

RESEARCH FOR THE MANAGEMENT  
OF THE FISHERIES ON THE  
LAKE TANGANYIKA

GCP/RAF/271/FIN-FM/10 (En)

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FIELD NOTES FOR HYDRODYNAMICS

by

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FINNISH INTERNATIONAL DEVELOPMENT AGENCY

FOOD AND AGRICULTURE ORGANIZATION  
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## **PREFACE**

The Research for the Management of the Fisheries on Lake Tanganyika project (Lake Tanganyika Research) became fully operational in January 1992. It is executed by the Food and Agricultural Organization of the United Nations (FAO) and funded by the Finnish International Development Agency (FINNIDA) and the Arab Gulf Programme for United Nations Development Organizations (AGFUND).

This project aims at the determination of the biological basis for fish production on Lake Tanganyika, in order to permit the formulation of a coherent lake-wide fisheries management policy for the four riparian States (Burundi, Tanzania, Zaïre and Zambia).

Particular attention will be also given to the reinforcement of the skills and physical facilities of the fisheries research units in all four beneficiary countries as well as to the buildup of effective coordination mechanisms to ensure full collaboration between the Governments concerned.

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## **1. INTRODUCTION**

The objectives of this field manual are to give detailed instructions on how 1) to unload LTR's automatic recorders and to handle P3059 software for unloading and filing collected data; 2) to conduct standardized water current and anemometer measurements on the Lake; and 3) to use basic data files, tables and field forms with filling instructions and examples of calculations. After data collection, the ultimate task is to compile all meteorological and hydrological data and use them for hydrodynamic modelling of Lake Tanganyika.

## **2. RECORDING EQUIPMENT IN HYDRODYNAMICS**

### **2.1 Mpulungu lake meteo station**

The structure of the lake meteo station has been introduced before in the 'Field manual for hydrodynamic measurements on lake Tanganyika' by Huttula, Peltonen and Nieminen, 1993.

The lake meteo station in Mpulungu collects wind and water temperature data. It is located in the south end of the Lake, 40 kilometers to the north of Mpulungu. The station consists of a buoy, solar cell power supply and sensors for wind speed, wind gust, wind direction, air temperature and water temperature. The sensors are controlled through a scanning unit. A data storing unit (DSU) is connected to it. A DSU is a memory unit where the recorded data are stored.

The station records automatically a total of 15 parameters during a certain interval, which is adjustable in the control panel of the scanning unit. In Mpulungu data are recorded every hour. The capacity of the memory is limited: it can store datasets of 16 measured parameters once an hour for 169 days. It has to be changed at least every fifth month. The personnel of LTR/Mpulungu is responsible for changing and unloading of DSUs.

The recordings of the lake meteo station give important information on winds, air temperature and water temperature from 1 down to 300 meters. By compiling these data, it is possible to focus on the seasonal variation of winds, stratification of water layers and the upwelling phenomena.

### **2.2 Bujumbura meteo station**

LTR's second automatic station, a meteo station, is located in Bujumbura. It consists of a scanning unit, a DSU in a housing, and of a pole of ten meters with two sensor bars, one at 4 meters and another one at 13 meters. At four meters there are three sensors recording parameters as wind speed, wind gust, air temperature and relative humidity. The same type of sensors are found at 13 meters and in addition wind direction, solar radiation and rainfall sensors are present. The recording interval is 10 minutes and the capacity of a DSU memory for a dataset of 12

parameters is 37 days. The DSU has to be changed every month. The personnel of LTR/Bujumbura is responsible for changing and unloading of DSUs. The structure of the meteo station has been introduced earlier in the 'Field manual for hydrodynamic measurements on lake Tanganyika' by Huttula, Peltonen and Nieminen, in 1993.

The meteo station is situated in Bujumbura port, in the northernmost part of the Lake. It gives accurate information on the seasonal variation of meteorological conditions in the area.

### **2.3 Kigoma wind station**

Kigoma wind station measures coastal wind speed, wind gust and wind direction. It consists of a scanning unit, a DSU in a housing and of a pole with two sensors. The recording interval is 20 minutes. For four parameters, including a reference channel, the capacity of a DSU is 225 days. It has to be unloaded every seventh month. The personnel of LTR/Kigoma is responsible for changing and unloading of DSUs. The wind station is situated one kilometer outside Kigoma on a hill top. The wind station gives important information on coastal winds in Kigoma representing the mid-northern part of the Lake.

### **2.4 Water level recorders**

At each LTR station, (in Mpulungu Kigoma and Bujumbura), there is a Telog automatic water level recorder. It is a pressure sensor in a plastic tube attached either to a pier or a pole. The sensor is recording hourly mean values of water level. It differs from the wind and meteo stations; data are stored in a Telog memory and unloaded and filed in Corderbase software. The Telog's in-built memory unit can store data of 9 months. The unloading interval is thus 8-9 months. Telog is always recording. When the memory becomes full, new recordings overwrite the old ones. So, the memory contains always the most recent data. The software and a portable computer are required for unloading. Because of the fairly large capacity of memory and special requirements of equipment for unloading the water level station, the units will be unloaded by the field coordinator in hydrodynamics during follow-up missions to the different LTR stations.

These three water level stations can detect variation of water level in space and time in Lake Tanganyika. The information can be used for the hydrological modelling of Lake Tanganyika.

### **2.5 Anemometers**

In Kipili and in Mpulungu LTR has anemometers for wind measurements. An anemometer has a counter, which is counting the number of rounds, indicating wind speed. The number of rounds are recorded manually three times a day: 8:00, 14:00 and 20:00 hours Burundi time. The average wind speed is proportional to the difference of two consecutive readings and the time difference

between the two readings. A Data entry table and form for anemometer recordings are presented in Annexes 1 and 2.

## **2.6 Current cylinders**

Water current measurements are conducted in Mpulungu, Bujumbura and Kigoma stations. Measurements are done with flow cylinders. A cylinder consists of two metal rings and of a water tight tissue between the rings. The diameter of a ring is 0.6 meters and the distance between the two rings is one meter. A cylinder is attached to a floating buoy with a rope of 2-40 meters; measurements are done at depths between 2 and 40 meters. Wind speed and direction are measured before and after each measurement.

These measurements give important information on wind, its direction and their relation to water currents. Especially the surface currents and lake winds are of importance, but also currents in deeper layers. With frequent measurements a pattern of seasonal changes in currents and winds can be determined in study areas. The methodology to conduct water current measurements is explained in chapter 5.

## **2.7 Working schedule for each station**

Each LTR station is responsible for conducting the measurements and unloading the recorders according to the working program in hydrodynamics.

Anemometer measurements are conducted in Mpulungu and Kipili. Responsibility of processing the measurements remains at the LTR personnel in Mpulungu and Kigoma (data from Kipili are to be sent to Kigoma). All data collected should be sent to Bujumbura on monthly or bimonthly basis as files on a diskette and copies of originals.

Current measurements should be conducted once a week at each station and data filed and sent to Bujumbura every second month as files on a diskette and copies of original data forms.

Telog recorders will be unloaded by the staff of LTR/Bujumbura. The working schedule for each station, (i.e. when to conduct the measurements and unload the recorders, is introduced in Annex 3.

## **3. HANDLING AUTOMATIC RECORDERS AND DATA FILING**

The Lake meteo and land meteo/wind stations mentioned above are in principle similar units, but differ from each other in their memory capacity and available sensors. The data unloading of a meteo or a wind station is done in the same way. This can be done with the software P3059. However, each station is unique and therefore their file setups are different. One has to pay attention to this. When the setup is carefully done, no problem will arise when unloading. It is important to follow the data

reading and transferring instructions.

- 1) Edit configuration of computer and create subdirectories for data files.
- 2) Install software P3059.
- 3) Connect DSU and DSU-reader to computer.
- 4) Start the software.
- 5) Update an empty DSU.
- 6) Configure path and ports for reading a DSU.
- 7) Create an info-file of calibration coefficients and unload raw data from DSU.
- 8) Convert the raw data to real values.
- 9) Restore the initial configuration of the computer.

### **3.1 How to change a DSU**

The memory unit (DSU 2990) where the data are stored, is changed in the same way for all stations. For that is needed an empty, updated DSU. How to update a DSU, is explained in chapter 3.3.3.

- 1) A DSU is removed between two recordings. If the scanning unit doesn't have a time display (time spent from the last reading), one has to wait for the next recording or calculate the time of the next recording. The number of the dataset can be calculated as well. For Mpulungu lake meteo buoy, the number of datasets is 25/day (1 dataset/hour + the date recording = 25 datasets) This is to confirm that the DSU has been working properly.
- 2) A label has to be attached to the DSU and written down the first recording for the empty DSU and the first and the last recording of the full one.
- 3) Cable plug is turned to counterclockwise direction and the plug is pulled out from the socket. A black cap is used to protect the socket of the unplugged DSU.
- 4) The new DSU is pushed in to the socket and turned to clockwise direction.
- 5) If possible, the first reading of the new DSU should be verified. During the reading, the number in the DSU display should increase by the number of channels (In Mpulungu 16, Bujumbura 12, Kigoma 4. These are the sizes of the datasets for each station (see also chapter 3.3.6). Once a day the date is recorded. The size

of its' dataset is 6 bits.

### 3.2 Installation of software P3059

#### 3.2.1 Changing computer's configuration

After a full DSU has been removed, it has to be unloaded. For this purpose, Aanderaa company has provided a software, P3059 (vol. 121093). With this software a memory of 18 channels can be unloaded. The software can be used for all DSUs. Before starting to unload the DSU, computer's configuration has to be edited. Computers are normally configured to use the upper memory area while running a software, not a conventional memory. The P3059 is an exception.

Conventional memory is needed for running it. The instructions, how to edit configuration of AUTOEXEC.BAT and/or CONFIG.SYS files, are presented below.

#### **ATTENTION!**

**BEFORE YOU CHANGE CONFIG.SYS OR AUTOEXEC.BAT FILES MAKE A SYSTEM DISKETTE AND COPY THE ORIGINAL AUTOEXEC.BAT AND CONFIG.SYS FILES**

1) PLACE AN EMPTY DISKETTE IN DRIVE A, TYPE **FORMAT/S A:** AND PRESS **ENTER**

2) A SYSTEM DISKETTE IS BEING CREATED.

WAIT UNTIL THE DISKETTE IS FORMATTED COMPLETELY.

SERIAL OR VOLUME NUMBER ARE NOT NECESSARY TO ENTER.

PRESS JUST **ENTER**.

COMPUTER ASKS 'DO YOU WANT TO FORMAT ANOTHER DISKETTE?'

TYPE **N**.

3) WRITE DOWN ON THE DISKETTE LABEL "SYSTEM DISKETTE" AND STORE IT.

4) COPY FROM DIRECTORY C: THE ORIGINAL AUTOEXEC.BAT AND CONFIG.SYS FILES TO ANOTHER EMPTY DISKETTE:

PLACE AN EMPTY DISKETTE IN DRIVE A: AND GO TO C: !> PROMPT.

TYPE **COPY AUTOEXEC.BAT A:** AND PRESS **ENTER**.

TYPE **COPY CONFIG.SYS A:** AND PRESS **ENTER**.

9) WRITE DOWN THE NAMES OF THE FILES ON THE LABEL AND STORE IT.

In case of problems in starting your computer after editing AUTOEXEC.BAT or CONFIG.SYS files, you can restart your computer by placing the system diskette in drive a, switch off the computer and after five seconds switch it on again. Then copy the original AUTOEXEC.BAT or CONFIG.SYS files from the diskette to your harddisk c:\ and restart your computer by pressing CTRL+ALT+DEL:

SWITCH OFF YOUR COMPUTER.

PLACE YOUR SYSTEM DISKETTE IN DRIVE A: AND SWITCH ON YOUR COMPUTER. WAIT FOR THE SETUP. YOU ARE IN C:\>.

REPLACE THE SYSTEM DISKETTE WITH THE DISKETTE OF AUTOEXEC.BAT AND CONFIG.SYS FILES IN DRIVE A.

GO TO DRIVE A: TYPE **A:**

TYPE **COPY AUTOEXEC.BAT C:** AND PRESS **ENTER**.

TYPE **COPY CONFIG.SYS C:** AND PRESS **ENTER**. REMOVE THE DISKETTE FROM DRIVE A:

PRESS **CTRL+ALT+DEL** AND WAIT FOR SETUP AND CONFIGURATION.

NOW YOUR COMPUTER'S SETUP IS THE SAME AS IT WAS BEFORE.

Editing of AUTOEXEC.BAT and/or CONFIG.SYS files can be done easily in DOSSHELL Editor.

Switch on your computer. When hardware reading and configuration is finished you are in prompt C:\V..

Type **cd dos** and press **enter**.

You are in C:\>dos prompt.

Type **dosshell** and press **enter**.

You should now be in DOSSHELL window.

You will see the directory tree in the left window and a list of files of that directory in the right window. Below these is the Main menu.

Go with mouse to Main menu, choose **EDITOR** and **click it twice**. DOSSHELL Editor will be loaded.

**A.** File to edit [.....] appears on the screen.

Type in the 'file to edit' **C:\AUTOEXEC.BAT**.

Now AUTOEXEC.BAT file in editor appears on the screen.

Choose FILE and then SAVE AS.

Use **backspace to remove the three last characters** and change them into TMP by typing **TMP**.

Now the whole line is **C:\AUTOEXEC.TMP**

Choose **<OK>**

Now your AUTOEXEC.BAT is saved also as AUTOEXEC.TMP

Check the file line by line, to see if there are no LOADHIGH or HIMEM.SYS options.

There might be a command line like:

```
DEVICE=C: \WINDOWS\HIMEM.SYS
```

1) If you find a similar line as above or another command line including the LOADHIGH command, type **REM** in the beginning of these lines and leave a space between REM and the next word.

```
For example: REM DEVICE=C: \WINDOWS\HIMEM.SYS
```

This means that your computer will not execute this command line next time you switch on the computer.

To save the file you have edited, go to FILE menu in the upper part of the screen by clicking FILE and choose there SAVE AS.

Use **backspace to remove the three last characters** and type **BAT**.

Now the whole line is **C:\AUTOEXEC.BAT**

Choose **<OK>**

Newly configured AUTOEXEC.BAT file for reading DSU is being saved.

The old AUTOEXEC.BAT file is still in C:\ saved as AUTOEXEC.TMP

Exit DOSSHELL Editor from the same **FILE menu** by clicking EXIT.

2) If there is neither HIMEM nor LOADHIGH command, choose directly **FILE menu** and leave DOSSHELL Editor by **clicking EXIT**.

You will see the Directory tree in the left window and list of files of that directory in the right window. Below these is the Main menu.

Go with mouse to Main menu choose **EDITOR** and **click it twice**.

DOSSHELL Editor will be loaded.

**B.** File to edit [.....] appears on the screen.

Type in the 'file to edit' **C:\CONFIG.SYS**.

Now CONFIG.SYS file in Editor appears on the screen.

Choose FILE and then SAVE AS.

Use **backspace to remove the three last characters** and type **TMP**.

Now the whole line is **C:\CONFIG.TMP**

Choose **<OK>**

Now your CONFIG.SYS is saved also as CONFIG.TMP

Check the file line by line, to see if there are no LOADHIGH or HIMEM.SYS options.

There might be a command line like:

```
DEVICE=C: \WINDOWS\HIMEM.SYS
```

1) If you find a similar line as above or another command line including the LOADHIGH command, type **REM** in the beginning of these lines and leave a space between REM and the next word.

For example: REM DEVICE=C:\WINDOWS\HIMEM.SYS

This means that your computer will not execute this command line next time you switch on the computer.

To save the file you have edited, go to FILE menu in the upper part of the screen by clicking FILE and choose there SAVE AS.

Use **backspace to remove the three last characters** and type **SYS**.

Now the whole line is **C:\CONFIG.SYS**

Choose **<OK>**

Newly configured CONFIG.SYS file for reading DSU has been saved.

2) If there is neither HIMEM nor LOADHIGH command, choose directly **FILE menu** and exit DOSHELL Editor by **clicking EXIT**.

You are now back in DOSHELL MAIN menu.

Choose there **EXIT in FILE menu** to quit DOSHELL.

You should be back in C:\>DOS prompt.

Switch off your computer and after 5 sec. switch it on again.

You can as well reboot your computer by pressing **CTRL+ALT+DEL**.  
If the computer starts normally you should be in C:\> prompt.

### **3.2.2 Creating subdirectories and installation**

In C:\> prompt create a subdirectory C:\p3059.

Type **md p3059** and press **enter**.

and another subdirectory for the data files.

Type **md hydro** and press **enter**.

Check in C:\> prompt, that you really did create the subdirectories C:\P3059 and C:\HYDRO and

type **dir** and press **enter**

You should have a list of your subdirectories on the screen, including the new ones. If not, try again.

Take the program diskette of P3059 and insert it in drive a:

Change the prompt from C:\> to drive A:> by typing a: and press **ENTER**.

You should be now in the a:\> prompt.

Type **hardinst C:\P3059**.

You should be now in the 'HARD INSTALLATION MENU OF P3059' "Press any key to continue..

Press **ANY key** to start the copying of the files.

Hardinst command copies the program to C:\P3059 and it is ready to use.

## **3.3 Running software P3059**

### **3.3.1 Connecting DSU and DSU-reader to computer**

DSU and DSU-reader should be connected to the computer while it is switched off.

Remove the black cover of the DSU. Connect the DSU-reader into the DSU as well as into your computer's COM1 port. Plug cable no. 2842C from DSU-reader into the DSU, cable no. 3016A with the extension into your computer's COM1 port and power cable for DSU-reader.

### 3.3.2 Starting P3059

You have connected the DSU and its reader to your computer. Switch on your computer.

You are in C:\> prompt.

To start the program you go first from c:\ prompt to:\P3059 prompt. So, type

**cd p3059** and press **enter**.

You should be now in C:\P3059> prompt.

Start the program.

Type **menu** and press **enter**.

Now you should be in the MAIN-MENU in ENTER OPTION >

### 3.3.3 Updating an empty DSU

Every time you change DSU you have to update it. It means that the real time and the date of a DSU have to be checked and changed if required.

From MAIN-MENU choose **D**, 'DATA STORING UNIT'.

You are now in DSU COMMAND MENU.  
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Press **D** 'DISPLAY AND/OR SET REAL TIME CLOCK:'.

The program reads the current date and time from the DSU and asks:

DO YOU WANT TO CORRECT (Y/N) ?

If the date and time are incorrect answer **Y**.

You get format:           yy-mm-dd (year-month-day, 94-01-09)  
                  SET DATE:

Follow the format and press **enter** when you have changed the date.

You get format:           hh-mm-ss (hours-minutes-seconds, 11-22-00)  
                  SET TIME:

Follow the format and press **enter** when you have changed the time.

Press **Q** to return to MAIN-MENU.

Now you have updated the DSU and it is ready for use.

### 3.3.4 Configuring paths and ports for reading DSU

Most of the commands in P3059 software work just by pressing **the first character of a command**, without entering. While working in P3059 you can in most cases return to previous menu by pressing **esc** to get the command line at the bottom of the screen and then **E** (EXIT) or simply pressing **E** to exit without ESC. The only exception is in DSU MENU.

Special attention should be paid while reading a DSU, because E command in DSU MENU will erase the unit!

If you have pressed E, software asks

'DO YOU WANT TO ERASE THE DSU?' (Y/N?)

Press **N**.

In the MAIN-MENU choose CONFIGURATE so, press **C**.

You should now be in the CONFIGURATION MENU and in Tape Reader COM1 cell.

Press **arrow down key twice** and you are in DATA FILES SETTINGS RAW-DATA FILE field.

Use **the backspace key** to delete the whole line.

Then type THE PATH and THE FULL NAME OF THE RAW-DATA FILE.

For example: **C:\HYDRO\MC101293.ASC**

For Mpulungu lake station it should be MC101293.ASC

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M=Mpulungu            B=Bujumbura            K=Kigoma  
C=Chain                M= Meteo station        W=Wind station

101293=day, month and year of last recording of DSU being unloaded.

While unloading the memory raw data will be saved as MC101293.ASC on the harddisk in directory C:\HYDRO.

Press **arrow down key**.

You should be now in ENG.UNIT FILE field.

Use **the backspace key** to delete the whole line.

Then type THE PATH and THE FULL NAME OF THE ENG.UNITS FILE.

For example **A:\MC101293.ENG**

When transferring the raw data file to engineer units, i.e. to

real values, this file will be saved on a diskette in drive a: as MC101293 .ENG.

Check that information is correct and press **arrow down key**.

COMMAND LINE appears on the bottom of the screen.

Press **E** to save the configuration file and to return to MAIN-MENU.

Now you have created a configuration file C:\P3059\P3059.CNF

You are ready to start to read the DSU.

### 3.3.5 Reading a DSU

You should be in the MAIN-MENU.

Press **D**.

You should be now in DSU COMMAND MENU.

Press **S**.

'ENTER NUMBER OF WORDS TO READ FROM DSU>' appears' on the screen.

Write down the number of words from the DSU digital display (This is for checking afterwards the success of unloading).

If on the screen appears 'DSU DO NOT RESPONSE. CHECK CONNECTIONS SERIAL PORT CONFIGURATION', then you should check the connections of DSU to 220V, to DSU-reader and to computer and try again.

If you still get the error message, go to MAIN MENU.

by pressing **Q**.

Then press **C**.

You are in the CONFIGURATION MENU.

Press **arrow down key twice** to get SET PORTS FOR: D.S.U. MENU and press **space bar**.

Port is changed to COM2.

Press **Esc** and **E**.

You are back in the MAIN MENU.

Choose **D**.

Start reading DSU, press **S**.

It should work now.

'ENTER NUMBER OF WORDS TO READ FROM DSU>' appears' on the screen.

Press **enter**.

In screen appears 'ALL' which means that the program will read the whole memory.

You can as well type the number of words you have in the DSU digital display, max 65520 (this is the maximum number of 10-bit words DSU can store).

If the DSU is full you type **65520** and press **enter**.

The number in the DSU digital display should start to decrease by 100 bits intervals.

Wait until the digital display of the DSU is zero.  
When the DSU is full, this will take approximately 10 minutes.

When the reading is finished the text '65520 WORDS READ FROM THE MEMORY' appears on the screen.

Compare this number to the number you wrote down from the DSU digital display before you started the reading. If they are the same, quit P3059 software to check if you managed to read the raw data completely.

Press **Q** and then press **E**.

You should now be in C:\P3059 prompt and out of the P3059.

Type **cd..** and press **enter**.

You should now be in c:\> prompt.

Type **cd hydro** and press **enter**.

You should now be in c:\HYDRO> prompt.

Type the following: **type [MC101293.ASC]** and press **enter**.

Raw data file lines start to scroll and the datasets (lines) should be horizontal and in straight columns. If you want to stop the scrolling press **pause** and **space bar** to continue.

If the columns are 'jumping' considerably (the lengths of the data sets vary), you did not manage to read the data from the DSU

properly.

Try to read the DSU again by following the instructions in the chapter 3.3.5.

If you managed to read the DSU press **Q** and then **E** to quit and you should be in the MAIN MENU.

Press **E** and you should be in the c:\P3059 prompt. If you have to abort the reading before it is finished

press **A**.

On the screen appears the text:

'TRANSFER ABORTED!'

Press **Q** (QUIT TO MAIN MENU) and you should be back in the MAIN MENU.

Try reading again, press **D** to go back to DSU COMMAND MENU and you can start reading the DSU again.

While you are in the DSU MENU

**NEVER ERASE THE DSU BEFORE YOU ARE 100% SURE THAT YOU HAVE READ THE RAW-DATA FILE COMPLETELY!**

### **3.3.6 Transferring raw-data file to real values**

To convert the raw-data file to eng. units you start the program in

C:\> prompt by typing

**cd p3059**

You should be in the C:\>P3059 prompt.

Type **menu**.

You should now be in the MAIN-MENU in 'ENTER OPTION >'

Press **I**.

You should be in the 'STATE THE TYPE OF DATA COLLECTING INSTRUMENT USED-MENU'.

There are three options.

Choose 'OTHER TYPES OF INSTRUMENTS' press **0**. You should now be in 'MAKE OR CORRECT EXISTING INFORMATION-FILES MENU'.

There are also three options, choose I, INPUT-PAGE, (check or correct the information)

You should now be in INPUT-PAGE in IDENTIFICATION-MENU in STATION field.

Type here:

**COAST.MONITORING BUOY/MPULUNGU** for Mpulungu lake meteo station  
**WEATHER STATION/BUJUMBURA** for Bujumbura meteo station  
**WIND STATION/KIGOMA** for Kigoma wind station

and press **enter**.

You should be in the INSTRUMENT field.

Type:

**SENSOR SCANNING UNIT 2900/20** for Mpulungu lake meteo station  
**SENSOR SCANNING UNIT 3010/905** for Bujumbura meteo station  
**SENSOR SCANNING UNIT 3110/346** for Kigoma wind station

and press **enter**.

You should now be in TIME OF MEASUREMENTS-MENU and in FIRST: DATE cell.

Type here **date of the first measurement** (see the label attached in the DSU) following the given format example.

Press **enter**.

You should now be in the TIME field.

Type **the time of the first measurement** and press **enter**.

You should now be in the GMT/LT field.

Type **LT** (LOCAL TIME) and press **enter**.

Fill in the 'LAST: DATE, TIME, GMT/LT' respectively (you should have the information for these fields written down when you changed the DSU) and press **enter** after filling up the information in each field.

You should now be in the 'SAMPLING INTERVAL' field.

15

Type **the sampling interval in minutes** into the field.

**60** for Mpulungu lake meteo station  
**10** for Bujumbura meteo station  
**20** for Kigoma wind station

and press **enter**.

You should now be in the 'NUMBER OF CHANNELS' field. Type

**16** for Mpulungu lake meteo station

**12** for Bujumbura meteo station

**4** for Kigoma wind station

and press **enter twice**.

You should now be in the 'SPECIFICATIONS FOR CHANNEL NO. MENU'.

Thus, there are 16 channels, 1 reference channel and 15 channels for different parameters for Mpulungu, 1+11 for Bujumbura and 1+3 for Kigoma wind station.

Then, fill in the specifications for each channel and save the file. The specifications and calibration coefficients of all stations are listed in Annex 4.

Fill in **the sensor types, serial no. remarks and calibration coefficients for each sensor**. The coefficients are A, B, a, b, C and D. Leave coefficients a and b as they are. You can move from one field to another by pressing **enter**. If you want to edit any of the channel information afterwards go to CHANNEL NO. cell and type **the number of the channel** you want to edit and press **enter**. When you have filled up all info for the channels, you will end up to COMMAND LINE at the bottom.

Press **E** and you should be in INPUT-MENU.

Press **ALT S**.

On the screen appears a text 'INFO-FILE SAVED!'

Press **E twice** and you are in MAIN-MENU.

Now you are ready to start to read 'RAW-DATA FILE to ENG. UNITS'.

Press **F** 'FILLING ON DISKETTE IN ENGINEER UNITS'.

You should be in FILLING ON DISKETTE IN ENGINEER UNITS-MENU.

Choose **0**, 'OTHER TYPE OF INSTRUMENT'.

Press **ALT L** to load the info-file you have created.

Press **E**.

You should be in FILLING IN ENGINEER UNITS-MENU.

**Insert** a new formatted diskette in drive a:

You should see also the paths and the file names you created in the CONFIGURATION MENU for reading the raw data file to engineer units file.

Program asks you (at the bottom of the screen) 'ARE YOU READY TO START? (Y/N)':

Press **Y** (if you are ready and **N** if not) Check that you placed an empty formatted diskette in to drive a.

Software starts to transfer the raw-data file to engineer units. The number of transferred lines scrolls in the bottom right corner.

When the transfer ends, write down the number of lines read in engineer units, in order to compare the number of readings to the time period and interval during which the DSU was recording.

If the interval of recording was 10 minutes and the period 30 days 10 hours and 50 minutes, the number of lines should be 4415.

$30 \text{ (days)} \times 24 \text{ (hours)} \times 6 \text{ (times per hour)} + 10 \text{ (hours)} \times 6 \text{ (times per hour)} + 5 \text{ (times per hour)} + 30 \text{ (number of date datasets)} = 4415 \text{ lines (datasets) read.}$

When the transfer is finished, press **N** and then **E** so many times as needed to get out of the program and back to c:\P3059 prompt.

Change the directory:

Type **a:** and press **ENTER**

Type **type MC101293.eng** and press **ENTER**

You are listing the file of engineer units and you should see the names of the parameters and the real values of measurements running on the screen. Let it scroll until the end of the file to verify that all datasets are complete. If something seems to be missing, repeat the instructions in chapter 3.3.5.

### **3.3.7 Editing configuration and info-file**

Once you have created the INFO-FILE, you don't have to repeat the instructions in 3.3.4. Next time you read a raw file, you can just edit the configuration and the old INFO-FILE and save them again.

Start P3059.

#### A. CONFIGURATION FILE

You are in the MAIN MENU.

Press **C**.

In the MAIN-MENU choose CONFIGURATE so, press **C**.

You should now be in the CONFIGURATION MENU and in Tape Reader COM1 cell.

Press **arrow down key twice** and you are in DATA FILES SETTINGS RAW-DATA FILE field.

Use **the backspace key** to delete the old name of the raw-data file.

Then type THE FULL NAME OF THE NEW RAW-DATA FILE.

For example: **C: \HYDRO\MC090294.ASC.**

Press **arrow down key.**

You should now be in ENG.UNIT FILE field.

Use **the backspace key** to delete the old raw-data file name.

Then type THE NEW NAME OF THE ENG.UNITS FILE.

For example **A:\MC090294.ENG**

When transferring the raw-data file to engineer units, i.e. to real values, this file will be saved on a diskette in drive a: as MC090294.ENG

Check that information is correct and press **arrow down key.**

COMMAND LINE appears at the bottom of the screen.

Press **E** to save the old edited configuration file.

Now you have edited file C:\P3059\P3059.CNF

## **B. INFORMATION-FILE**

You are in the MAIN-MENU.

Press **F** and then **0**.

You are in the INPUT-MENU. Press there **ALT L**.

'INFORMATION-FILE LOADED !' appears on the right bottom corner.

Press **I**.

You are in the INPUT-PAGE.

Press **enter twice** and you should be in 'TIME OF MEASUREMENT' cell.

Enter now new times of measurements and press **esc**.

Command line appears on the bottom. Press **E**.

You are in INPUT-MENU. Press **ALT S** to save the edited INFO-FILE.

Press **E** to EXIT.

You are now in FILING ENGINEER UNITS-MENU.

Are you ready to start ? (Y/N)

Check that you have correct filenames, if not, answer **N**

and go to CONFIGURATION-MENU and change the filenames and paths.

If the files names and the paths are correct then press **Y**.

Software starts to read the raw data file.

### **3.3.8 Erasing an unloaded DSU**

When you are sure that you have succeeded to unload the DSU completely, erase it. Start the program by typing MENU in C:>\ prompt and choose in MAIN-MENU DATA STORING UNIT, D.

Check that you made connections as in chapter 3.3.1.

Press **E** and wait until the display of DSU shows zero.

Now you have erased the memory. Next time you need it, set real date/time and it is ready for use.

Press **Q** and **E** so many times that you are in C:\P3059.

Type **cd..**

You are now in C:\> prompt.

### **3.3.9 Changing back computer's configuration**

**IF YOU DIDN'T EDIT AUTOEXEC.BAT OR CONFIG.SYS FILES SKIP THIS.**

IMPORTANT: TO USE WINDOWS OR ANY OTHER SOFTWARE IN HIGH MEMORY YOU HAVE TO RESTORE THE CONFIGURATION OF CONFIG.SYS AND/OR AUTOEXEC.BAT AS THEY WERE BEFORE.

Earlier on, the old AUTOEXEC.BAT and CONFIG.SYS files were saved as AUTOEXEC.TMP and CONFIG.TMP, respectively.

The only thing that has to be done is to save the files again with new names.

You are in prompt C:\>.

Type **cd dos** and press **enter**.

You are in C:\>dos prompt.

Type **dosshell** and press **enter**.

You should now be in DOSSHELL window.

You see the Directory tree in the left window and the list of files of that directory in the right window. Below these is the Main menu. Go with the mouse to the Main menu choose **EDITOR** and click it **twice**.

DOSSHELL Editor will be loaded.

**A** File to edit [.....] appears on the screen.

Type in the 'file to edit' **AUTOEXEC.BAT**.

Now AUTOEXEC.BAT file appears on the Editor screen.

Choose **FILE** and then **SAVE AS**.

Use backspace to remove **the last three characters** and type DSU

Now you see typed: **AUTOEXEC.DSU**

Choose **<OK>**.

Now your AUTOEXEC.BAT is saved also as AUTOEXEC.DSU

Choose **FILE** and there **EXIT** and you are back in DOSSHELL.

Go again with the mouse to the Main menu choose **EDITOR** and click it **twice**.

DOSSHELL Editor will be loaded.

**B** File to edit [.....] appears on the screen.

Type in the 'file to edit' **AUTOEXEC.TMP**.

Now AUTOEXEC.TMP file appears on the Editor screen.

Choose **FILE** and then **SAVE AS**.

Use backspace to remove **the last three characters** and type **BAT**

Now you see typed: AUTOEXEC.BAT

Choose **<OK>**.

Now your AUTOEXEC.TMP is saved also as AUTOEXEC.BAT

Choose **FILE** and there **EXIT** and you are back in DOSSHELL.

Go with the mouse to the Main menu choose **EDITOR** and **click it twice**.

DOSSHELL Editor will be loaded.

C File to edit [.....] appears on the screen.

Type in the 'file to edit' **CONFIG.SYS**

Now CONFIG.SYS file appears in the Editor screen.

Choose **FILE** and then **SAVE AS**.

Use **backspace to remove the last three characters** and type **DSU**

Now you see typed: CONFIG.DSU

Choose **<OK>**.

Now your CONFIG.SYS is saved also as CONFIG.DSU.

Choose **FILE** and then **EXIT** and you are back in DOSSHELL.

Go with mouse to Main menu choose **EDITOR** and **click it twice**.

DOSSHELL Editor will be loaded.

D File to edit [.....] appears on the screen.

Type in the 'file to edit' **CONFIG.TMP**

Now CONFIG.TMP file appears on the Editor screen.

Choose **FILE** and then **SAVE AS**.

Use **backspace to remove the last three characters** and type **SYS**

Now you see typed: CONFIG.SYS

Choose **<OK>**.

Now your CONFIG.TMP is saved also as CONFIG.BAT

Choose **FILE** and then **EXIT** and you are back in DOSSHELL.

Press **ALT+CTRL+DEL**, remove diskette (if any) from drive a: and wait for the computer to restart.

Setup should again be the same as before you used the P3059 software.

Next time you use P3059, you can just save the names of AUTOEXEC.BAT and CONFIG.SYS files in specified order (Annex 5).

AUTOEXEC.BAT and CONFIG.SYS are files, which determine the configuration of computer.

AUTOEXEC.TMP and CONFIG.TMP are those files which are temporarily saved and are used to normally run normally windows and other software using the high memory area of the computer, when the extensions are \*.BAT and \*.SYS

AUTOEXEC.DSU and CONFIG.DSU are those files which are temporarily saved and are used to only run only P3059 software in conventional memory, when their extensions are \*.BAT and \*.SYS.

### 3.3.10 Data analysis

A spare DSU has already been delivered and a DSU-reader will be delivered to all stations. until then it is recommended just to change the full DSU to an empty one and deliver the full DSU to Bujumbura.

In future, LTR will get a Fortran software for PCs, so data analysis can then be done by LTR. It will be delivered with instructions to all stations as soon as it is available.

## 4. WIND RECORDINGS WITH ANEMOMETER

Anemometer reading and the wind direction are recorded three times a day. The table and the form to use were already introduced in Annexes 1 and 2. Calculation of wind speed is done automatically, only anemometer reading, time and wind direction have to be entered. The formula for wind speed calculation is:

$$W = 0.879037 * (N_{t_2} - N_{t_1}) / (T_{t_2} - T_{t_1}) * 100 + 0.769984$$

W = Average wind speed (in/sec.)

$N_{t_2}$  = Anemo reading at  $t_2$

$N_{t_1}$  = Anemo reading at  $t_1$

$T_{t_2}$  = Time reading at  $t_2$

$T_{t_1}$  = Time reading at  $t_1$

Wind direction can be recorded as main directions (NE, SSW, etc.), but if a compass is available it is recommended to record it more accurately.

In the table the format for time has to be entered correctly to obtain average wind speeds. Any illogic readings should be noticed with remarks on the spreadsheet. File naming for anemometer recordings is made on monthly basis.

MP = Mpulungu

KI = Kipili

AN = Anemometer recordings

02 = Month (February)  
94 = Year (1994)

In Kipili recordings for February 1994 is saved as

KIAN0294.XLS

## **5. WATER CURRENT MEASUREMENTS WITH CYLINDERS**

### **5.1. Preparation**

Current measurements take place every Thursday and also once a month on Friday in Mpulungu. The measurements will last the whole day from 8:00-16:00. So, every Wednesday, the boat has to be checked and on Thursday morning the equipment for the measurements has to be collected.

Things that have to be checked for the boat:

- 1) Fuel
- 2) Oil
- 3) Battery

Equipment for the measurements:

- 1) Life jackets
- 2) Flow cylinders (5-6)
- 3) Rope set: 5 x 2m, 5 x 5m, 3 x 10m, 3 x 20m, 3 x 40m
- 4) Buoys for cylinders (5-6), numbered from 1 to 5 (6)
- 5) Anemometer
- 6) Forms for measurements
- 7) Watch
- 8) Paper and pencils
- 9) Calculator
- 10) Food and drinks

The boat should be ready to leave at 8:30-9:00.

### **5.2 Measurements in principle**

The measurements will be conducted with 5-6 cylinders. The buoys have to be numbered 1-5 (6). Each cylinder will be dropped into the water attached to a buoy with a rope. Every time when a cylinder is let free, position and time have to be recorded. The cylinders will be placed according to the detailed instructions in chapter 5.2.1.

The cylinders will be floating for 1-2 hours and then lifted. Lifting position and time of each cylinder should be recorded and also the drifting distance and the average direction readout from GPS when the cylinders are lifted.

It is essential to measure the wind speed before and after each current measurement. If the wind speed is changing or wind is shifting rapidly while measuring, wind speed has to be recorded

also during the measurement.

### 5.2.1 Lines to be measured

#### 5.2.1.1 Mpulungu and Nsumbu

A total of five lines has been chosen for doing the current measurements in Mpulungu. The first one is on the east coast of Zambia, off Chisanza Bay, the second off Mpulungu to the southwest of Mutondwe Island, third one to the northeast of Cap Kaku, fourth one to the east of Cape Chaitika and the last one off Nsumbu (Table 1, Map 1). Every line consists of two sublimes, A and B.

**Table 1: Lines for current measurement off Mpulungu and Nsumbu.**

Line	Latitude (S)	Longitude (E)
1/A, Chisanza Bay, W	8°39,50'	~30°10,50', 1 Nm from the coast (1.8-2 km) to direction of 270°
1/B, Chisanza Bay, W	8°39,50'	From the last cylinder location of line 1A to direction of 270°
2/A, Mutondwe Island, SW	8°42,50'	~30°06,00', 1 Nm from the island (1.8-2 km) to direction of 235°
2/B, Mutondwe Island, SW		From the last cylinder location of line 2A to direction of 235°
3/A, Cap Kaku, NE	8°38,50'	~30°53,50', 1 Nm from the coast (1.8-2 km) to direction of 50°
3/B, Cap Kaku, NE		From the last cylinder location of line 3B to direction of 50°
4/A Cape Chaitika, NE	8°33,00'	~30°48,00', 1 Nm from the coast (1.8-2 km) to direction of 45°
4/B Cape Chaitika, NE		From the last cylinder location of line 4B to direction of 45°
5/A Inanga Peninsula	8°28,00'	~30°41,00', 1 Nm from the coast (1.8-2 km) to direction of 30°
5/B Inanga Peninsula		From the last cylinder location of line 5A to direction of 30°

Line A is closer to shore and line B starts from the place of the last deposited cylinder of line A and continues to open water. The presumption is that currents are different in open water compared to those closer to shore. To tie up the results of these two lines, one of the cylinder location of both lines has to be the same. Too much overlapping in the measurements should be avoided.

#### 5.2.2.2 Bujumbura

There are 4 lines in Bujumbura area for current measurements. The first one is off Bujumbura and the others are south of Bujumbura heading to the west, to a direction of 270° (Table 2, Maps 2 and 3).

The southernmost line is off Nyabage, and its latitude is 3°31' S. Every line consists of two sublines, A and B. Line A is close to the shore, starting 1.8-2.0 km from the coast and line B starts, where the line A ends up.

**Table 2: Lines for current measurements off Bujumbura.**

Line	Latitude (S)	Longitude (E)
1/A Bujumbura port	3°22,00'	1 Nm from the coast (1.8-2 km) to direction of 225°
1/B Bujumbura port	3°22,00'	From the last cylinder location of line 1A to direction of 225°
2/A Kanyosha	3°25,00'	1 Nm from the coast (1.8-2 km) to direction of 270°
2/B Kanyosha	3°25,00'	From the last cylinder location of line 2A to direction of 270°
3/A Nyamugari	3°28,00'	1 Nm from the coast (1.8-2 km) to direction of 270°
3/B Nyamugari	3°28,00'	From the last cylinder location of line 3A to direction of 270°
4/A Nyabage	3°31,00'	1 Nm from the coast (1.8-2 km) to direction of 270°
4/B Nyabage	3°31,00'	From the last cylinder location of line 4A to direction of 270° location

### 5.2.2.3 Kigoma

In Kigoma, 4 lines have been chosen for doing the current measurements. The first two ones lie north of Kigoma and the other two south of Kigoma heading west and south-southwest, approximately to direction of 270° and 198°, respectively (Table 3, Map 4 and 5) Every line consists of two sublimes, A and B. Line A is closer to the shore than line B, which starts where line A ends up.

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Table 3: Lines of current measurements off Kigoma.

Line	Latitude (S)	Longitude (E)
1/A Katongwe point	4°48,00'	1 Nm (1.8-2 km) from the coast to direction of 270°.
1/B Katongwe point	4°48,00'	From the last cylinder location of line 1A to direction of 270°.
2/A Nondwa point	4°52,00'	1 Nm (1.8-2 km) from the coast to direction of 270°.
2/B Nondwa point	4°52,00'	From the last cylinder location of line 2A to direction of 270°.
3/A Bangwe point	4°54,00'	1 Nm (1.8-2 km) from the coast to direction of 270°.
3/B Bangwe point	4°54,00'	From the last cylinder location of line 3A to direction of 270°.
4/A Ujiji	4°56,00'	1 Nm (1.8-2 km) from the coast to direction of 198°.
4/B Ujiji		From the last cylinder location of line 4A to direction of 198°.

### 5.2.2 Distance between cylinders

The optimal distance between cylinders should be checked first. A starting distance can be 200 m between each cylinder. If no remarkable differences are recorded, the distance can be increased to 300 meters and finally up to 500 meters. If weather is rough, 500 meters may be too much to find back all cylinders. The distance between the cylinders should be constant. Naturally, the cylinders have to be followed while drifting. The idea of finding the optimal distance between cylinders is to make the lines as long as possible. In Bujumbura, a distance of 300 meters has been used, because 200 meters was found to be too short. Also, if the distance between cylinders would be 50 meters, a line of only 200 meters could be covered with 5 cylinders.

### 5.2.3 Forms and tables

Forms used on the lake and the tables for filing are presented in Annexes 6 and 7. They were already delivered to all stations.

Calculations on the lake should be recorded on forms. Essential information for filing are the line number 1A, 1B 1AB etc., cylinder number, starting latitude, longitude and time and ending latitude, longitude and time. Other information is necessary for the calculations and the use of the GPS on the lake: GPS memory location number, measuring time in seconds and average speed (cm/s) and direction of the cylinder from GPS (in degrees °). The table used for filing has the same information as the forms, but also formulas to verify the calculations made on the lake. When opening the table in Excel, following question appears on the screen: '? Update references to unopened documents?', one has to click NO. For each month a new file should be created. It is easily done by opening the CURRFOR.XLS and saving it with a new name.

File is saved as:

MP = Mpulungu  
BU = Bujumbura  
KI = Kigoma  
CM = Current measurements

02 = Month (February)  
94 = Year

File name for Mpulungu current measurements for February this year is:

MPCMO294.XLS

It is important not to delete the formulas. Some of them are in hidden columns and cannot be edited accidentally.

### 5.3 Measurement scheme

A) Preferably four, minimum three measurements/trip should be conducted each time.

B) During the first week, all cylinders should be put to 2 meters depth, first in line A, then in line B. These basic measurements should be conducted every three months. Below are the schemes for the measurements.

#### 5.3.1 In Mpulungu

##### Week 1:

line	depths (m)	cylinder distance (m)
1A	2,2,2,2,2, (2)	200-400 (500)
1B	2,2,2,2,2, (2)	200-400 (500)
[1A	2,5,10,20,40,2	200-400 (500)]
[1B	2,5,10,20,40,2	200-400 (500)]
1AB	5,10,20,40	600-1000
	5,10,20,40	between groups

Line 1AB means, that 2 (3) cylinders are deposited at the same time in the middle of line A and 2 (3) at the same time in the middle of line B. Three depths out of 5, 10, 20 and 40 should be chosen. The measurements in hard brackets can be left out, if necessary.

**Week 2:** The same as week 1 but for lines 2A and 2B.

**Week 3:** The same as week 1 but for lines 3A and 3B.

**Week 4:** The same as week 1 but for lines 4A and 4B. The same as week 1 but for lines 5A and 5B.

##### Week 5:

line	depths (m)	cylinder distance (m)
1A	2,5,10,20, (40),2	200-300 (500)
1B	2,5,10,20, (40),2	200-300 (500)
1AB	2,5,10,20,40	600-900
	2,5,10,20,40	between the groups

Line 1AB means, that 2 (3) cylinders are deposited at the same time in the middle of line A and 2 (3) at the same time in the middle of line B. Preferably three depths out of 2, 5, 10, 20 and 40 should be chosen. For the third measurement, the depths should be chosen according to the results of the first measurements. If any strange results are recorded, measurements 1A and 1B should be repeated with a slightly different depth configuration (for example in case that measurements are completely different at the same depths or strongly against the wind direction)

- Week 6:** The same as week 5, but for lines 2A and 2B
- Week 7:** The same as week 5, but for lines 3A and 3B.
- Week 8:** The same as week 5, but for lines 4A and 4B.  
The same as week 5, but for lines 5A and 5B.
- Weeks 9-12:** The same as weeks 5-8 for lines 1A/1B to 5A/5B.
- Week 13:** Start again the basic measurements for lines 1A and 1 B like in week 1 and follow the scheme of Mpulungu.

### 5.3.2 In Bujumbura and Kigoma

**Week 1:**

line	depths (m)	cylinder distance (m)
1A	2,2,2,2,2, (2)	200-300 (500)
1B	2,2,2,2,2, (2)	200-300 (500)
[1A	2,5,10,20, (40),2	200-300 (500)]
[1B	2,5,10,20, (40),2	200-300 (500)]
1Ab	5,10,20,40	600-1000
	5,10,20,40	between groups

Line 1Ab means 2 (3) cylinders are deposited at the same time in the middle of line A and 2 (3) at the same time in the middle of line B. Three depths out of 5, 10, 20 and 40 should be chosen. If only five or four cylinders are available, one depth can be left out. The measurements in hard brackets can be left out, if necessary.

**Week 2:** The same as week 1 but for lines 2A and 2B.

**Week 3:** The same as week 1 but for lines 3A and 3B.

**Week 4:** The same as week 1 but for lines 4A and 4B.

**Week 5:**

line	depths (m)	cylinder distance (m)
1A	2,5,10,20, (40),2	200-300 (500)
1B	2,5,10,20, (40),2	200-300 (500)
1Ab	2,5,10,20,40	600-900
	2,5,10,20,40	between the groups

Line 1Ab means, that 2 (3) cylinders are deposited at the same time in the middle of line A and 2 (3) at the same time in the middle of line B. Three depths out of 2, 5, 10, 20 and 40 should be chosen. For the third measurement, the depths should be chosen according to the results of the first measurements. If any strange results are recorded, measurements 1A and 1 B should be repeated with a slightly different depth configuration (for example if the results are completely different at the same depths or strongly

against the wind direction).

- Week 6:** The same as week 5, but for lines 2A and 2B
- Week 7:** The same as week 5, but for lines 3A and 3B.
- Week 8:** The same as week 5, but for lines 4A and 4B.
- Weeks 9-12:** The same as week 5-8, but for lines 1A/1B to 4A/4B.
- Week 13:** Start again the basic measurements for lines 1A and 1B like in the first week and follow the scheme of Bujumbura and Kigoma.

#### 5.4. Measurements in practice

##### 5.4.1 Wind speed measurement

Before starting current measurements, wind speed and direction have to be measured. Every flow measurement has to start and end with a wind measurement (ANEMO) . A wind measurement has to be done in two different ways.

###### A. FIRST METHOD:

The first method was introduced by Huttula in 1993, is slightly modified, and is done in two phases with two persons. One person is measuring the wind with an anemometer. The other person is recording and writing down the information from the GPS and the wind speed recordings but is also guiding the skipper and telling the wind measurer what to do.

###### 1) Recording GPS location and time of measurement

Wind recording position can be read from GPS in POS-menu. GPS goes automatically to POS-menu, when it is switched on. It can be read also in NAV2-menu by pressing the **NAV/2** key and then the right **black arrow** key. On the right of the display should appear a text, NAV2 (Figure 1). It is recommended to use NAV2 menu, because of its usefulness during the measurement process.

###### 2) In the first phase the vessel should be headed exactly against wind.

When the exact heading against wind has been reached and the speed of the boat is stable, the recorder calls the measurer to record the wind speed and reads himself the speed and the heading of the boat from the GPS. These are found in the NAV2 MENU. Speed of the boat, kph, is in the GPS display as SOG (Speed Over Ground) in the lower left corner and heading, in degrees, the direction the boat is sailing to, COG (Course Over Ground) in the lower right corner of the display (Figure 1).

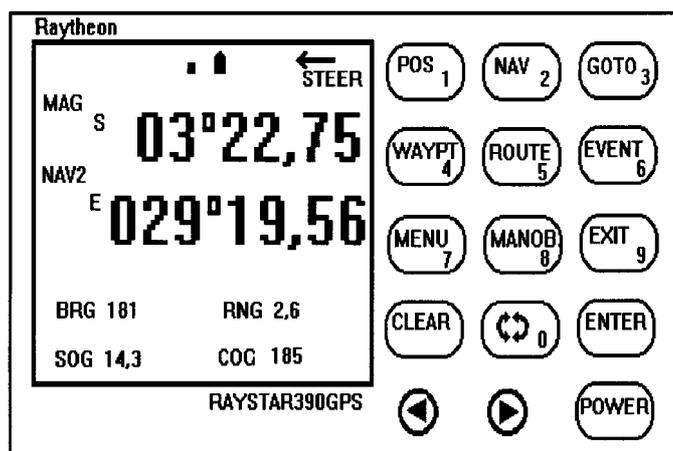


Figure 1: GPS in NAV2-menu.

Following important things should be taken care of while measuring:

- A) Speed of the boat should stay steady during the wind recording.
- B) Course of the boat should be exactly against the wind.

3) In the second phase the boat should be headed exactly with wind.

After the first phase the boat should be turned to the direction of the wind. When the correct heading has been reached and it stays stable, the recorder calls the measurer to record the wind speed and records simultaneously the speed and heading of the boat from the GPS. The heading should be 180° less than the first heading recorded against the wind. **The speed of the boat should be the same to both directions.**

Wind measurer should remember following things:

Anemometer should be kept arm stretched straight up until recorder orders him to measure. When recorder calls measurer, he pushes down the red button in the hand of the anemometer and keeps it pushed down until he has read the wind speed, m/sec. After that, the recorder or anyone of the crew calculates the wind speed. Notice, that there are four unit speed scales on the anemometer: m/s, knot/hour, km/h and beaufort. **One should use the scale of m/s.**

Calculation is done as follows:

Against the wind:

**Wind speed  $W_1$  = measured wind speed - boat speed**

To the direction of the wind:

**Wind speed  $W_2$  = measured wind speed + boat speed**

**True wind speed  $W = (W_1 + W_2) \times 0.5$**

Wind direction can be read directly from GPS when boat is heading against wind.

An example:

Date: 12.08.93

Time: 12:20

Position: 3°22,75' S, 29°19,56' E

Measured against wind:

Wind speed (with ANEMO) = 16 m/s  
Boat speed (from GPS) = 7.5 kph  
Boat's heading (from GPS; **COG in degrees °**) = 191°

Measured in wind direction:

Wind speed (with ANEMO) = 4 m/s  
Boat speed (from GPS) = 7.5 kph  
Boat's heading (from GPS; **COG in degrees °**) = 011°

Speed of the boat in kph units has to be changed to in/sec.

7.5 kph = 7500 meters per hour

1 hour = 3600 S

$$\frac{7500m}{3600s} = 2.083m/s$$

Wind speed  $W_1 = 16 \text{ m/s} - 2.083 \text{ m/s} = 13.917 \text{ m/s}$

Similarly as for  $W_1$ , to calculate Wind speed<sub>2</sub> ( $W_2$ ) the speed of the boat in kph units has to be changed to m/sec.

7.5kph = 7500 meters per hour

1 hour = 3600 S

$$\frac{7500m}{3600s} = 2.083m/s$$

Wind speed  $W_2 = 4 \text{ m/s} + 2.083 \text{ m/s} = 6.083 \text{ m/s}$

True wind speed can be calculated as follows:

$$(13.917 \text{ m/s} + 6.083 \text{ m/s}) \times 0.5 = 10.00 \text{ m/s}$$

## B. SECOND METHOD:

According to the second method, the wind speed is measured as an average of five measurements on a drifting boat. Especially when the lake is rough, it is easier to measure the wind speed by using this method.

Wind measurer reads five times anemometer's reading, recorder writes them down and calculates the average:

Average wind speed =  $(1.\text{rec.}+2.\text{rec.}+3.\text{rec.}+4.\text{rec.}+5.\text{rec.})/5$  An example:

1. recording = 7.5 m/s
2. recording = 7.0 m/s
3. recording = 6.5 m/s
4. recording = 7.0 m/s
5. recording = 7.5 m/s

$$(7.5 \text{ m/s} + 7.0 \text{ m/s} + 6.5 \text{ m/s} + 7.0 \text{ m/s} + 7.5 \text{ m/s})/5 = \mathbf{7.1 \text{ m/s}}$$

If the wind is strong and the boat is drifting fast, the drifting speed of the boat can be calculated and added to the average wind speed. The drifting speed is at maximum few kilometers per hour i.e. 1-1.5 in/s. When the cylinders have been deposited and the engine stopped, recorder presses the **EVENT** key and writes down the memory location. After a floating time of 1-2 hours, the recorder presses the **GOTO** and the **CLEAR** keys and enters the memory location number which was stored before to the GPS and presses twice the **ENTER** key. By pressing the **NAV** key and the **right black arrow** key the drifting distance to the starting position can be read in kilometers (=RNG) (Figure 1). Changing the drifting distance to in/s and adding it to the measured average wind speed the real wind speed can be obtained.

Drifting distance = 1.35 km = 1350 meters

Drifting time = 1:20 = 4800 sec.

Measured wind speed (average of five measurements) = 7.1 m/sec.

Thus, the drifting speed is  $1350 \text{ m}/4800 \text{ sec.} = 0.28 \text{ m/sec.}$

The real wind speed is  $7.1 \text{ m/sec.} + 0.28 \text{ m/sec.} = 7.38 \text{ m/sec.}$

Direction of the wind can be determined by heading the boat against the wind. In NAV2-menu (Figure 1) the heading of the boat, in degrees, is COG (Course Over Ground). It is displayed in the lower right corner of the screen. It is the same as the direction of the wind. Recorder writes it down. After the wind measurements the cylinders can be put in the water.

## 5.4.2 Current measurements

### Placing the cylinders

The measurements can be done with two persons. A recorder and a person to put the cylinders into the water. Cylinders have to be prepared in advance. Attach correct ropes on cylinders and buoys and arrange them on the deck of the boat in the deposing order. The boat should be around the starting position for placing the first cylinder and its heading to the direction of the line to be measured (see Tables 1-3).

1) When the exact position is reached, the recorder calls the second person to throw out the first cylinder. Skipper should slow down the speed for a moment.

**Special attention should be paid, that cylinder rope doesn't go around the engine's propeller.**

2) Then the recorder presses the **EVENT** key and records the number of the cylinder and the deposit position (latitude and longitude). The **EVENT** key stores boat's present position. It is stored as a **WAYPOINT** into the next available memory location of GPS. The number of GPS memory has to be written down. It appears immediately after pressing the **EVENT** key below the longitude as a title '**EVENT STORED IN WAYPOINT 004**' (Figure 2). The **EVENT** key can be used only when GPS is in **POS** or **NAV** mode.

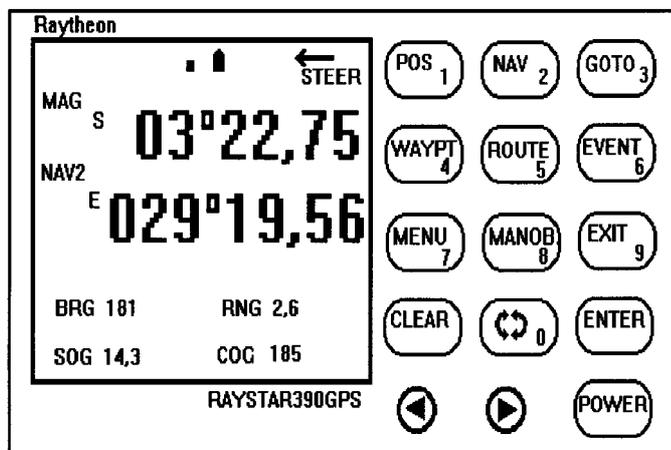


Figure 2: Event is stored in memory location 004.

3) Recorder presses the **GOTO** key. On the screen will appear a title '**Goto ent 001**' (the number of the memory location used earlier).

4) Recorder presses once the **CLEAR** key. The left digit in the number of '**Goto ent**' starts to flash (Figure 3).

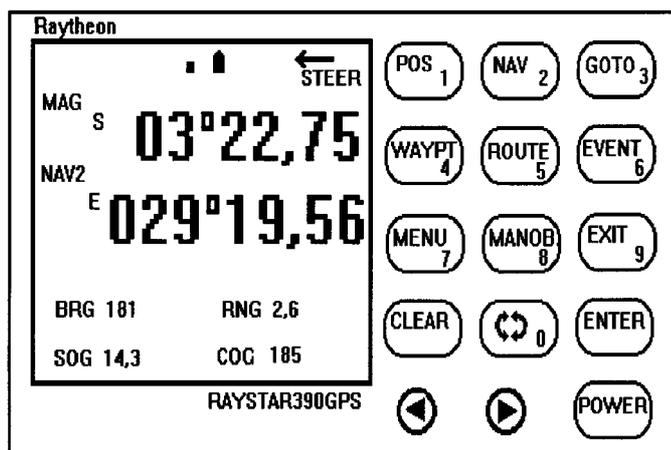


Figure 3: GPS in GOTO mode.

5) Then recorder presses the number of **WAYPOINT** stored, for example **004** and then the **ENTER** key **twice**.

6) Then he pushes the **NAV** key and the right **black arrow** key. On the left side of the screen appears NAV2 MENU (Figure 1) and he can read now the distance in kilometers (=RNG on the screen) and the direction (=BRG on the screen) to the first buoy's placing position. The direction should be kept the same all the time (for each line there is a specific direction; see Tables 1-3). Skipper can increase the speed following the direction of the line, but the recorder or the skipper himself has to verify that the correct course is kept and to change it if necessary.

7) When the wanted distance between two cylinders is reached (normally 200-500 meters; Tables 1-3), the recorder orders the second person to deposit the next cylinder and repeats paragraphs 2) - 6) to store and to write down the start position, time, and controls the distance of the following cylinder. Naturally, this time the position of the second cylinder will be stored into the next available memory location of GPS (e.g. 005).

8) All cylinders should be put into the water in the same way using GPS, checking the heading of the boat, the distances between the cylinders, and that the cylinders are properly deposited (e.g. if any air remains inside a cylinder, it stays floating at the surface instead of sinking).

**When depositing several cylinders at the same time, one has to ensure that the ropes of the cylinders are not getting entangled.**

#### Lifting the cylinders

Lifting should be started from the first deposited cylinder, if possible.

1) When the number of the cylinder is detected, its number has to be verified. Recorder enters into the GPS the memory location of that cylinder.

2) He presses first the **GOTO** key and then the **CLEAR** key. '**Goto ent**' title starts to flash (Figure 3)

3) Then he presses **004** for the first cylinder and the **ENTER** key **twice**.

4) If wrong keys are pressed, one can start again by pressing the **EXIT** key.

5) Recorder presses the **NAV** key and the **right black arrow** key. GPS should now be in the **NAV2** menu (Figure 1).

6) When the cylinder is being lifted, recorder reads the coordinates and the time, and also the distance (=RNG) and the direction (=BRG) to the deposit location of the lifted cylinder. The direction to the deposit location is opposite to the direction of the cylinder movement, so 180° degrees has to be added or subtracted from the direction (=BRG) which the GPS gives to the deposit position.

7) He writes down the information on the form.

If the boat passes the cylinder very close but not close enough to catch it, the information can be recorded anyway at that moment as if the measurement is finished. Then try to lift the cylinder again.

8) For next cylinders repeat the paragraphs 1) - 7).

After lifting all the cylinders, wind measurements have to be repeated as explained in chapters 5.4.1, 5.4.2 and 5.4.3.

The used memory locations in the GPS can be cleared for the next measurements. Before that, the recorder compares the recorded deposit coordinates with the coordinates in the memory locations. To do that, the recorder presses the **WAYPT** key and enters the memory location number of the first deposited cylinder. Then he presses the **ENTER** key **five times** and the deposit latitude and longitude of the first cylinder appear on the display. He compares the recorded latitude and longitude on the form with the coordinates on the screen and presses the **EXIT** key. For the second cylinder recorder changes the memory location number. All the deposit positions can be checked. If in the display appears a text '**Used**' recorder presses the **GOTO** key and changes the number of this memory location and then presses the **ENTER** key **twice**. When the comparison is done and corrections made to the form, the used memory locations can be deleted.

Press the **WAYPT** key. Enter the waypoint number you want to erase and press **ENTER**. Be sure that the number of the memory location is one you want to delete. Press **0** so many times that latitude is **00°00,00'** and then press **ENTER twice**. The display will

change to longitude. Press so many times 0, that longitude is 000°00,00'. Then press **ENTER** twice. Within a few seconds the display shows, that the coordinates are zeroed. Now you can use these zeroed memory locations for the next measurements. Zero all the memory locations you used for the first measurement.

### 5.4.3 Calculations on the lake

After each measurement, the speed and the direction of each cylinder must be calculated and read from the GPS. This gives you information on how to determining the distance between cylinders and on the pattern of currents. Normally, a cylinder moves with the wind at the surface (i.e. 2 meters) and against the wind when deposited in deeper layers (10) 20-40 meters. If any strange movement of cylinders is recorded, such results can be confirmed by repeating the measurements with not exactly the same, but a fairly similar scheme of cylinders. If any peculiarities take place they should be remarked on the form. Manual calculations for the distance and direction of a cylinder is given in Annex 8.

### 5.5 Other GPS options Minimizing ARRIVE alarm distance

Press the **MENU** key. Choose 3 in **MENU**. You should see ENT 0.18 NM in the display and the first zero flashing (Figure 4). Press 0,0,1 and press **ENTER**. Now **ARRIVE** alarm is set to 0.01 nm(=18.52 meters).

You have to do it every time you switch on the GPS, because the default setting is 0.10 nm, so GPS is giving an alarm when you are within a 185 meter range from the WAYPOINT chosen.

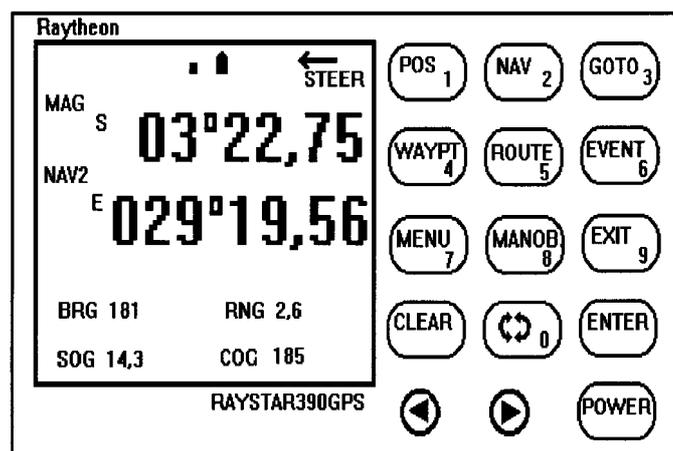


Figure 4: Changing the ARRIVAL ALARM in the GPS.

## Error message in reading position

In case of an error message in the GPS display in NAV menu, you can check the status of the satellites.

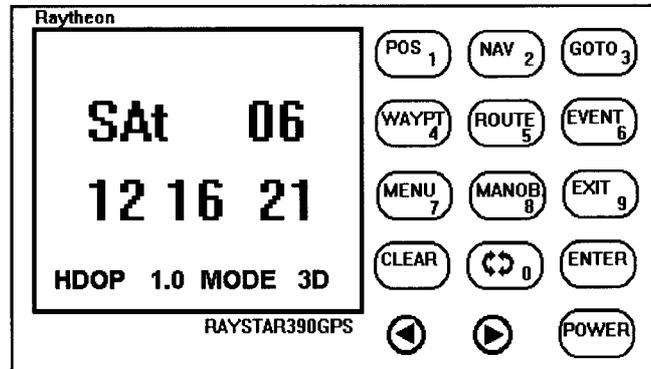
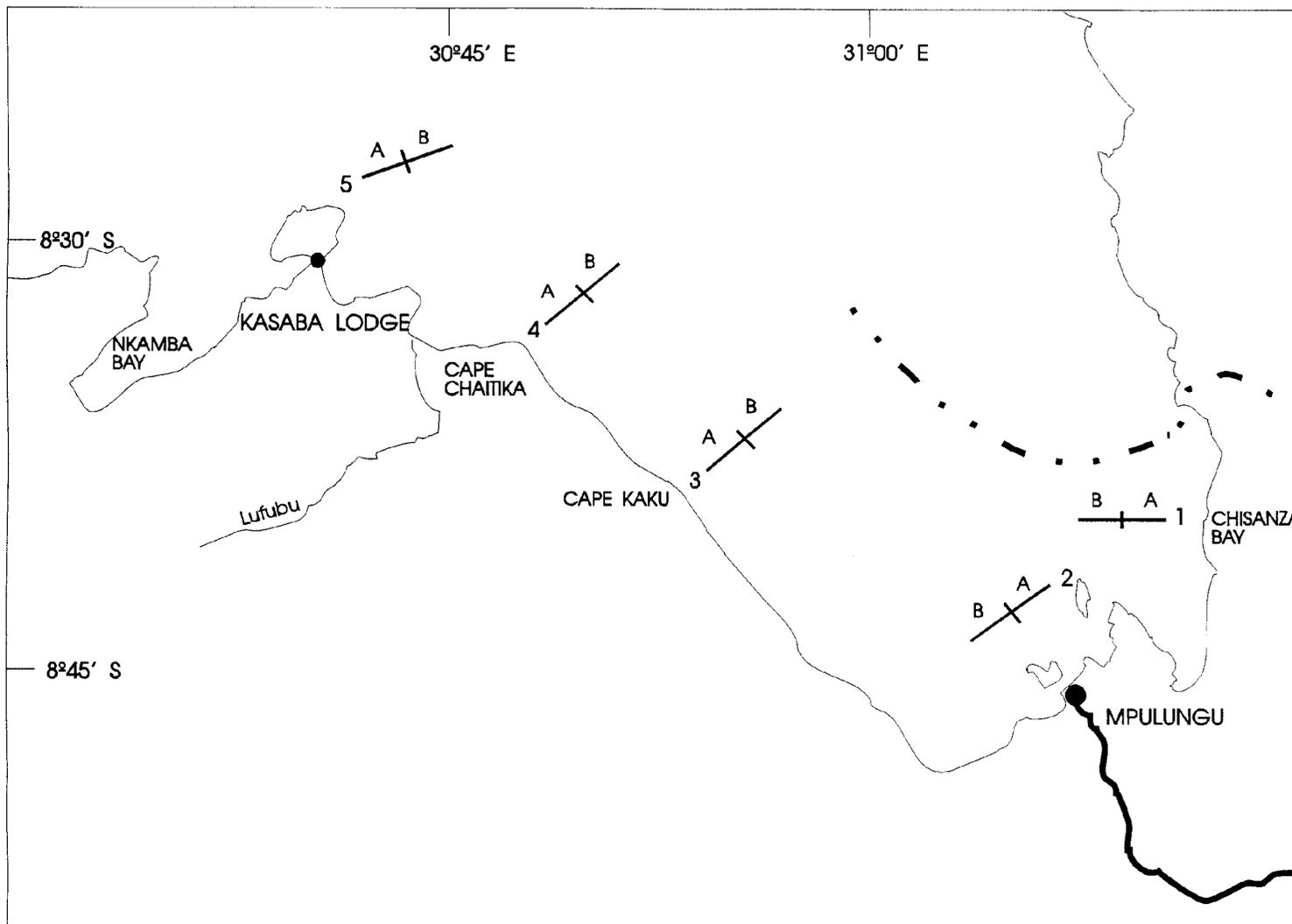


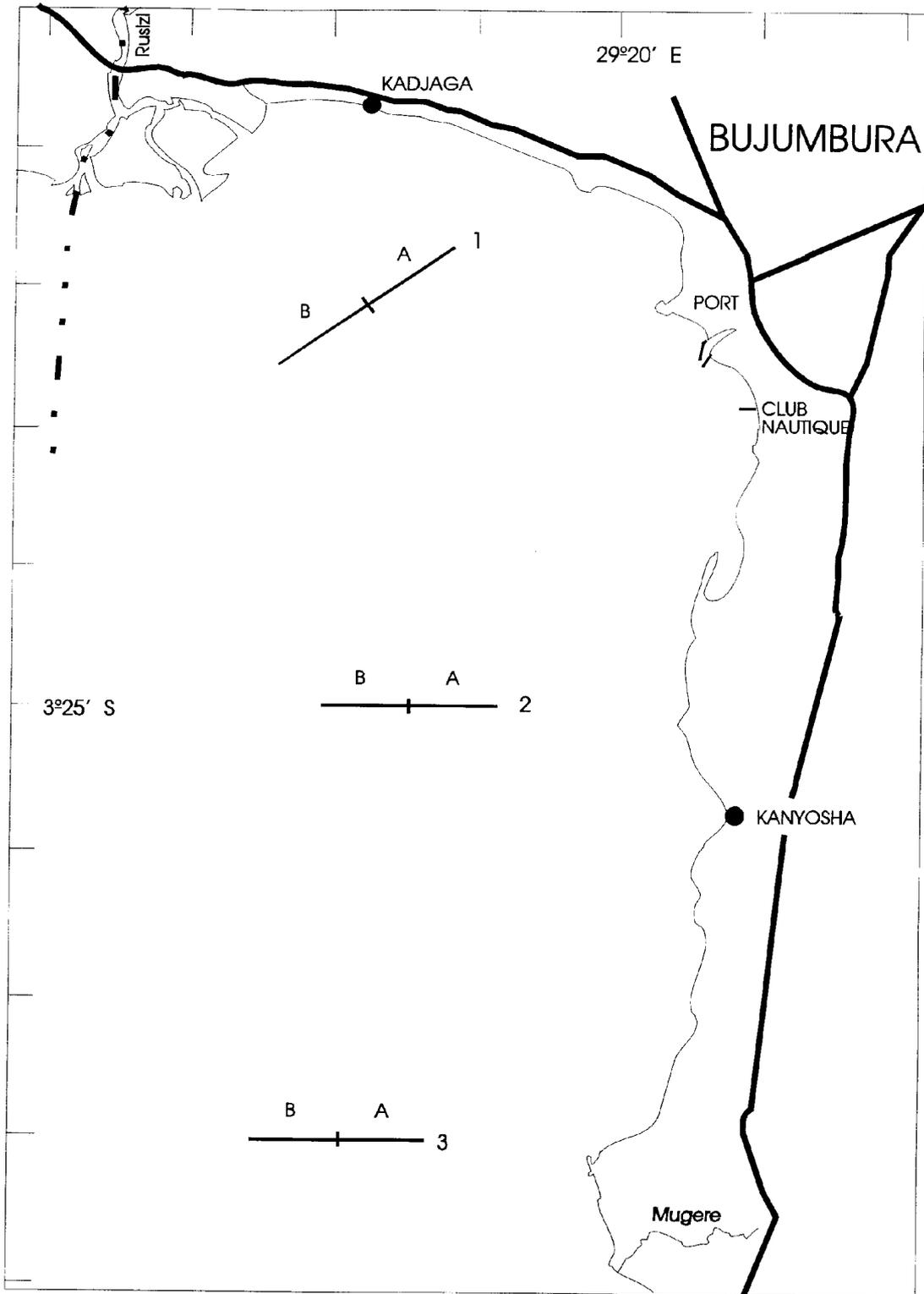
Figure 5: GPS showing the spreading of satellites.

Choose **MENU**. Press **1-INITIAL**. Press **arrow to the right**. You have four choices: **1-STATUS**, **2-UNITS**, **3-OUTPUT** and **NEXT**. Choose **1-STATUS**.

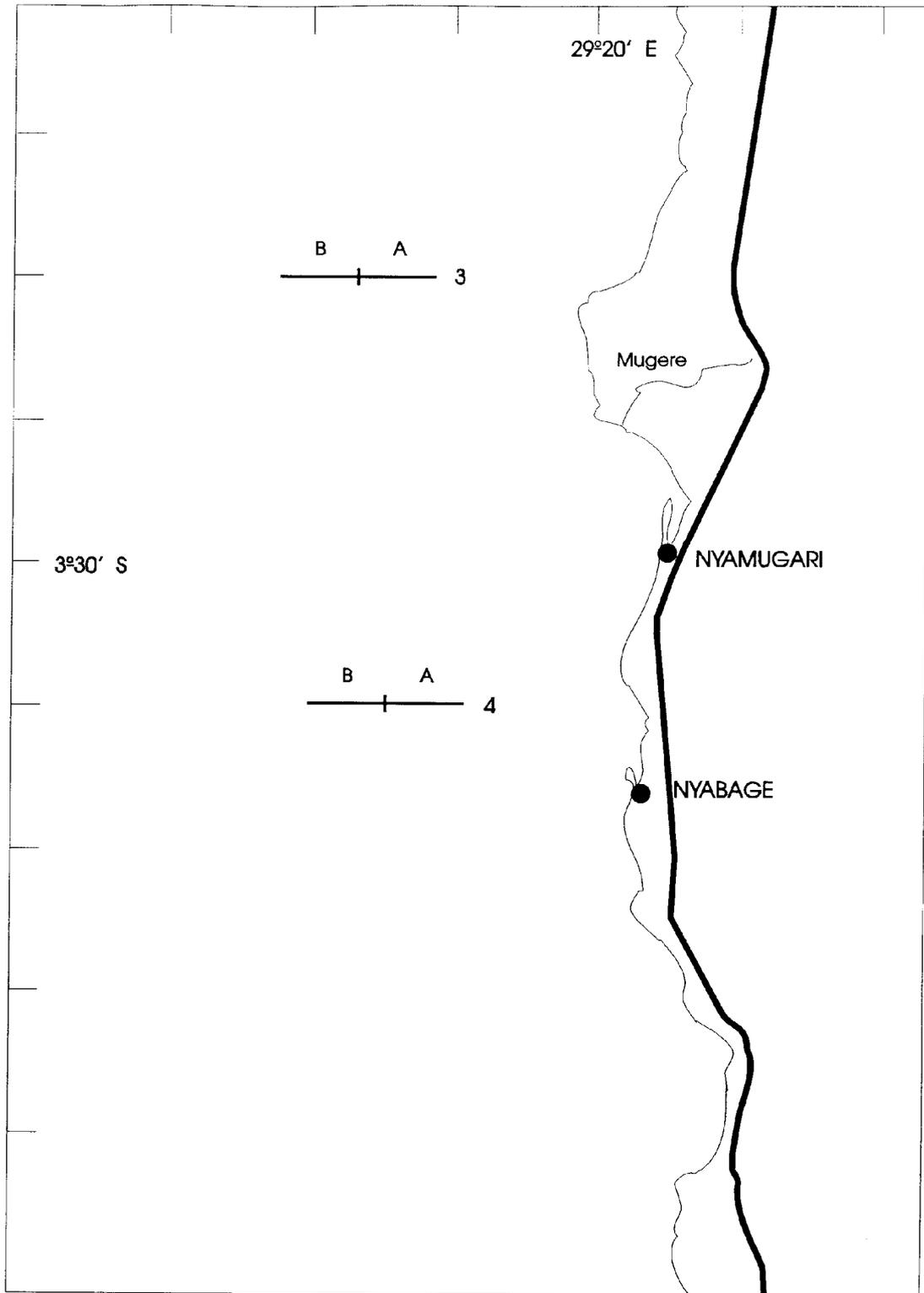
You see in the display the identification numbers of tracked satellites, **HDOP** and **MODE 3 D** at the bottom of the display. **HDOP** is a measure of the expected navigation fix accuracy. If **HDOP** value is small (001-002) the accuracy is good enough, and satellites are widely spread, if not, some problems may arise in reading the positions. It happens very seldom and lasts normally only for a few minutes. You can just wait until the **HDOP** becomes 1.0 or 2.0.



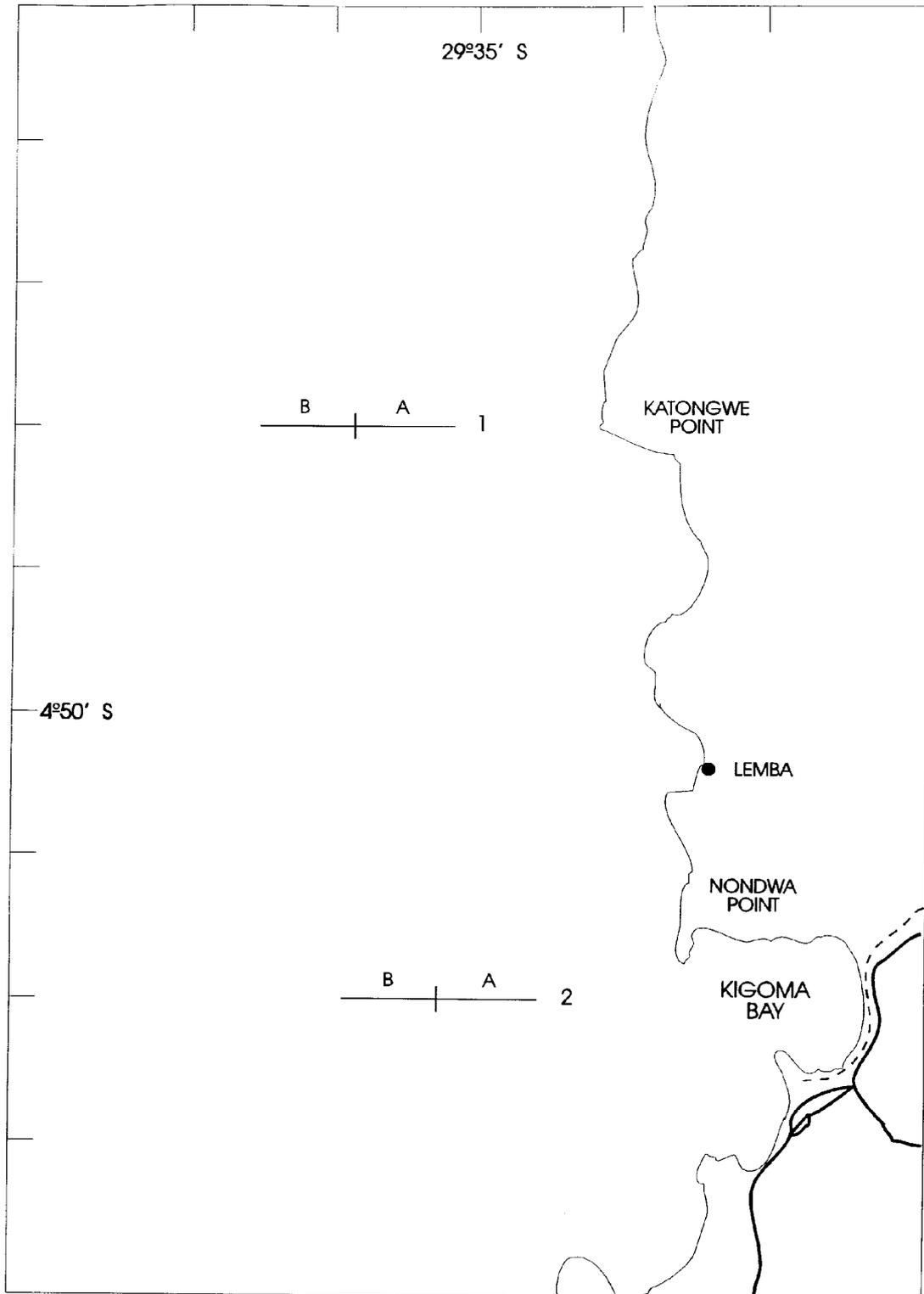
Map 1: Water current measurement lines 1, 2, 3, 4 and 5 in Mpulungu and In Nsumbu.



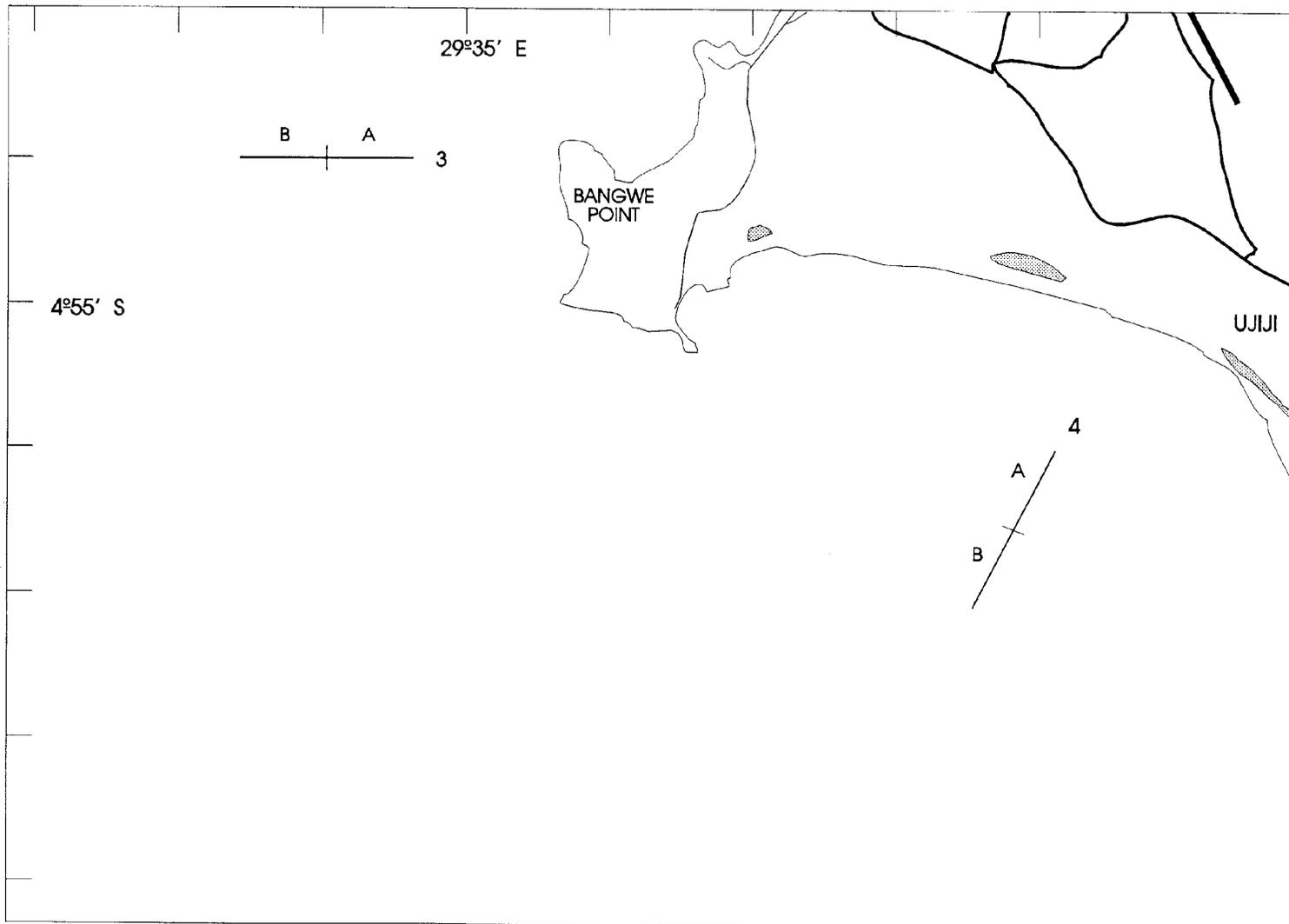
Map 2: Water current measurement lines 1, 2 and 3 in Burundi.



Map 3: Water current measurement lines 3 and 4 in Burundi.



Map 4: Water current measurement lines 1 and 2 in Kigoma.



Map 5: Water current measurement lines 3 and 4 in Kigoma.





## Working schedule in hydrodynamics.

STATION/ MEASUREMENT	MPULUNGU	BUJUMBURA	KIGOMA
LAKE METEO BUOY UNLOADING	MAY 1994, OCTOBER 1994, MARCH 1995, AUGUST 1995		
METEO STATION UNLOADING		ONCE A MONTH	
WIND STATION UNLOADING			MARCH 1994, OCTOBER 1994, MAY 1995 DECEMBER 1995
TELOG WATER LEVEL STATION UNLOADING	WILL BE UNLOADED EVERY NINTH MONTH DURING FOLLOW-UP MISSIONS OF THE FIELD COORDINATOR IN HYDRODYNAMICS. MARCH 1994, DECEMBER 1994		
ANEMOMETER RECORDINGS	THREE TIMES A DAY 9:00, 15:00 AND 21:00 HOURS LOCAL TIME		THREE TIMES A DAY 8:00, 14:00 AND 20:00 HOURS LOCAL TIME
WATER CURRENT MEASUREMENTS	ONCE A WEEK 3-4 MEASUREMENTS, EACH LINE ONCE A MONTH	ONCE A WEEK 3-4 MEASUREMENTS, EACH LINE ONCE A MONTH	ONCE A WEEK 3-4 MEASUREMENTS, EACH LINE ONCE A MONTH

**RESEARCH FOR THE MANAGEMENT OF THE FISHERIES ON LAKE TANGANYIKA**

CHANNELS, MEASURED PARAMETERS AND CALIBRATION COEFFICIENTS FOR MPULUNGU, BUJUMBURA AND KIGOMA METEO AND WIND STATIONS

**MPULUNGU LAKE METEO STATION**

CHANNEL NO.	PARAMETER	SENSOR TYPE	SERIAL NO.	REMARKS	CALIBRATION COEFFICIENTS			
					A	B	C	D
1	REFERENCE			0	1.000E+00	0.000E+00	0.000E+00	0.000E+00
2	WIND SPEED	2740		2.6m	4.000E-01	7.460E-02	0.000E+00	0.000E+00
3	WIND GUST	2740		2.6m	4.000E-01	7.460E-02	0.000E+00	0.000E+00
4	WIND DIRECTION (= BUOY ORIENTATION)	2864		2.6m	1.500E+00	3.490E-01	0.000E+00	0.000E+00
5	AIR TEMPERATURE	3145	1274	2.6m	-4.394E+01	8.115E-02	9.288E-06	0.000E+00
6	WATER TEMPERATURE	2903	109	1m	-5.774E-01	4.382E-02	-1.945E-05	6.732E-09
7	WATER TEMPERATURE	2903	109	5m	-5.827E-01	4.396E-02	-1.945E-05	6.732E-09
8	WATER TEMPERATURE	2903	109	30m	-6.270E-01	4.400E-02	-1.945E-05	6.732E-09
9	WATER TEMPERATURE	2903	109	50m	-7.146E-01	4.407E-02	-1.945E-05	6.732E-09
10	WATER TEMPERATURE	2903	109	70m	-7.180E-01	4.415E-02	-1.945E-05	6.732E-09
11	WATER TEMPERATURE	2903	109	90m	-8.108E-01	4.433E-02	-1.945E-05	6.732E-09
12	WATER TEMPERATURE	2903	109	110m	-8.133E-01	4.439E-02	-1.945E-05	6.732E-09
13	WATER TEMPERATURE	2903	109	150m	-8.531E-01	4.432E-02	-1.945E-05	6.732E-09
14	WATER TEMPERATURE	2903	109	200m	-9.453E-01	4.447E-02	-1.945E-05	6.732E-09
15	WATER TEMPERATURE	2903	109	250m	-9.519E-01	4.462E-02	-1.945E-05	6.732E-09
16	WATER TEMPERATURE	2903	109	300m	-9.519E-01	4.462E-02	-1.945E-05	6.732E-09

**BUJUMBURA AUTOMATIC WEATHER STATION**

CHANNEL NO.	PARAMETER	SENSOR TYPE	SERIAL NO.	REMARKS	A	B	C	D
2	WIND SPEED	2740	1894	13m	0.000E+00	7.460E-02	0.000E+00	0.000E+00
3	WIND GUST	2740	1894	13m	0.000E+00	7.460E-02	0.000E+00	0.000E+00
4	WIND DIRECTION	3150	159	13m	1.500E+00	3.490E-01	0.000E+00	0.000E+00
5	AIR TEMPERATURE	3145	1273	13m	-4.392E+01	8.178E-02	8.732E-06	0.000E+00
6	RELATIVE HUMIDITY	2820	1184	13m	-1.098E+01	2.360E-01	-9.685E-05	-3.165E-08
7	SOLAR RADIATION	2770	427	13m	-2.271E+03	4.444E+00	0.000E+00	0.000E+00
8	AIR PRESSURE	2810	762	13m	9.117E+02	1.806E-01	0.000E+00	0.000E+00
9	RAINFALL	3064	200	13m	0.000E+00	2.100E-02	0.000E+00	0.000E+00
10	WIND SPEED	2740	1896	4m	0.000E+00	7.460E-02	0.000E+00	0.000E+00
11	RELATIVE HUMIDITY	2820	1185	4m	-2.383E+00	2.448E-01	-1.595E-04	1.537E-08
12	AIR TEMPERATURE	3145	1275	4m	-4.402E+01	8.191E-02	8.944E-06	0.000E+00

**KIGOMA WIND STATION**

CHANNEL NO.	PARAMETER	SENSOR TYPE	SERIAL NO.	REMARKS	A	B	C	D
2	WIND SPEED	2740		2.6m	4.00E-01	7.46E-02	0.00E+00	0.00E+00
3	WIND GUST	2740		2.6m	4.00E-01	7.46E-02	0.00E+00	0.00E+00
4	WIND DIRECTION	2864		2.6m	1.50E+00	3.49E-01	0.00E+00	0.00E+00

**EDITING COMPUTER'S CONFIGURATION**

Configuration files can be edited in DOSSHELL Editor. Go to C:\dos prompt and start DOSSHELL and then the **Editor** by clicking it **twice**. Write the file name you want to edit and then choose **FILE** and **SAVE AS** and write the new file name for the file. How to start DOSSHELL and how to run Editor is explained in chapters 3.2.1 and 3.3.9.

**A I. BEFORE USING FIRST TIME P3059**

	<b>FILE TO EDIT</b>	<b>FUNCTION</b>	<b>FILE TO SAVE</b>
1.	AUTOEXEC.BAT	SAVE	AUTOEXEC.TMP
	CONFIG.SYS	SAVE	CONFIG.TMP

Original AUTOEXEC.BAT and CONFIG.SYS files are saved with different names; they are 'stored' to be retrieved after using P3059.

2.	AUTOEXEC.BAT	EDIT and SAVE	AUTOEXEC.BAT
	CONFIG.SYS	EDIT and SAVE	CONFIG.SYS

Original AUTOEXEC.BAT and CONFIG.SYS files have been edited to run P3059 software. The stored \*.TMP files remain untouched. Press **CTRL+ALT+DEL** and wait for the setup. Now you can use P3059.

**A II. AFTER USING P3059 FIRST TIME**

3.	AUTOEXEC.BAT	SAVE	AUTOEXEC.DSU
	CONFIG.SYS	SAVE	CONFIG.DSU

AUTOEXEC.BAT and CONFIG.SYS files edited in paragraph 2, have been saved with other names, AUTOEXEC.DSU and CONFIG.DSU.

4.	AUTOEXEC.TMP	SAVE	AUTOEXEC.BAT
	CONFIG.TMP	SAVE	CONFIG.SYS

AUTOEXEC.BAT and CONFIG.SYS files have been saved and AUTOEXEC.BAT and CONFIG.SYS files are similar as before using P3059 software. By pressing **CTRL+ALT+DEL** and waiting for the setup you can run **WINDOWS** as before.

You should have in your c:\directory at least three different AUTOEXEC.\* and CONFIG.\* files:

The original     AUTOEXEC.BAT     and     CONFIG.SYS     files  
                   AUTOEXEC.TMP and CONFIG.TMP files and  
                   AUTOEXEC.DSU and CONFIG.DSU files

Check that you have these files in the root directory,

C:\>. Go to the root directory by typing **CD\** and press **ENTER**

Type **DIR AUTOEXEC.\*** and press **ENTER**

Type **DIR CONFIG.\*** and press **ENTER**

**BI. BEFORE USING SECOND TIME P3059**

	<b>FILE TO EDIT</b>	<b>FUNCTION</b>	<b>FILE TO SAVE</b>
1.	AUTOEXEC.DSU	SAVE	AUTOEXEC.BAT
	CONFIG.DSU	SAVE	CONFIG.BAT

AUTOEXEC.DSU and CONFIG.DSU files, which are used for running P3059 have been saved as AUTOEXEC.BAT and CONFIG.SYS files. Press **CTRL+ALT+DEL** and wait for the setup. Now you can use P3059.

2.	AUTOEXEC.TMP	SAVE	AUTOEXEC.BAT
	CONFIG.TMP	SAVE	CONFIG.SYS

AUTOEXEC.TMP and CONFIG.TMP files are copies of the original AUTOEXEC.BAT and CONFIG.SYS files. Your \*TMP files have been saved as AUTOEXEC.BAT and CONFIG.SYS files and you can run your computer as before after pressing **CTRL+ALT+DEL** and waiting for the setup.

RESEARCH FOR THE MANAGEMENT OF THE FISHERIES ON LAKE TANGANYIKA

WATER CURRENT MEASUREMENTS WITH CYLINDERS

OBSERVERS:

DATE/LINE	CYL NO.	GPS	DEPTH m	START LATIT	START LONGIT	STOP LATIT	STOP LONGIT	START TIME	STOP TIME	dLATIT	dLONGIT	SECONDS	DISTANCE m	AVERAGE SPEED (cm/s)	AVERAGE DIRECTION
WIND(m/s)															
WIND(m/s) average of five															
WIND(m/s)															
WIND(m/s) average of five															

DATE/LINE	CYL NO.	GPS	DEPTH m	START LATIT	START LONGIT	STOP LATIT	STOP LONGIT	START TIME	STOP TIME	dLATIT	dLONGIT	SECONDS	DISTANCE m	AVERAGE SPEED (cm/s)	AVERAGE DIRECTION
WIND(m/s)															
WIND(m/s) average of five															
WIND(m/s)															
WIND(m/s) average of five															

**RESEARCH FOR THE MANAGEMENT OF THE FISHERIES ON LAKE TANGANYIKA**

**WATER CURRENT MEASUREMENTS WITH CYLINDERS**

OBSERVERS:

DATE	CYL NO.	GPS	DEPTH m	START LATIT	START LONGIT	STOP LATIT	STOP LONGIT	START TIME	STOP TIME	dLATIT	dLONGIT	SECONDS	DISTANCE m	AVERAGE SPEED (cm/s)	AVERAGE DIRECTION
WIND(m/s)															
WIND(m/s) average of five															
										#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
										#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
										#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
										#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
										#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
WIND(m/s)										#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
WIND(m/s) average of five															
DATE	CYL NO.	GPS	DEPTH m	START LATIT	START LONGIT	STOP LATIT	STOP LONGIT	START TIME	STOP TIME	dLATIT	dLONGIT	SECONDS	DISTANCE m	AVERAGE SPEED (cm/s)	AVERAGE DIRECTION
WIND(m/s)															
WIND(m/s) average of five															
										#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
										#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
										#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
										#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
										#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
WIND(m/s)										#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
WIND(m/s) average of five															
DATE	CYL NO.	GPS	DEPTH m	START LATIT	START LONGIT	STOP LATIT	STOP LONGIT	START TIME	STOP TIME	dLATIT	dLONGIT	SECONDS	DISTANCE m	AVERAGE SPEED (cm/s)	AVERAGE DIRECTION
WIND(m/s)															
WIND(m/s) average of five															
										#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
										#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
										#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
										#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
										#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
WIND(m/s)										#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
WIND(m/s) average of five															

**MANUAL CALCULATIONS FOR CURRENT MEASUREMENTS ON THE LAKE**

After a measurement, following information is available for each cylinder:

Number of line: 1A  
 Number of cylinder: 1  
 Depth: 2 meters  
 Start latitude: 04°53,96'  
 Start longitude: 029°35,32'  
 Start time: 10:20  
 Stop latitude: 04°54,27'  
 Stop longitude: 029°35,26'  
 Stop time: 11:22

Wind speed and direction before and after the measurement:

6 m/sec., 40°

It is easy to calculate the approximate distance and the direction, to which a cylinder has moved. One has to remember, that:

**one degree (°) = 60' (minutes) and**

**decimals of minutes = one hundreds of a minute**

**one minute = 1852 meters**

one hundreds of a minute = 18.52 meters

1) Calculate the difference in latitude and longitude

dlatitude is the difference between stop and start latitude  
 dlongitude is the difference between stop and start longitude

dlatitude = Stop latitude-start latitude  
 $(4*60' + 54,27') - (4*60' + 53,96') = +0.31'$

dlongitude = Stop longitude-start longitude  
 $(29*60' + 35,26') - (29*60' + 35,32') = -0.06'$

2) Calculate the distance between the start and the stop position.

A = dlatitude  
 B = dlongitude           =>    C = **sqrt(A<sup>2</sup>+B<sup>2</sup>)**  
 C = distance

1 minute = 1852 meters or 1/100 of minute = 18.52 meters

If dlatitude = A, dlongitude = B and C = distance

then    C = **SQRT(0.31<sup>2</sup> + (-0.06)<sup>2</sup>)\*1852 METERS**  
           = **SQRT(0.0961+0.0036)\*1852 METERS**

or       C = **SQRT(31<sup>2</sup> + (-6<sup>2</sup>))\*18.52 METERS**  
           = **SQRT(961 + 36)\*18.52 METERS**

C = distance between the start and stop positions

= **584,78 METERS**

3) Calculate the speed (cm/sec.) of a cylinder

dtime = Stop time - Start time

**dtime = 11:22 - 10:20 = 1:02**

**1 \* 3600 sec. + 02 \* 60 sec. = 3720 sec.**

Speed of a cylinder = distance (C)/dtime and in cm/sec

**584,78\*100 cm/3720 sec. = 15.72 cm/sec.**

4) Estimate the direction of the cylinder

dlatitude or dlongitude can get positive, negative or zero values. Here are all the possible directions.

<b>direction</b>	<b>dlatitude</b>	<b>dlongitude</b>
<b>0°&gt;d&lt;90°</b>	negative	positive
<b>90°&gt;d&lt;180°</b>	positive	positive
<b>180°&gt;d&lt;270°</b>	positive	negative
<b>270°&gt;d&lt;360°</b>	negative	negative
<b>d=0°</b>	negative	zero
<b>d=90°</b>	zero	positive
<b>d=180°</b>	positive	zero
<b>d=270°</b>	zero	negative

In each quarter of 90°, the direction of a cylinder can be determined more accurately from the list below. This accuracy is normally enough to determine the pattern and the direction of a cylinder. The values are considered as absolute values.

