Wind Atlas for South Africa (WASA)
Western Cape and parts of Northern and Eastern Cape

WP2 Report on Training

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INTRODUCTION

One of the outcomes of WP2 is that training would be provided by DTU (Risø) on two aspects of the measurements programme, namely:

i. The correct methods for setting up and installing the hardware on the mast to ensure high quality wind measurements

ii. The RODEO database and quality control system that was supplied by DTU for the WASA project.

The training was done by two groups of specialists from DTU and a number of CSIR staff were trained in separate training sessions. These training sessions were held in February and May 2010 for the Rodeo database and the mast hardware respectively.

In addition to this, training was also provided by DTU on the quality control of the weather data from the ten stations. Initially the quality control was done exclusively by DTU. This was phased out over a period of a few months during which time DTU played a supervisory role to the point where CSIR took full responsibility for the monthly QA of the data.
2. TRAINING

1.1 RODEO data management course
ITC specialists from Risø (Karen Enevoldsen and Steen Sørensen) arrived to set up the RODEO Database Server in February 2010, and made sure that the system integrated and conformed to the CSIR LAN system and protocols. Johan Notnagel from CSIR ITC in Pretoria was brought in to assist with any LAN integration issues. The Risø personnel then presented a course on the setting up and use of the RODEO Database to the following persons: Ursula von St Ange, Steven Pietersen, Mario August, Johan Notnagel and Eric Prinsloo. ANNEXURE A contains a copy of the RODEO manual.

1.2 WASA instrument installation workshop
In May 2010 a mock-up of the top part of a mast was set up in the laboratory at CSIR, Stellenbosch (Figure 1) to allow a hands-on demonstration of the correct installation procedures of the WASA instruments by the Risø technicians (Michael Rasmussen) and Søren Lund. The following CSIR technicians attended: Eugene Mabille, Pieter Truter, Terence Hendricks and Eric Prinsloo.

![Figure 1](image-url)  
Figure 1. The mock-up mast with instruments set up in CSIR laboratory with training in process by Michael Rasmussen (on left) and Søren Lund (second from right), both from Risø, DTU

The instruments allocated to each station were then installed on the 60m masts at WM04 and WM05.
At that stage there were no CSIR technicians certified to do the actual mast climbing, so the company Alpinist Safety Consultants (Pty) Ltd. were contracted to do the installation of the sensors. After an incident in which amongst others an anemometer was damaged, a decision was made to send a number of CSIR technical staff on a Working at Height course so that CSIR had full control over the installation of the sensors. Subsequently no equipment has been damaged during the commissioning of the remaining eight masts as well as during any of the maintenance tasks undertaken at the stations.

1.3 Site selection:
The purpose of this task was to undertake “preparatory” investigations for the Wind Atlas installation and operation. Guided by experts from Risø (Denmark) the CSIR team was trained in site selection for the placement of a wind mast. Two candidate
sites (Napier and Sutherland) were used to obtain insight into the aspects that needed to be considered.

Using this knowledge, the other eight sites were selected (Alexander Bay, Nieuwoudtville, Vredendal, Vredenburg, De Rust/Beaufort West, Humansdorp, Noupoort, and Butterworth). The site locations were checked and verified by Risø, using GoogleEarth.

2 EXCERPT FROM PIU MINUTES (SEPTEMBER 2010)

- **Training in instrumentation of masts completed.** It was done as on-the-job cooperation between CSIR and Risø during the visit of 2 Risø technicians May 2010.

- **All 10 WASA measurement masts and the data acquisition system are installed and in operation.** CSIR informed that the work of installing instruments on a mast had been developed from initially taking 2 days to taking only 5 hours at the 10th mast. Some special issues mentioned were
  - M06 was installed with 10 candela air warning lights approved by aviation authorities and the telescope
  - M06 special mast (+18000 ZAR) due to snow loading
  - Mounting brackets for lights had to be lowered in order to be within the acceptable cone of IEC
  - M08 protection of guy wires against cows
  - M09 directional antenna needed to get stable signal for communication
  - Cabling should be on south side of mast legs (out of the sun)

- **CSIR took over the work of installation of instrumentation in order to optimize procedures and ensure that knowledge and lessons learned were retained.** 6 CSIR staff members had taken the mast climbing and rescue course (5 of which have been directly involved in the WASA project).

- **CSIR will check masts after 6 months.**

- **CSIR will make a write-up of these lessons learned in a kind of guidelines, standard or best practices for instrumentation on lattice masts.**

- **A LOG-BOOK should be maintained for each station recording modifications done to any part or sensor that may have an impact on measurements or analyses.** Karen Enevoldsen will draft the template for such a LOG-BOOK and CSIR will comment and modify this template and fill in relevant information.

- **It was noted that environmental approvals are no longer needed for masts like**
the 10 WASA measurement masts (no height limit). A development that is good for the wind energy project developers, and where the WASA project could be seen as having contributed to making such a decision possible.

3 EXCERPT FROM PIU MINUTES (SEPTEMBER 2010)

- Online RODEO display website and the data download website
- The online RODEO display website and the data download website are now in operation ready for demonstration at the 2nd Wind Energy Seminar, held in Johannesburg, 28 September 2010, including
- Data are being processed and entered in RODEO from all of the 10 WASA measurement masts. Data comes into the server at CSIR every 10 minutes, and graphs are made available automatically for viewing online on the project web site http://www.wasa.csir.co.za.
- The RODEO server is in Stellenbosch
- The graph server is in Pretoria, but it is being investigated whether it should move to Stellenbosch as well.
- Program for extracting monthly data from the database has been developed by Risø in close collaboration with CSIR
  The application that creates the data text files with the monthly data is a console application that is scheduled to run one time each month. It collects the 10 min. averaged data for the previous month and puts the data in a comma-separated text file (.CSV file). One file contains all the mean, minimum, maximum and standard deviation values for one station averaged over a 10 min. period. The file is organized as a series of rows, each containing the values of one 10 min. period, and each row has a number of values corresponding to the measurements of the sensors at the station.
- Values have been suggested for automatic online quality control in RODEO (Document describing the proposed procedure uploaded to the teamsite). RODEO will send alarms to EP in case any of the alarm settings are exceeded. Over time these settings can be fine tuned, so that only actual faults will be causing alarm, but for some time it might be advisable to observe somewhat narrow settings, knowing that some of the alarms are not faults, but only concerns that will not require any action.
- The monthly release procedure and QA of data for the Download website was discussed
  o Data collected so far have been QA’ed at Risø and changes made accordingly and reflected in the database. Niels’ document on this first QA has been uploaded to the teamsite.
Every monthly QA report should be uploaded to the teamsite, and this report or parts it should be accessible from the download site – to enable users understanding any changes to raw data made.

It was agreed that Risø will do QA of monthly files initially. CSIR will gradually take over all QA responsibility within approximately 6-8 months, however Risø will be available for support or discussion of any issues arising in the process. CSIR confirmed that their budget allows for this work throughout the project period (estimated to be of the order of one person-day of work per month).

It was agreed that AK investigates the interest and possibilities of SAWS data experts to take a look as part of the monthly QA. This could work as an added QA to that done by Risø and CSIR in order to make optimal use of the many years of expertise and knowledge of the SA-weather as observed at SAWS stations.

Risø and CSIR will seek to develop automation of the QA procedure further, however some degree of visual inspection of plots of the files will remain part of the procedure.

Data will be released by CSIR after completion of the QA, which is about a week after the turn of the month. The wind data will be made available from http://wasadata.csir.co.za/wasa1/WASAData

4 EXCERPT FROM PG REPORT (PERIOD: APRIL 2011 TO MARCH 2013)

The Wind Atlas of South Africa (WASA) (www.wasa.csir.co.za) comprises a network of ten 60 m masts, with weather sensors at five levels. This data needs to undergo a quality assurance (QA) process before it can be put on the download site. (wasadata.csir.co.za/wasa1/WASAData)

Project Tasks and Progress Reports

Ursula von St Ange (UvSA) creates a full set of monthly matlab graphs for each station. These graphs are imported into MSWord documents, and then printed to pdf. The pdf document, together with the data itself, is sent to Eric Prinsloo (EP) for visual analysis, and noting of any obvious irregularities in the graphs. For example, in Figure 3 the 62m anemometer of Mast WM02 started to go faulty from the 9th of December. Eric then requests Ursula to redraw the graph, but with the faulty 62m data removed (Figure 4).
Figure 3. Graph for December 2013 for Mast WM02, showing the faulty 62m data

Figure 4. Graph for December 2013 for Mast WM02 with the faulty 62m data removed.

From Figure 1 it appears as if there might be periods where the 62m data seems to revert back to normal, but the PDF graphs allows one to sufficiently zoom-in to note that these readings are constantly lower than the 60m ones, which is incorrect. So all data from the 9th to the end of the month had to be removed. When the site was later visited in February, it was found that one of the three cups of the 62m anemometer had broken off, possibly due to a hail strike.

The corrected data is then imported into the Climate Analyst program in WAsP, where one can check for further possible problems in the data (Figure 5).
Figure 5. Graphs and tables generated by the WASP Climate Analyst program.
The Climate Analyst generation report for the 62m anemometer height at Mast WM09, which, amongst others, shows the number of calm speeds <0.5m/s for October 2012.

A useful feature of the Climate Analyst program is that it generates a report (Figure 6) where, amongst others, it gives the number of calm speeds below 0.5m/s within a month (this threshold can be set). If the number of “calms” from all five anemometers are more or less the same, one can certainly assume that the anemometers are all in good working order.
However, if one anemometer regularly produces a lot more “calms” than the rest, it should be kept under close scrutiny, as it might be starting to go faulty.

Together with the matlab graphs, the data can be assessed in detail for correctness. Ursula deletes the final identified bad records out of the database, re-extracts the data and places it on the download site.

**Project Deliverables**

The data on the WASA download site is free of anomalies after it has undergone this stringent QA process. A short report on the QA of the data from the ten stations is produced and put onto the WASA Project Team website (http://teamsites.risoe.dk/wasa/WP2 Measurements). The website is however only accessible to the WASA team. These reports are now also available in the Report on Measurements.
ANNEXURE A

6.1 RODEO User’s Manual
Risø Online Database for Environmental Observations (RODEO)

Rodeo is a data management system where online measurement data is stored in a MySQL database. From this database data is automatically displayed on a web page.

Every measurement campaign has its own database. The database includes both statistical and time series.

The aim is that data, which enters Risø automatically, by modem, satellite or an Internet connection, are put in the database. The data are then automatically evaluated to the extent that this is possible and then calibrated. The calibrated data can then be accessed from the database along with the raw values. The quality check is documented in the database. Data is displayed on the Internet or locally if that is preferred. The displays are updated when new data arrives. The data can be downloaded as ascii-files from the Internet. The Rodeo for Risø data can be seen on http://veamonline.risoe.dk

1 Introduction

For a couple of years the Wind Energy Department at Risø National Laboratory in order to handle the large amount of data from several measurement projects it has been decided to store the data in databases rather than in simple text files.

To simplify the set up and maintenance of the database and online display of data a concept of having most of the databases managed through web interfaces is used.

2 Database overview

To separate the tasks of managing the measurement projects, the online web display and the measurement instruments a number of databases is used. Each database holds information on a specific collection of data and a number of web interfaces and input/output interfaces are used to link the databases together and store data in the databases. An overview of the database design is shown below.
The Open Source database MySQL is used for the database implementations. MySQL is a very fast, multi-threaded, multi-user, and robust SQL (Structured Query Language) database server. MySQL is free software. It is licensed with the GNU GENERAL PUBLIC LICENSE. It runs on many platforms and operating systems. MySQL is a relational database management system. This adds speed and flexibility. The tables are linked by defined relations making it possible to combine data from several tables on request. The SQL part of MySQL stands for “Structured Query Language” - the most common standardised language used to access databases.

2.1 Display Setup

The information on the formatting of the online web display for each individual measurement station is kept in XML files.

- Graphical elements used for the display (graphs, xy-plots, wind rose, etc.)

Project managers for each of the measurement projects manage the Display Setup DB using the online ‘Manage Graphical Configuration’ page.

2.2 Projects Overview DB

The Projects Overview DB is used to hold administrative information on each individual measurement project in the Measurement Data DB's.

This information includes:

- Name of the project
- Reference to a Measurement Data DB
- Contact information (project responsible, email, ...)
- Measurement site description
2.3 Measurement Data DB's

The Measurement Data DB's holds the actual measurement. There must be one Measurement Data DB for each measurement project to be stored in the databases. The data is stored in the database as time series data, statistical data or both and may be uncalibrated (raw) or calibrated depending on the use of the database.

These databases include:
- Time series data (fast sampled data e.g. at 35 Hz)
- Statistical data (mean value, minimum, maximum and standard deviation e.g. on a 10 minute time scale)
- Information on the measurement setup (sample rate, parameters measured, etc.)
- Sensor calibration information
- Quality control parameters (limit checking, etc.)

The primary interface for these databases is the Measurement Data Interfaces and the Analysis Tools.

The Measurement Data Interfaces are primarily considered to be input interfaces, which runs automatically during data acquisition to store measurement data 'on-the-fly'. This means that new data are put into the databases on regular time intervals e.g. by using email transmission or ftp data transfer.

The Analysis Tools are primarily considered to be output interfaces operated manually during analysis. Examples of such tools are database tools like Microsoft Access, spreadsheet tools like Microsoft Excel or plotting tools like GnuPlot. Also custom made software may be used for analysis or post processing on the measurement data.

3 Web interfaces

To simplify the management of measurement projects and access to measurement data a number of web interfaces is used to exchange information with the databases. Using this approach gives an easy access to the databases using a standard web browser. Two web interfaces is used for managing the measurement projects setup and online data display while one web interface offers access to the measurement data from the outside world.

Some basic tasks (like managing users) and tasks that require a lot of decisions to be made (like adding a new measurement project) is not available through the web interfaces initially, but may be included in future releases.
3.1 Online Display Management Web

The Online Display Management Web is used to set up web display information on measurement projects. Before setting up a web display the measurement project must be defined in the Projects Overview DB and in a Measurement Data DB using the Project Management Web. This way most of the textual information to be presented on the online display may be retrieved from the project databases.

The Online Display Management Web is divided into two groups of functionality - one for the web master and one for the project manager. The web master have access to all the functionality provided for the project manager and additional functions for adding or removing measurement projects from the online data display.

The functionality of the Online Display Management Web must include:

- Adding a new measurement project for online data display
- Modifying an existing measurement project
- Setting up display parameters

Both the web master access and the project manager access to the database is password protected. The functions available depend on the user logged in and the security level of the projects.

Project security levels:

1. Secret project, name not in the list of projects.
2. existenceonly, name on the projectlist and map, No access
3. overviewonly, only the overview page shown, Overview only
4. Public graphics (no download of data) No download
5. Public, Full access

User roles:

- Administrator (full access to all information)
- Project manager (full access to project)
- Project member (read access to project)

3.2 Online Display Web

The Online Display Web is the external web interface for displaying online data from the databases. While the other web sites described in this document is for management purposes, this is a presentation-only web site with access for the public or a predefined group of people using password protection. As an option the online display web page may include download of measurement data for further processing.

Before adding a new measurement project to the online display web the project manager must decide whether to use password protection and whether to have the option of downloading measurement data.

The main entrance of the Online Display Web is a map for selecting the requested measurement location. An example of the main entrance is shown in Figure 3.
A special login window is used for access to password protected measurement data. After login the user has the same navigation facilities as for the public measurement data.

Some measurement projects may allow public display of measurement data using a graphic display, but not public access to the measurement data itself. For these measurement projects a login window will not be displayed until the measurement data is requested.

After selecting a measurement location on the map, a window showing information on the measurement station is displayed. An example of such a window is shown in Figure 2.

Further information on a measurement project may be given by linking to a project web site. This web site may be hosted anywhere in the world and may hold information e.g. on research projects related to the measurements. Alternatively, this link may be used for web pages holding special reports on the measurement data either produced manually or scheduled automatically. These web
pages with specialized reports may be hosted locally or remote and must be specified by the project manager.

Figure 2 Measurement station, Description page

By clicking graphs, the user is directed to the actual plot page. The layout and number of graphs on the plot page depend on the plots selected when setting up the measurement project in the Online Display Management Web. An example of the online data page is shown in Figure 3.

The Risø online display pages of today have a fixed time scale selection of one day, one week or one month. However, storing the measurement data in databases result in a more flexible interface for picking data out on various time scales.

As an option the online data page has a link for downloading the actual measurement data. This option is, of course, controlled by the project manager and password protected.
3.3 Project Management Web

The Project Management Web is used to manage the measurement projects stored in the Measurement Data DB. While updating the individual projects in the Measurement Data DB an overview of the measurement projects including administrative information is maintained in the Projects Overview DB. This means that the Project Management Web operates in both databases when changes are made to the measurement setup.

The functionality of the Project Management Web includes:
- Modifying administrative information on measurement projects
- Modifying instrumentation setup
- Modifying sensor calibrations
- Setting up automatic quality control
A channel specification is a set of data describing the complete measurement setup and a new channel specification is created each time the measurement setup changes.

Some means of quality control is implemented in the database system. Information on the quality control is be stored in the Measurement Data DB The quality control includes these features:
- Limit checking on statistic data
- Slope checking on statistic data
- Watch for special values
- Watch for missing data

As part of the standard quality control, there is a message system for sending data values or warnings via email or SMS messages.

# 4 Data interfaces

In this manual we refer to all kinds of programs and analysis tools that access the database as data interfaces. It can be commercial or custom made software. The description is divided in two parts “Measurement Data Interfaces” which retrieves data and stores data in the Measurements data DB and “Analysis tools” which is used to retrieve data from the database.

## 4.1 Measurement Data Interfaces

Online data can be collected from the measurements station in a number of ways: They can be retrieved by use of modem, they can be sent by electronic mail or they can come as text files via ftp. The interface programs, which receive data and store data in the database, can either run on scheduled times or whenever there are new data.

The measurement data interface programs do calibration and quality control of data. The information for doing this is stored in the database. The programs also send a message by email or SMS if limits are exceeded or other alarm situations are discovered by the quality control. The measurement data interface programs must therefore run on a “modem server”, from which it is possible to interact with the database server and send messages.

Channels calculated from measured values are also handled by this program and treated as any other channel in the database.

### Quality control

To the extent quality control is possible to implement automatically, this is done in this database. For instance an upper and lower limit for each data channel can be specified together with a maximal rate of change and values, such as error codes, that need to be changed. A message can be sent to the data owner if these limits are exceeded. Also if data fails to arrive for a specified amount of time a message will be sent to the data owner.
No changes in the database is done by the automatically control. All sorts of quality control might be implemented along with the most general ones described. These will probably vary from project to project.

**Time series**

Time series of data are usually collected and stored on a computer at the measurement site and only the statistically data are sent to the database server.

### 4.2 Analysis Tools

As mentioned the database can be accessed from many existing programs: You can link directly to the tables using Access or Excel using an ODBC-driver.

Another way to get data is by downloading data files from the web display. This download can be password protected.

It is possible to have automatically generated reports. A batch process can be scheduled to run at specified intervals and the generated reports can be uploaded to some custom web pages linked to from the “Online Display Web” description page.