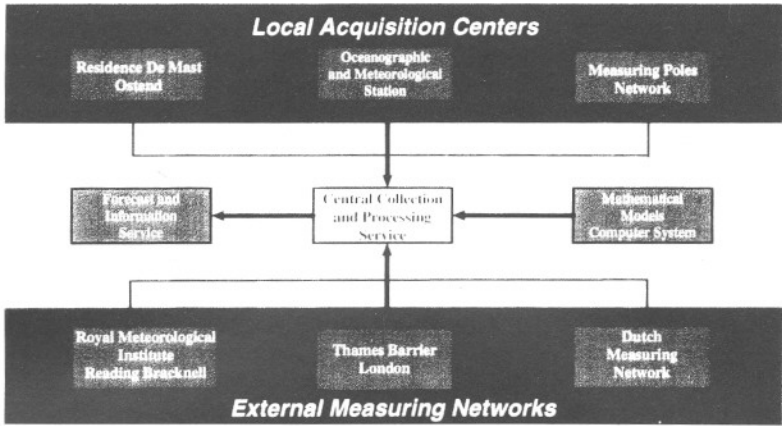


Figure 1. Dataflow Hydro-Meteo-System

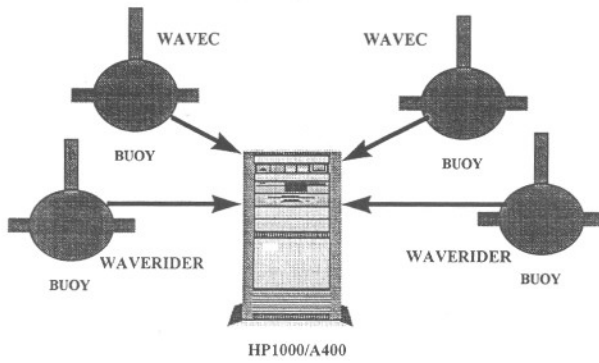


Figure 2. Local Acquisition Centra Residence De Mast - Ostend

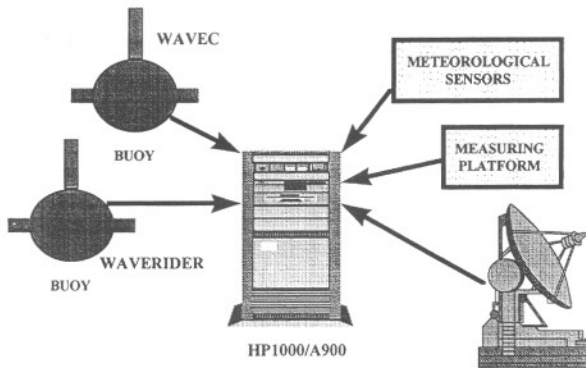


Figure 3. Local Acquisition Centra Oceanographic and Meteorological Station Zeebrugge

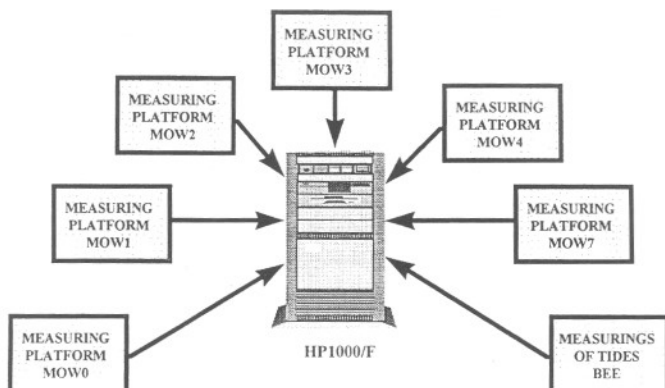


Figure 4. Local Acquisition Centra Measuring Platform - Ostend

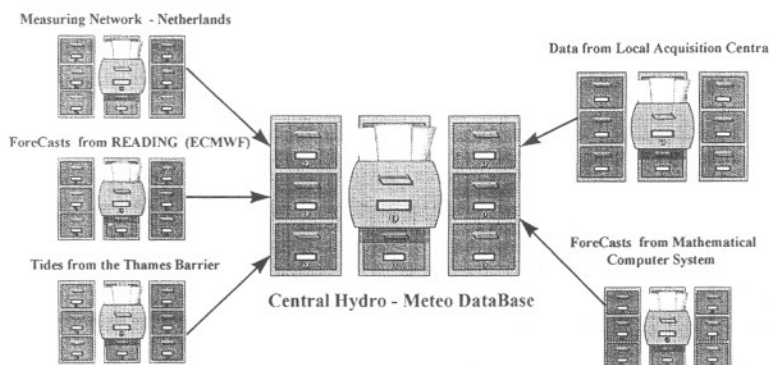


Figure 5. Central Hydro-Meteo Database

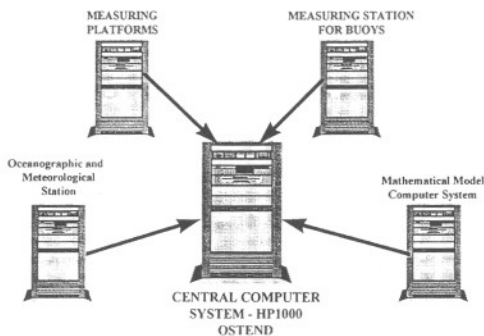


Figure 6. Central Collection and Processing Center

3.3. Links with external measuring networks

The links with the external measuring networks aim at achieving the hydro-meteo parameters data exchange. Thus, the available information is not limited to the Belgian Continental Platform and the Flemish Coast, but is expanded to the North Sea.

The links provide connections with :

- the [Belgian] Royal Meteorological Institute which furnishes the Hydro-Meteo System with data originating from the European Centre for Medium Range Weather Forecasts' (ECMWF) mathematical model in Reading (G.B.) and the National Meteorological Office Bracknell (G.B.);
- the Dutch measuring network, which provides to and requests data from HMS data file ;
- the Thames Barrier in London and the National Meteorological Office Bracknell which feed tidal data gathered along the British Coast into the Hydro-Meteo System.

The above data exchange occurs on an uninterrupted basis.

3.4. Mathematical models computer system

The mathematical models' computer system is used principally for the "*wave prediction model*" and the "*μ-storm model*" developed by the Mathematical Models' Management Unit. Forecasts can be requested through the presentation system of the Mathematical Models Computer System and a forecasts' selection is stored in the Hydro-Meteo System's central data file. The latter are then available to the users.

3.5. Central acquisition and processing service

The tasks of the Central Collection and Processing Service encompass :

- collection of the hydro-meteo data of
 - * the Local Acquisition Centres (Belgian Continental Platform and Flemish Coast) ;
 - * the external measuring networks (actual information and forecasts) ;
 - * forecasts of the mathematical models computer system ;
- the build-up of the central data file ;
- off-line data processing ;
- information distribution ;
- management of the central data file ;
- management of the network.

The central acquisition and processing Centre is the core and includes the main computer. That computer contains the central data file (*figure 5*) where all data of the LACs, external measuring networks and Mathematical Models Computer System, as well as actual forecast data are centralised.

The Local Acquisition Centre and the Mathematical Models Computer System are directly linked with the main computer (*figure 6*) by means of various communication apparatus.

There is a backup line with the main computer through the Belgacom data network (DCS-network), because of the LACs enormous importance as well as their continuous need for data.

3.6. Forecast and information service

The main function of the Forecast and Information Service is the analysis and interpretation of the collected data, which consists in :

1. the control and improvement of the actual and forecast data ;
2. the use of the mathematical models computer with the hydro dynamic wave forecast model and specifically :
 - * follow-up of the model's performance during the various runs, e.g. the generation of the forecasts ;
 - * interpretation, control and processing of the output data (e.g. the forecasts) of the model.
3. the utilisation of other mathematical models, such as tide astronomical model, statistical tide prediction, hydrodynamic tide model and statistical wave forecast ;
4. follow-up and spelling-out of forecasts concerning weather prediction, wave climate, swell and water stand (level) ;
5. preparation of forecast notices on a continuous basis ;
6. preparation of special forecast notices during the exceptional meteorological conditions ;
7. general providing of information at the request of the Direction ;
8. statistical analysis and data processing for storing the collected data in the archives (records).

3.7. Software build-up

It follows from the above description that various programmations had to be developed to set-up the Hydro-Meteo System.

Software (eventually) developed can be subdivided as follows :

- data acquisition software to relay data acquisition apparatus from the LACs (RMO, MPN, OMS) ;
- on-line processing to calculate parameters and derivated parameters in the LACs and their storage in local files ;
- data communication software to request data from the LACs and external measuring networks ([Belgian] Royal Meteorological Institute, [Dutch] State Waterstaat, Thames Barrier) and to store them in the central database ;
- programming for the build-up, control and management of the central data file on the main computer ;
- communication and control programming for the data exchange with the mathematical models computer system ;
- data processing software for the control and correction of data in the central database ;
- off-line processing software for information from the central data file ;
- on-line print-out at various sites ;
- distribution of data from the central data file ;
- back-up and storing of the central data file ;
- programming for the computer network management.