REMOTE ACCESS TO DATA AND EXPERIMENTS. APPLICATION TO HYDRAULIC LABORATORY FACILITIES

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Abstract

RADE, acronym for Remote Access to Data and Experiments, is a Joint Research Activity of project HYDRALAB IV – More than Water. Its aim is to develop a robust set of information systems to improve access to hydraulic experiments and data through innovative use of modern data management, curation and communication technologies. The objective of the present work is to describe two different methodologies, developed by the National Laboratory for Civil Engineering (LNEC) and by DELTARES, on remote access to data and experiments applied to hydraulic laboratory facilities.

Keywords: RADE; remote access; data sharing; video streaming

1. Introduction

Traditionally, the hydraulic research community is accustomed to exchanging the results of their experiments through papers and conferences, with direct exchange of data being limited to partners cooperating in projects. The objectives of RADE (Remote Access to Data and Experiments) are to allow research partners to access and input laboratory experiment data (including video and images) remotely, thereby saving on costs and on the environmental impacts of long distance travel.

The present paper presents the work developed under this project, namely the methodologies and results obtained by National Laboratory for Civil Engineering (LNEC) and DELTARES, two of the partners of HYDRALAB IV consortium.

LNEC'S methodology is simple and cheap. It is based on the use of a film camera, installed at the flume or tank, and free software that enables real-time streaming over the internet, enabling a direct, quasi-real-time access to the video from web users. Moreover, the methodology also permits the visualization and sharing of the data as it is acquired. Deltares' methodology is more complicated and expensive. It is based on a power film camera which serves as a server-client system, by means of which the measurements taken during the experiment (data) can be visualized real-time and distributed among all project members at once.

Next sections present details of both methodologies and the main results of their applications with different users.

2. LNEC´s methodology

The objective of the work performed at the National Laboratory for Civil Engineering (LNEC) is to develop simple procedures/methodologies to enable remote video access and experimental data access to laboratory experiences at LNEC's wave flumes and basins, located in the maritime and hydraulics installations of the Harbours and Maritime Division (NPE). Visualization of real-time acquisition data coming from physical experiments and online communication between partners to share results are the ultimate goals of the work being developed.

2.1 The remote video access - Image Streaming

The methodology is based on the use of a fairly simple scheme (Figures 1 and 2), composed by a low-cost consumer SLR camera installed at the flume, connected to a PC computer on which the software "Microsoft Expression Encoder" resides and video (or images) is stored, decoded and sent to a streaming web server. This server will then stream images and video in real time over the internet, enabling a direct, quasi-real-time, access to video and data.

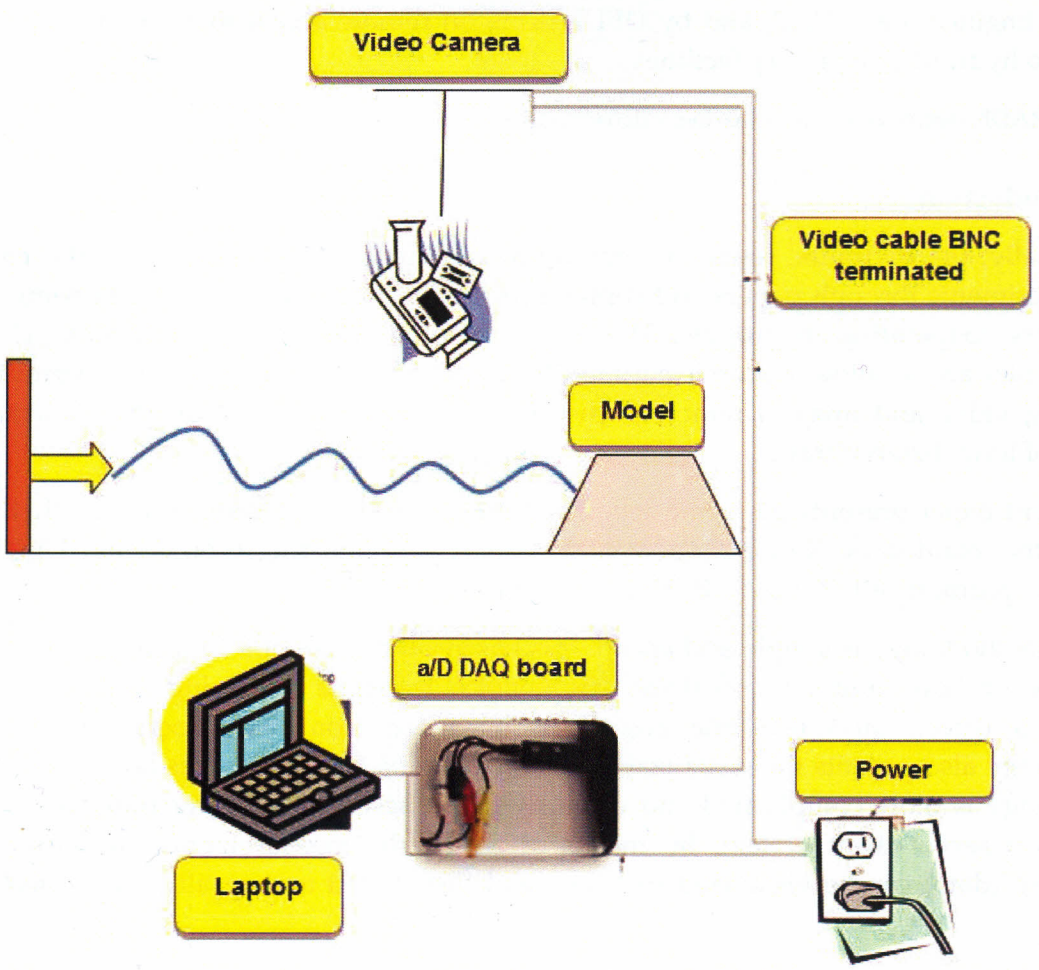


Figure 1. General scheme of a remote access experiment.

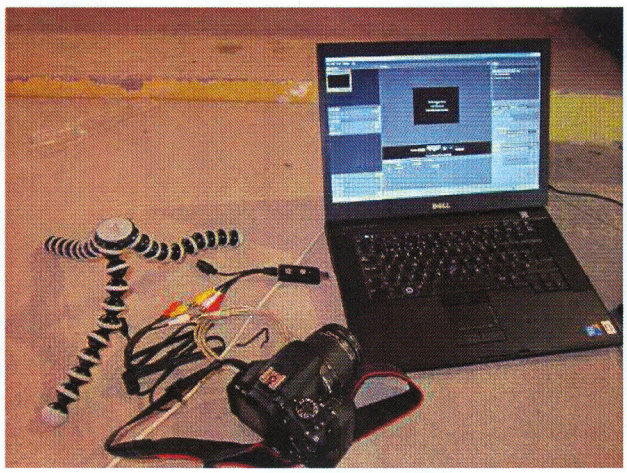
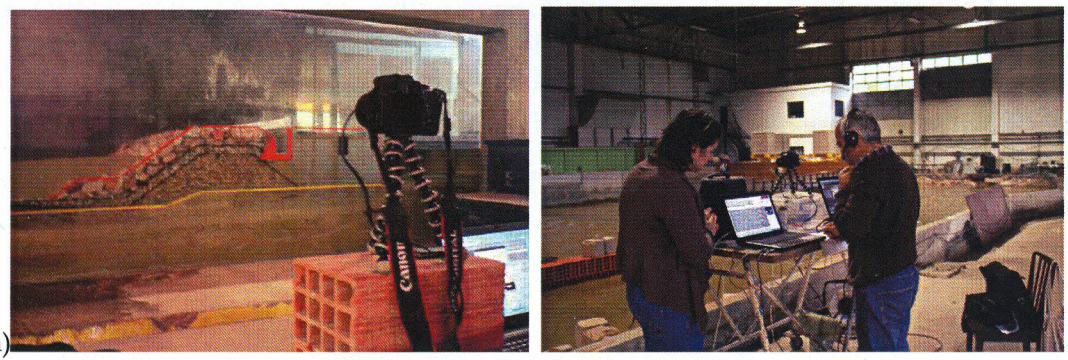


Figure 2. Equipment used during the remote access experiment. Laptop computer, A/D Converter DAQ board, cables with USB-composite video adapter, a Canon camera and a flexible tripod.

This work involved the collaboration of FCCN (www.fccn.pt), the Portuguese Foundation for Scientific Computing that provides the web server where video images are sent. Figure 3 shows some aspects of the experiences obtained in the wave flume.

Results from the wave basin are shown in Figure 4, through a Windows Media Player session on a client's computer of live video of the experiment. Clients were invited to access the video stream through the address http://wms.fccn.pt/lnec_canal. For that the client can either use the Windows media player on a windows personal computer or the Quicktime player through Safari browser on a Macintosh computer.

a)



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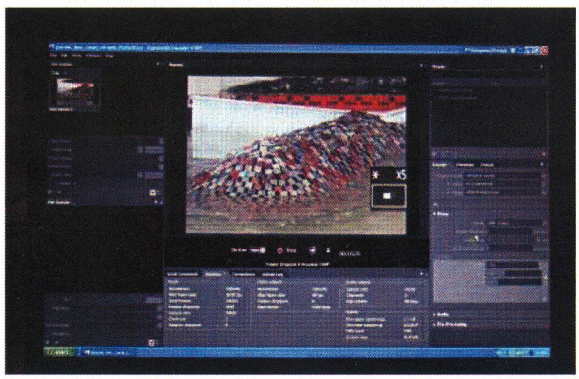

Figure 3. a) Installed set up in a wave flume (left) and in a wave basin (right). b) Video streaming on Microsoft's Expression Encoder 4 software.

Figure 4. Windows Media Player playing a live stream video on a client´s computer

2.2 Remote visualization of data acquisition

The methodology for remote visualization of data acquisition is based on the use of free version of TeamViewer© (www.teamviewer.com). This software, besides enabling online meetings, also supports the remote control of the host computer via internet, through a password-coded session provided by the client.

Therefore, project team members in a given experiment are invited to join the meeting and to remotely access experimental data, using the "Remote Control" feature. After LNEC staff sends an e-mail invitation to the participants, it is sufficient for each of the participants to access the link provided, which will lead to the meeting session without needing to install any software. All participants who join the session will be able to see the desktop panel session, see Figure 5a, and will have immediate access (conditioned by the permissions granted) to the presenter´s desktop , allowing real time display of data acquisition, Figure 5b.

At the same time, the TeamViewer´s "Online Meeting" feature enables chat, VOIP, video and file transfer, amongst many others features, therefore avoiding time consuming and expensive travel (Figure 6).

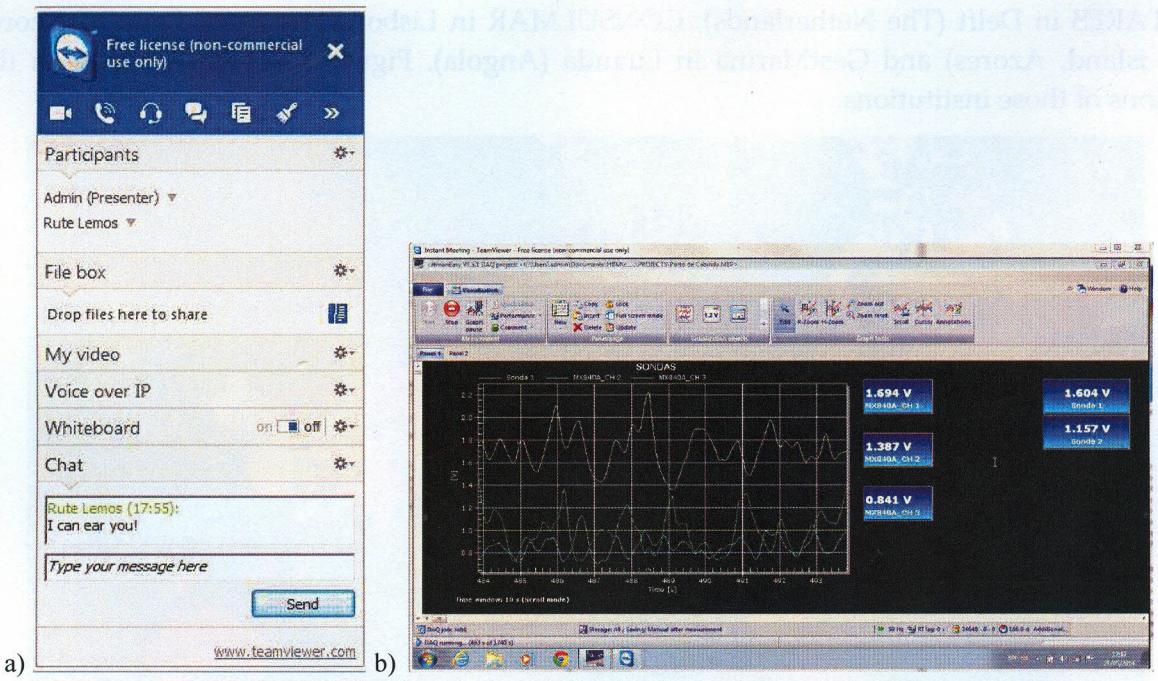

Figure 5. View of data acquisition on a client´s computer.

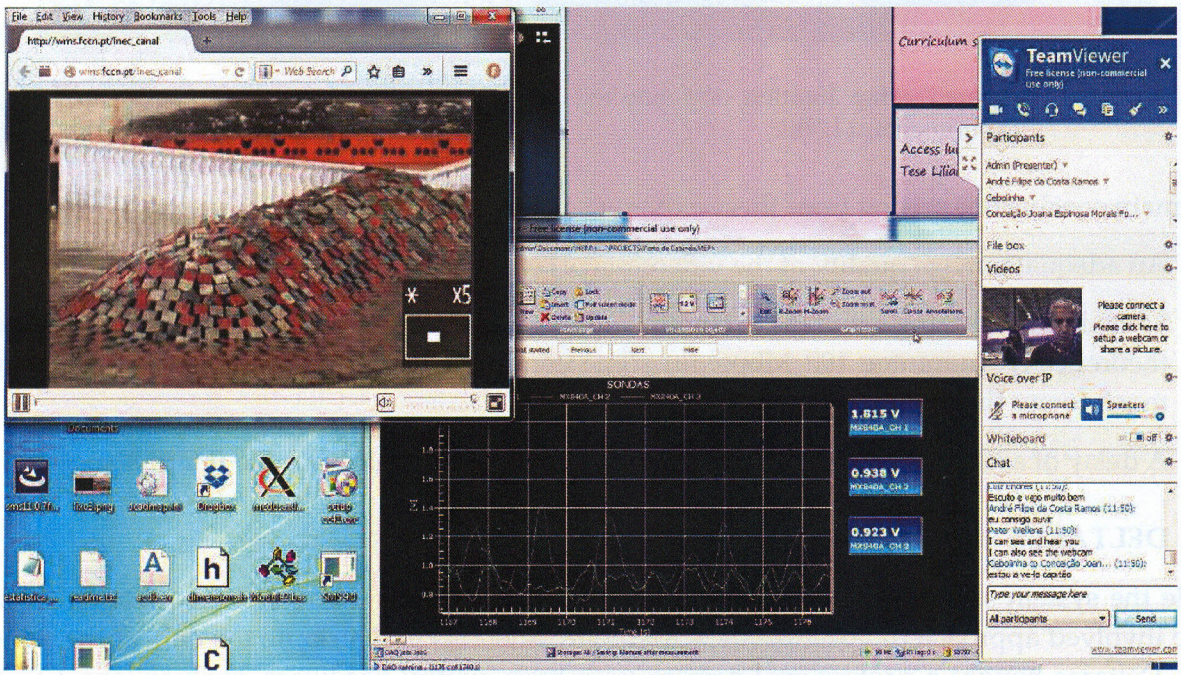

Figure 6. Image streaming and online meeting software showing data acquisition on a client´s computer.

2.3 Applications

To test both the remote video access and the remote visualization of data acquisition, ten experiences using this methodology were carried out at LNEC´s wave flumes and tanks, involving several institutions national and abroad, including University of São Paulo (Brazil), the Federal University of Rio Grande do Norte (Brazil), the University of Rio Grande do Sul (Brazil), the Lisbon Superior Engineering Institute (Portugal), University of Hull (United kingdom), University of Aalto (University of Finland), and the consultant companies

DELTARES in Delft (The Netherlands), CONSULMAR in Lisbon (Portugal), Ports of Azores (Pico island, Azores) and GestMarina in Luanda (Angola). Figure 6 shows a map with the locations of those institutions.

Figure 7. Map location of connected institutions to remote access experiments at LNEC

The main conclusions arising from these experiences were:

- An adequate image quality of the video images was attained at all times;
- Some image freezing occurred. Actually, although LNEC's internal network speed should theoretically guarantee 100 Mbps, on some conditions (high traffic levels and users) a much lower throughput was sometimes observed;
- A delay of around 20 s to 2 minutes occurred, depending mainly on the internet speed.

3. DELTARES´ methodology

While the system set up of LNEC was designed as a low cost system, Deltares worked on a more involved approach to visualize the experiment and also to distribute the data at the same time. Deltares bought a professional camera with high quality hardware, such as lens, CCD-chip and servo motors for motion control, with an internal server. Project team members of an experiment receive a user name and password to log on to the server. The project team leader has a special account that enables him to control the camera position (roll, pitch and yaw) within a pre-configured range. In this way, the project team is free to focus on that aspect of the experiment that they find relevant at that moment.

When the experiment commences, and the data acquisition system starts taking measurements, an additional process is started to distribute the data among the project team members. The process on the data acquisition system converts the data to the open NetCDF format, sends it to a server, which then synchronizes the data between the server and the clients, which are running on the computers of the team members. While the experiment is going, the data is

distributed to the clients in real-time and can also be visualized real-time. The set up of the system of distributing data is shown in Figure 7.

The server-client system at Deltares is based on Delft FEWS. Delft FEWS is originally a operational flood forecasting system, but is flexible enough by design to be configured as a server-client system for sharing hydraulic experimental data. The biggest challenge for Delft FEWS was the sample rate of the measurements that is orders of magnitude higher in the laboratory (between 25 and 100Hz) than in field stations (between 0.1 and 1Hz). But we dealt with this issue and the delay now was less than half a minute after a 25 minute experiment.

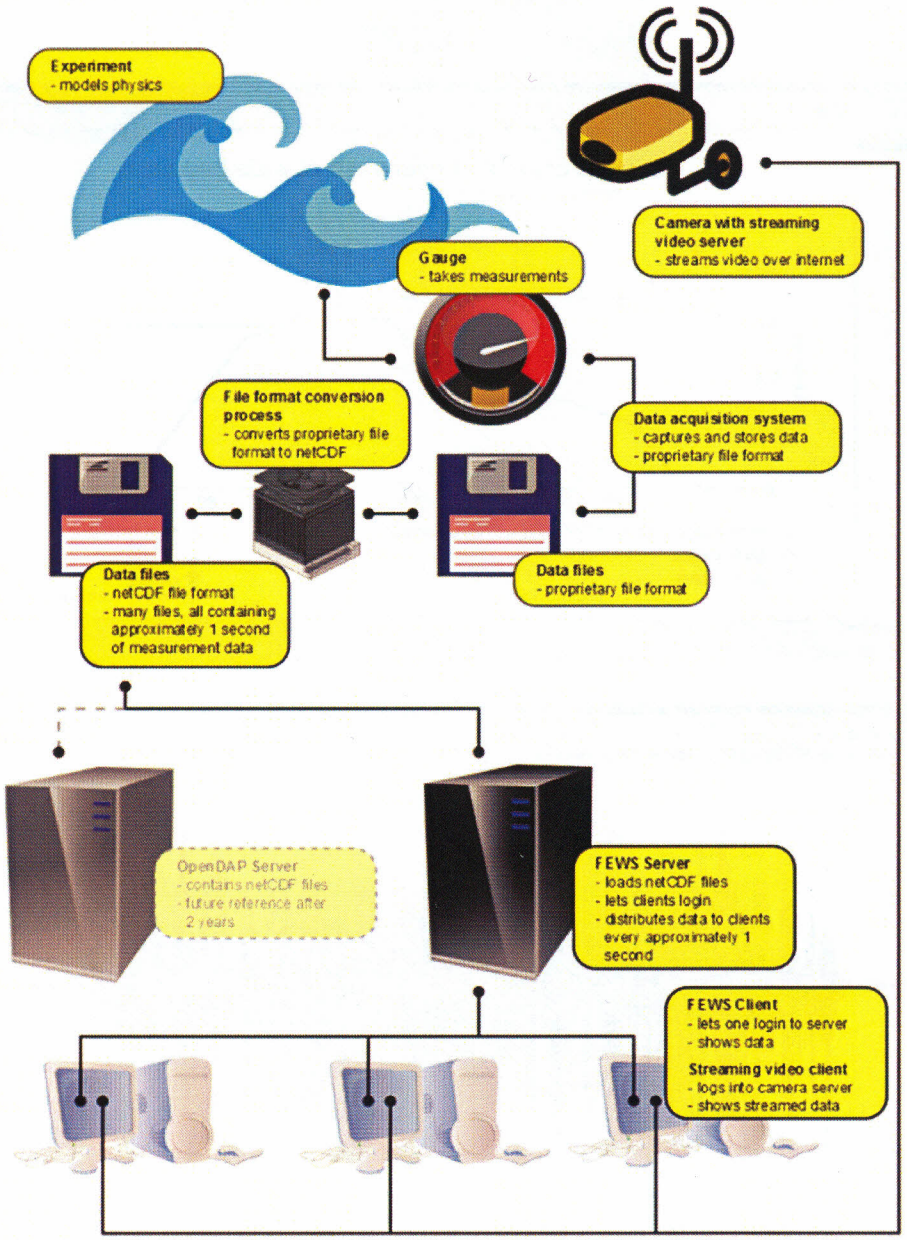

Figure 8. Deltares' system set up for remote access and exchanging data

Deltares' system was tested at Deltares. Colleagues at the premises and a colleague in the United Kingdom were asked to act as a test users. During the experiment the delay was tested by keeping a telephone connection open and mentioning every five minutes how far the experiment was in the lab. Figure 8 gives some screenshots of the client software running at the remote locations. One screen shows a drawing of the set up of the experiment. In this screen project team members can click the locations of the instruments to see the measurements that they are interested in. After the experiment (or during) the data can be processed within the client software, because it contains many statistical functions by default. Alternatively, the data can be exported to almost any format to be processed by means of other software.

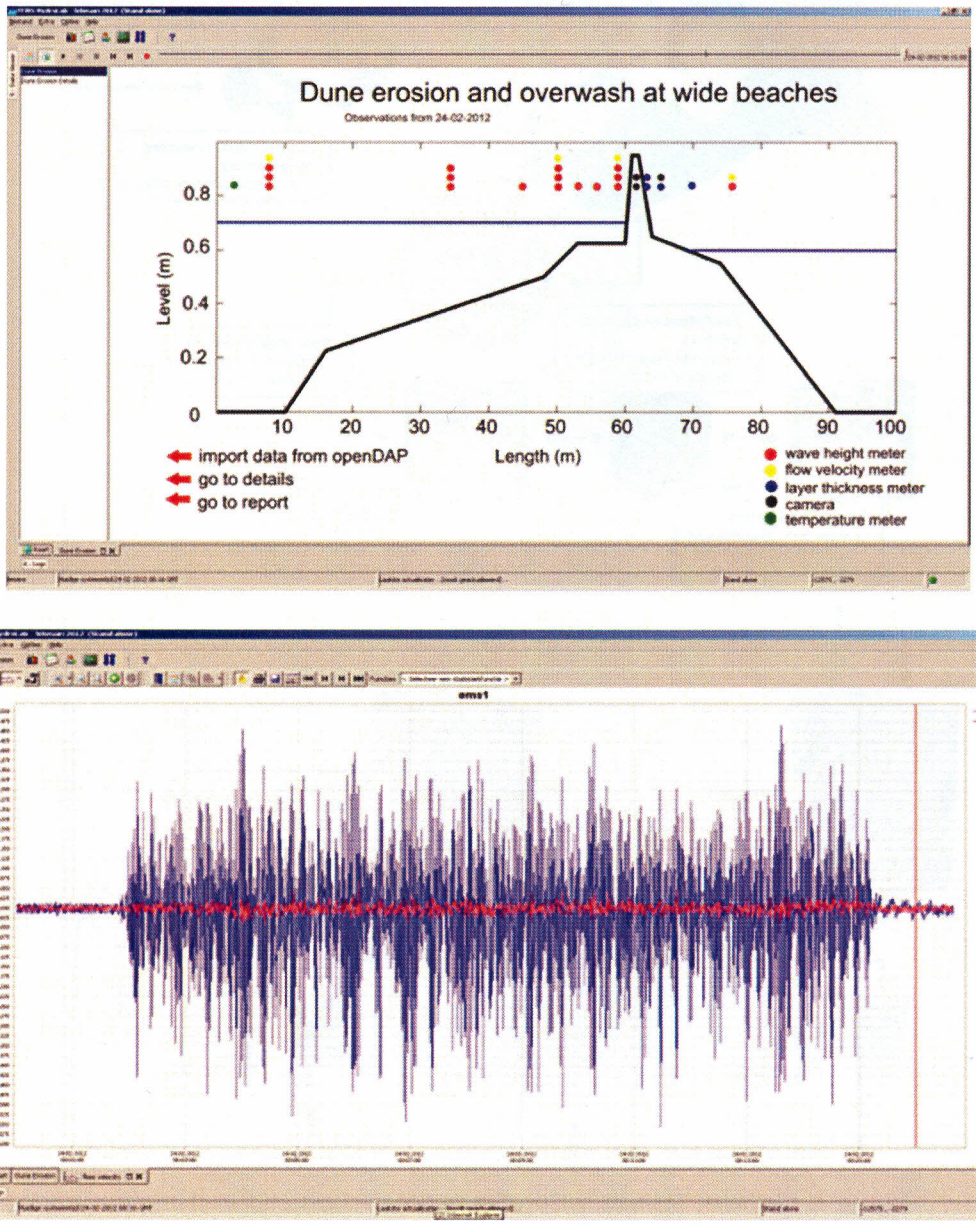

Figure 9. Screen shots of the client software for remote access and data distribution

4. Conclusions and future developments

This paper presented two methodologies (LNEC's and DELTARES´s) for remote video and experimental data access to laboratory experiences.

LNEC's methodology is based upon low cost hardware free software, in order to make experiments of physical modelling in research institutions easily accessible and portable to other laboratories and universities as well as other interested clients. From the tests performed, it may be concluded that LNEC´s methodology is appropriate both for 2D and 3D scale model tests and is very simple, easily portable and quite cheap to implement. However, some problems were identified such as incidental image freezing occurrences and delays, depending of the speed of the user internet connection.

Deltares' methodology is more involved. It gives project teams a visual impression of a hydraulic experiment by means of a camera system that can be operated by the project leader. In addition to the visual impression, a specialized version of Delft FEWS is used as a server-client system, by means of which the measurements taken during the experiment (data) can be visualized real-time and distributed among all project members at once. In what concerns to DELTARES´s methodology, the remote access and data distribution showed, at the end of a 25-minute test, a delay less than half a minute.

In both methodologies, the characteristics of the computer and the speed of the user internet connection are essential for the success of the experiences, although the internet characteristics of the provider are also important. More experiments with European and other countries are planned, in order to test the methodology with partners with different network and computer characteristics.

Some aspects of the methodology are planned to be improved, as to optimize the video transmission bit-rate in order to maximize image quality and at the same time avoid dropped frames, to increase LNEC's internal network speed as well as to improve the server live streaming, in order to maintain long-term records.

Deltares will set up their system during one of the Transnational Access experiments, in which a selected international research group received access time to conduct an experiment in one of the large facilities associated with HYDRALAB. During this experiment, experiences will be collected which we will communicate through the consortiums website at www.hydralab.eu.

Acknowledgments

The authors acknowledge the financial support of HYDRALAB IV – More than water; dealing with the complex interaction of water with environmental elements, sediment, structures and ice. HYDRALAB IV is a FP7 project, Contract N. 261520.

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