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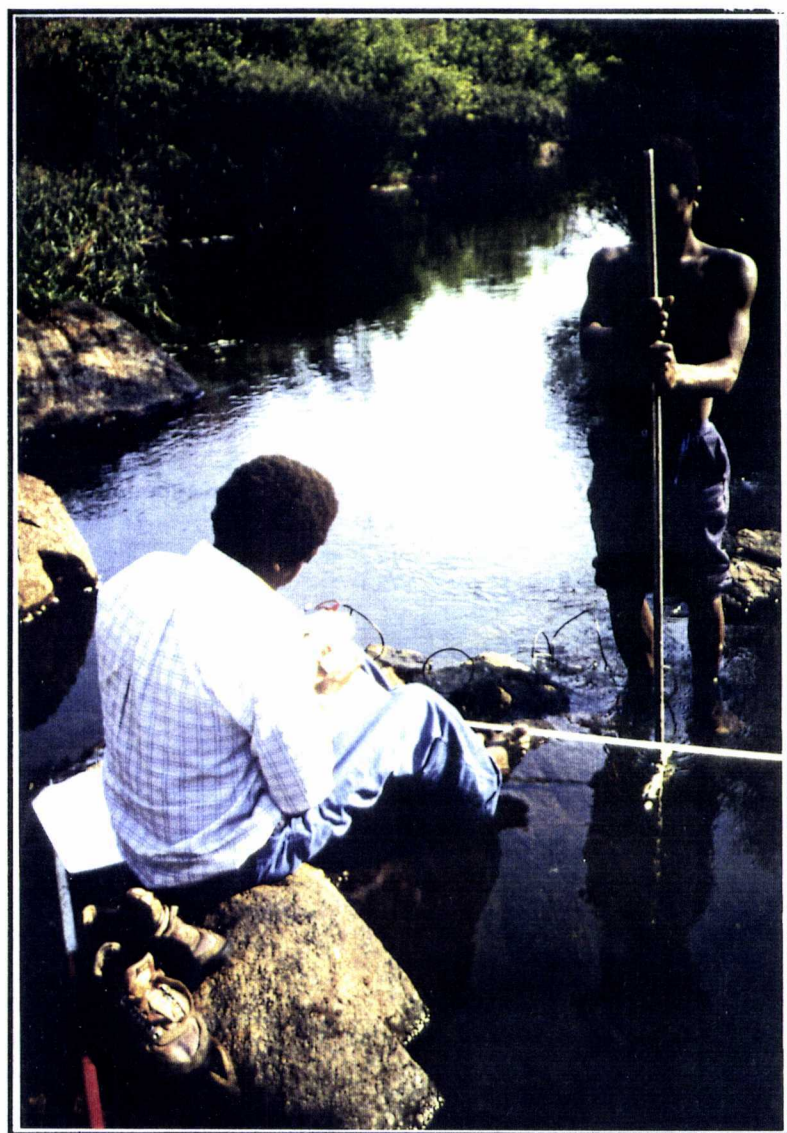
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NVE
NORWEGIAN
WATER RESOURCES AND
ENERGY ADMINISTRATION

FIFTH MAJI/NORAD TRAINING COURSE FOR HYDROLOGY TECHNICIANS

16 October - 1 December 1989



By

J. M. Mihayo

B. Krokli

NVE
NORWEGIAN
WATER RESOURCES AND
ENERGY ADMINISTRATION
Division of development
assistance

NORAD
NORWEGIAN AGENCY
FOR DEVELOPMENT
COOPERATION

UNITED REPUBLIC
OF TANZANIA
MINISTRY OF WATER



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ENERGY ADMINISTRATION


Tittel/Title FIFTH MAJI/NORAD TRAINING COURSE FOR HYDROLOGY TECHNICIANS IN TANZANIA 16 October - 1 December 1989	Nr/No 05-90
Forfatter(e)/Saksbehandler(e)/ Executive Officer(s) J.M. Mihayo, Ministry of water, MAJI B. Krokli, Norwegian Water Resources and Energy Administration	Dato/Date June 1990
	ISBN

Sammendrag/Abstract

The fifth MAJI/NORAD training course for hydrology technicians in Tanzania was held in Dar es Salaam, Tanzania, 16 October - 1 December 1989. The course was mainly organized by the Tanzanian Ministry of Water (MAJI), with only limited contribution by the Norwegian Water Resources and Energy Administration (NVE).

The report summarizes the course preparations and accomplishment.

Emneord/Subject Terms Tanzania Hydrology Course
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Ansvarlig underskrift/ Project Co-ordinator  Egil Skofteland NVE/NORAD-Coordinator

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MINISTRY OF WATER
MAJI
Hydrology section, Ubungo

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1. BACKGROUND

NORAD received in 1981 a request from the Project Preparation Division, Ministry of Water and Energy in Tanzania (MAJI), to assist in organizing and financing a practical oriented course for their regional hydro staff.

NORAD agreed on financing three courses, and the Norwegian National Committee for Hydrology (NHK) in cooperation with the Project Preparation Division of MAJI were asked to prepare the practical parts of such a programme.

NHK recruited professional hydrologists to be responsible for the syllabus and the performance of the programme. In 1987 this programme was followed up by a fourth course.

The following courses were concluded:

Course no.	Period	Responsible person/institution
1	April 11 - May 25, '83	Ole Stang/VHL
2	April 30 - June 13, '84	Knut Sand/VHL
3	Oct 8 - Nov 23, '84	Anton Tomsen /DHI
4	Sept 14 - Nov 30, '87	Knut Sand/VHL

Senior hydrologist J. Kobalyenda has acted as MAJI course coordinator and principal Tanzanian lecturer through all four courses.

A request for a fifth course was received by NORAD in 1988. The request was accepted, but the local contribution to the budget was increased. In addition most of the preparations for the course were taken care of by the Hydrology Section on behalf of the Principal Secretary, Ministry of Water.

As it has been demonstrated in this course, MAJI is fully competent in arranging a course like this with only limited contribution from NORAD. In cooperation with Rwegalulila Water Research Institute (RWRI) the professional skill and the teaching facilities are also present.

2. INTRODUCTION

The fifth MAJI/NORAD training course for hydrology technicians in Tanzania was held in Dar es Salaam at the Rwegalulila Water Research Institute from 16. October to 1. December 1989. Mr. M. Msuya, Acting Head of Hydrology Section, has been responsible for the accomplishment of the course on behalf of the Principal Secretary, Ministry of Water.

The course was performed as a co-operation between

- Tanzanian Ministry of Water (MAJI), Ubungo
- Norwegian Agency for Development Co-operation (NORAD)
- Rwegalulila Water Research Institute (RWRI)
- Norwegian Water Resources and Energy Administration (NVE)

Mr. J.M. Mihayo, Head of Electronic section, the preparations for the course in Dar es Salaam with assistance from Mr. A. Hollerud, NORAD. The preparations in Norway were mostly taken care of by NVE.

Senior hydrologist Mr. B.A. Luhumbika, Head of Field Op. Ser, has been the course co-ordinator. lecturers have been hydrologists from Mbungo and RWRI and Mr. B. Krokli from NVE has been the external examiner.

2. COURSE PREPARATIONS

The preparations for this course were mainly done in Tanzania with only limited contribution from NVE in Norway.

In Tanzania, discussions were held with the Principal of the Water Resources Institute to arrange for accommodation for the course participants, classroom for lecturers and other facilities which were to be provided by the Institute.

Through discussions with NORAD it was decided that most of the teaching materials and other requirements which can be obtained

locally should be purchased in Tanzania and only those which are unavailable can be purchased in Norway.

The following were purchased locally and the payment was made by NORAD in Dar-es-Salaam:

- writing pads, ball points, rulers, pencils, sharpeners, graphs papers, french curves, markers and photocopying papers.
- 40 bags for both course participants and the course lecturers.

Items which were purchased from Norway were:

- Xerox photocopying machine with spare parts and other accessories plus photocopying papers.
- 25 HP-32S hand calculators with 300 spare non-chargeable batteries.
- 4 HP-41CV programmable calculators with 20 spare chargeable battery packs for the HP-41 CV calculators and 4 packs of spare blank cards.
- 40 text books "Hydrology in Practice" by Elizabeth Shaw.

3. RECOMMENDATIONS

With this fifth course, there are a total of about 124 hydrology technicians who have been trained through this MAJI/NORAD training programme which started in 1983.

It is expressed from MAJI that such cooperation and assistance should be continued also in other areas.

The status of most of the hydrometric as well as climatic stations is not good due to non-availability of instruments and equipments which are mostly obtained from abroad. This situation makes the collection of data from these stations difficult and

also the quality and reliability of such data to be doubtful.

MAJI is of the view that, with the good number of trained hydrology technicians and of the availability of the provided HP programmable hand calculators in the regional hydrological offices, there is a need to seek for external assistance in order to rectify the present situation of hydrological stations. The assistance required includes among other things the following:

- Provision of various hydrological and meteorological instruments and equipment which are only obtained from abroad. These includes items such as sunshine cards, meteorological instruments, current meters etc.
- In order to inspect and check the status of stations, there is a need to have a good and reliable transport. Most of the regional hydrological offices are short of vehicles. This situation makes the regional offices unable to verify the reliability of the data which they receive from gauge readers and meteorology observers. This condition makes the exercise of analyzing such data useless as it will lead to conclusions which are based on unreliable data.
- Hydrological data digitizing and analysis have been difficult to perform due to serious trouble with the discs on the I.C.L. computer belonging to the Ministry of Water. In order to perform the duties, the Hydrology Section, Ubungu, has a requirement for a Personal Computer.

4. TEACHING STAFF

Mr. B.A. Lhumbika (MAJI) was the course leader. He also lectured the following items:

- Item 2: Network design
- Item 3: Operation of stations
- Case study no. 1

Mr. M.O. Msuya (Head of Hydrological Services gave a lecture on:

- Item 1: Introduction

Mr. J.M. Mihayo (MAJI) was the assistant course leader. He lectured on the following:

- Item 7: Processing of streamflow data
- Case study no. 2

Mr. J. Dukuduku (MAJI) lectured on:

- Item 4: Repair and maintenance of instruments

Mr. S. Salamba (MAJI) lectured on:

- Item 6: Processing of hydrometeorological data
- Case study no. 4

Mr. I.E. Mwakalinga (MAJI) lectured on:

- Item 10: Operation of HP-32S hand calculators

Mr. M. Msalali (Water Resources Institute) lectured on:

- Item 8: Hydrological analysis

Mr. S.H. Mkhandi (MAJI) lectured on:

- Item 5: Water resources
- Case study no. 5

Mr. S.A. Faraji (MAJI) lectured on:

- Case study no. 3

MR. B. Krokli (NVE) gave a short lecture on how data is collected and processed in Norway.

The Tanzanian lecturers were paid an allowance of Tsh. 400/ per hour of lecturing and Tsh. 1000/ for setting and marking of the final examinations.

5. COURSE PARTICIPANTS

A total of 25 technicians attended the course as shown in Appendix A. They were selected from all the twenty regional hydrological offices and the Headquarters.

Most of the participants did well during the course. There were a few participants who had problems in following some of the course material. This was due to little theoretical background and also for being away from school for a very long time.

All the course participants were accommodated at the Water Resources Institute (W.R.I.) and each participant was paid an allowance of Tsh. 600/ per day for meals and personal expenses.

6. COURSE SYLLABUS

The course syllabus for this course was the same as the one which was used during the last four courses. This time different worked examples and exercises were used than the ones used during the previous fourth course.

The course syllabus is enclosed in Appendix B and the weekly timetables are shown in Appendix C.

The textbooks which were used during the course were:

Shaw, E.: Hydrology in Practice. Van Nostrand Reinhold (UK) Co. Ltd. 1983. ISBN 0-442-30566-4.

World Meteorological Organization: Guide to Hydrological Practices. Vol. 1: Data acquisition and processing, 1981.
ISBN 92-63-14168-1

MAJI, NORAD, NHL: Work Book, vol 1 & 2.

Hewlet Packard: HP-32S Owners Manual

7. FINAL EXAMINATION

Final examinations were held in the following subjects:

- Processing of Hydrometeorological data
- Streamflow data processing
- Hydrological analysis

Appendix D shows the papers given.

The marking was done by the respective lecturers for each item and an external examiner. The highest possible score was 100 and the passing mark was set at 50. Below is a summary of the examination results:

Item	Grades		
	Lowest	Highest	Mean
Processing Hydrometeorological data	42	95	76
Streamflow data processing	30	97	69
Hydrological analysis	24	92	76

23 participants passed the final examination by obtaining a score of 50 or more as an average for the three papers. These were awarded with a diploma, certificate of attendance and a grades certificate. 2 participants did not reach the average passing mark of 50. They were given a "Certificate of attendance" and a grades certificate.

8. COURSE EVALUATION

At the end of the course a course evaluation was held. The participants were asked to answer eight questions, the same as the ones which were asked during the previous third and fourth courses. The questions are listed below:

- Q1: List the three items you found the most interesting.
 Q2: List the three items you found the least interesting.

- Q3: List the items you would have liked to spend more time on.
 Q4: List the items you would have liked to spend less time on.
 Q5: List new items you would have liked to be included in the course.
 Q6: List what you liked best about the course.
 Q7: List what you liked least about the course.
 Q8: List your complaints, compliments or suggestions about the course.

The answers to these questions are as presented below:

Question 1-4:

Item no	Title	Question number			
		1	2	3	4
1	Introduction	1	2	0	7
2	Network design	2	6	2	6
3	Operation of stations	2	5	4	4
4	Repair and maintenance of instruments	0	4	15	1
5	Water resources	1	6	0	8
6	Processing of hydrometeorological data	14	1	8	3
7	Processing of streamflow data	13	6	12	0
8	Hydrological analysis	13	2	13	0
9	Case studies	5	2	7	5
10	operation of hand calculators	18	2	16	0

Question 5: List new items you would have liked to be included in the course.

Answers: Practicals (14)
 Statistics (1)
 Engineering mathematics (1)
 Engineering hydrology (1)
 Advanced programming (1)
 Management (1)
 Economics (1)
 Study tours (2)

Question 6: List what you liked best about the course.

Answers: Good coordination (1)
Gained extra knowledge about hydrology (2)
The way the course was conducted (1)
Time table set up (1)

Question 7: List what you liked least about the course.

Answers: Time too short (1)
Life at the Water Resources Institute bad (1)
Bad teaching approach by some lecturers (2)
Poor care of course participants, eg. when sick (1)
Spacing of time table not good (1)
Allowances not enough (1)

Question 8: List your complaints, compliments or suggestions about the course.

Answers: The allowance was not enough (3)
The course should be conducted outside the Water Resources Institute (1)
Sponsorship was not fair (1)
The lecturers should be trained before teaching the participants (3)
Accommodation not good (2)
Next course participants should stay in guest houses (1)
The duration of the course should be extended (10)
The next course should be conducted in Norway (1)
At the end of the course participants should be given money for shopping (1)
There should be another sixth course (3)
Number of participants should be increased (1)
The course was good (2)
Next course should have practicals included (1)
Time table too compact (2)
Streamflow data processing examination set up wrong (1)

The course should be recognised by the Ministry of Water so that successful participants can get one salary increment (1)

The course was well organised (1)

APPENDIX A: COURSE PARTICIPANTS

5TH TRAINING COURSE FOR HYDROLOGY TECHNICIANS PARTICIPANTS.

1	Charles Kalusa	Techn. III	Shinyanga
2	Joyce K. Reuben (Miss)	" IV	Iringa
3	Wilfred Isaac	" IV	Mtwara
4	Mataru M. Said	" IV	"
5	Constancia Timothy (Mrs)	" IV	Ruvuma
6	Robert Mwamasage	" III	Rukwa
7	Omary Nyamonde	" II	Dar/Coast
8	Dedan A. Mundo	" II	Morogoro
9	Thadeo Malogo	Asst.Tech.	Dodoma
10	Ally Shamte	Sen.Tech.	"
11	Arthur P. Mtoi	Techn. II	Tanga
12	Muhidin Mrisho	" III	Tabora
13	Daniel Mwaipopo	" II	Mbeya
14	Isaiah J. M. Macha	" III	Kilimanjaro
15	Frank Linyembe	" IV	Lindi
16	David N. Shokora	" IV	Kigoma
17	Faustine Songo	" IV	Mwanza
18	Nyamhanga Kitang'ita	" IV	Mara
19	Hassan K. Mwasolile	" III	Arusha
20	Elijah L. Mayuki	" III	Singida
21	Salvatory Mukebezi	" III	Kagera
22	Faustine Lweganwa	" II	Dsm
23	Wilson E. Lugomamo	" III	"
24	Samson Andrew	" IV	"
25	Deothila Mgoli (Miss)	" IV	"

APPENDIX B: COURSE SYLLABUS

5TH TRAINING COURSE FOR HYDROLOGICAL TECHNICIANS IN TANZANIA

COURSE SYLLABUS:

Item no:	Title	No. of hours	Lecturer
1	Introduction	3	M.O.Msuya (MOM)
2	Network design	6	B.A.Luhumbika (BAL)
3	Operation of stations	8	"
4	Repair and maintenance of instruments	10	J.Dukuduku (JD)
5	Water resources	9	S.H.Mkhandi (SHM)
6	Processing of hydro- meteorological data	14	S.Salamba (SS)
7	Processing of streamflow data	21	J.M.Mihayo (JMM)
8	Hydrological analysis	27	M.Msalali (MM)
9	Case studies	46	Several lecturers
10	Operation of HP-32S hand calculators	18	I.E.Mwakalinga (IEM)

ITEM NO 1: INTRODUCTION (6 hrs)

Lecturer	Hour	Literature	Topic
MOM	1-3	-	: Definition of Hydrology : The hydrological Cycle : Objectives of the course : The need for hydrological investigations : Regional hydrological offices duties : Hydrological failures : Status hydrology in Tanzania today

ITEM NO: 2 NETWORK DESIGN (6 hrs)

Lecturer	Hour	Literature	Topic
BAL	1	Shaw 2.1+2.2	Introduction - basic defination
BAL	2	Shaw 2.3+2.4	Precipitation and evapo- ration networks
BAL	3	Shaw 2.5	Hydrometric networks
BAL	4	WB I2	Deviation from ideal networks
BAL	5	WB I2	Network in Tanzania
BAL	6	WB I2	Concequances of inadiquate networks

ITEM NO: 3 OPERATION OF STATIONS (6 hrs)

Lecturer	Hour	Literature	Topic
BAL	1	WB I3 + Tilrem Manuals	Measurements - General on measurements of different variables
BAL	2	"	Water levels - staff gauges - automatic recorders
BAL	3-4	"	Discharges - station creteria - current meter -computation of discharge -other methods
BAL	5-6	"	Operation of stations
BAL	7	"	Sediment - general - computation
BAL	8	"	Rainfall and evaporation - bucket gauge - automatic gauge evaporation

ITEM NO 4: REPAIR AND MAINTENANCE OF INSTRUMENTS (10 hrs)

Lecturer	Hour	Litterature	Topic
JD	1	WB I4	● Theory of current meter and practice
JD	2	"	● Theory of buzzers and practice
JD	3	"	● Theory of winches and practice
JD	4-5	"	● Theory of automatic water level recorders and practice
JD	6	"	● Theory of anemometers and practice
JD	7-8	"	● Theory of automatic rainfall recorders and practice
JD	9	"	● Theory of thermohygrographs and practice
JD	10	"	● Theory of stop watch/clocks and practice

ITEM NO: 5 WATER RESOURCES (9 Hours)

Lecturer	Hour	Literature	Topic
SHM	1-6	WB I5	Introduction
		Shaw	Water resources invetories
			Groundwater resources
			Water quality
			Tanzanian water master plans

ITEM NO 6: PROCESSING OF HYDROMETEOROLOGICAL DATA (14 hrs)

Lecturer	Hour	Litterature	Topic
SS	1	Shaw 1.1 + 1.3 + 1.4 Shaw 9.1	<ul style="list-style-type: none"> ● Hydrological cycle ● Data processing
SS	2-3	Shaw 3.1 - 3.2 Shaw 9.2 - 9.4, 9.7	<ul style="list-style-type: none"> ● Rainfall data <ul style="list-style-type: none"> - data collection - data processing
SS	4-5	WMO 4.2.4	<ul style="list-style-type: none"> ● Data Quality Control
SS	6-7		<ul style="list-style-type: none"> ● Rainfall intensity
SS	8-9	Shaw 4.4 - 4.4 Shaw 4.5 + IM 5.5	<ul style="list-style-type: none"> ● Evaporation data ● Temperature data ● Humidity ● Wind
SS	10-13	Shaw 11.1-11.3 WB I6	<ul style="list-style-type: none"> ● Calculation of evaporation
SS	14	IM 6 WMO 4.2.5	<ul style="list-style-type: none"> ● Data reports

ITEM NO 7: PROCESSING OF STREAMFLOW DATA (21 hrs)

Lecturer	Hour	Litterature	Topic
JMM	1	WB 17 + Tilrem Man.	● Establishment of station
JMM	2-4	"	● Rating curves
JMM	5-6	"	● Point of zero flow
JMM	7	"	● Rating equation
JMM	8-9	"	● Verification of rating equation
JMM	10	"	● Extrapolation of rating curve
JMM	11-12	"	● Daily mean discharge
JMM	13	"	● Missing data
JMM	14	"	● Data correction
JMM	15-16	"	● Consistency of data
JMM	17	"	● Data application
JMM	18	"	● Data reporting
JMM	19-20	"	● Data processing at Ubungo
JMM	21	"	● Discussion

ITEM NO 8: HYDROLOGICAL ANALYSIS (27 hrs)

Lecturer	Hour	Litterature	Topic
MM	1-2	WB I8	<ul style="list-style-type: none"> ● Introduction
MM	3-6	Shaw 10.1, 10.2	PART I - PRECIPITATION ANALYSIS <ul style="list-style-type: none"> ● Areal rainfall ● Statistical analysis ● Rainfall frequency
MM	7-9	WB I8	<ul style="list-style-type: none"> ● Double mass curves - exercise
MM	10-12	"	<ul style="list-style-type: none"> ● Areal rainfall - exercise
MM	13	"	<ul style="list-style-type: none"> ● Analysis of trend
MM	14-16	"	<ul style="list-style-type: none"> ● Moving average - exercise
MM	17-18	Shaw 12.1-12.2	PART II - RIVER FLOW ANALYSIS <ul style="list-style-type: none"> ● River Flow
MM	19-24	Shaw 12.3-12.9	<ul style="list-style-type: none"> ● Flow Frequency - exercise
MM	25	Shaw 13.3	<ul style="list-style-type: none"> ● Hydrograph analysis
MM	26	Shaw 13.1	<ul style="list-style-type: none"> ● Rational method
MM	27	WB I8	<ul style="list-style-type: none"> ● Flow estimation

ITEM NO 9: CASE STUDIES (46)

Lecturer	Hour	Litterature	Topic
SAF	1-15	WB I9	Case study number 3 - Sediment transport
BAL	16-21	"	Case study number 1 - Discharge computations
JMM	22-31	"	Case study number 2 - Determination of Ho - Rating curves
SS	32-38	"	Case study number 4 - Penman evaporation
SHM	39-46	"	Case study number 5 - Extreme flow analysis

SAF = S.A.Faraji

BAL = B.A.Luhumbika

JMM = J.M.Mihayo

SS = S.Salamba

SHM = S.H.Mkhandi

ITEM NO 10: OPERATION OF HP-32S HAND CALCULATORS

Lecturer	Hour	Litterature	Topic
IEM	1-3	HP-32S manual	Introduction
IEM	4-8	"	HP-32S keyboard
IEM	9-11	"	Statistics
IEM	12	"	Regression
			analysis
IEM	13-15	"	Special keys
IEM	16-18	"	Programming

APPENDIX C: WEEKLY TIMETABLES

COURSE WEEK NO. 1 (16/10 - 20/10/89)

DATE _____

TIME	MONDAY	TUESDAY	WEDN. DAY	THURSDAY	FRIDAY
0800	REGISTRATION BAL 2	NETWORK DESIGN BAL 2	REPAIR MAINTEN. BAL 4	NETWORK DESIGN BAL 2	OPERATION OF STATIONS BAL 3
0900	-11-	BAL 2	BAL 4	BAL 2	BAL 3
1000	-11-	BAL 2	BAL 4	BAL 2	BAL 3
1045	OPENING SESSION BAL 2	-11-	-11-	-11-	-11-
LUNCH	/ / / / /				
1200	/ / / / /				
1200	1 SEM INTRODUCTION HP 11C BAL 10	1 SEM HP 11C BAL 10	1 SEM HP 11C BAL 10	REPAIR MAINTEN. BAL 4	HP 11C BAL 10
1300	-11-	HP 11C BAL 10	-11-	-11-	-11-
1400	-11-	HP 11C BAL 10	-11-	-11-	-11-
1445	-11-	HP 11C BAL 10	-11-	-11-	-11-

COURSE WEEK NO. 2 (23/10 - 27/10/89)

TIME	MONDAY	TUESDAY	WEDN. DAY	THURSDAY	FRIDAY	DATE
0800	BAL 3 OPERATION OF STATIONS	BAL 3 OPERATION OF STATIONS	JMM 7 ESTABLISHMENT OF GAUGING STNS.	JMM 7 PROCESSING STREAMFLOW DATA	SS 6 PROCESSING HYDROMET DATA	
0900	BAL 3 -11-	BAL 3 -11-	JMM 7 PROCESSING STREAMFLOW DATA	JMM 7 -11-	SS 6 -11-	
1000	SS 6 PROCESSING HYDROMET DATA	BAL 3 -11-	SS 6 PROCESSING HYDROMET DATA	JMM 7 -11-	SS 6 -11-	
1045						
LUNCH						
1200	SS 6 -11-	JEM 10 HP 11 C	BAL 9 DISCHARGE COMPUTATIONS	BAL 9 DISCHARGE COMPUTATIONS	JEM 10 HP 11 C	
1300	JD 4 REPAIR MAINTEN.	JD 4 REPAIR MAINTEN.	BAL 9 -11-	BAL 9 -11-	JEM 10 -11-	
1400	JD 4 -11-	JD 4 -11-	BAL 9 -11-	BAL 9 -11-	JEM 10 -11-	
1445						

Item 3 : 5 Item 6 : 6 Item 9 : 6

Item 4 : 4 Item 7 : 5 Item 10 : 4

Total = 30

COURSE WEEK NO. 3 (30/10 - 3/11/89)

TIME	MONDAY	TUESDAY	WEDN. DAY	THURSDAY	FRIDAY	DATE
0800	SAF 9 SEDIMENTS	SS 6 PROCESSING HYDROMET DATA	IMM 7 PROCESSING STREAMFLOW DATA	SS 6 PROCESSING HYDROMET DATA	MM 8 HYDROLOGICAL ANALYSIS	
0900	SAF 9 -11-	SS 6 -11-	IMM 7 -11-	SS 6 -11-	MM 8 -11-	
1000	SAF 9 -11-	SS 6 -11-	IMM 7 -11-	SS 6 -11-	MM 8 -11-	
1045						
LUNCH						
1200	SAF 9 -11-	SAF 9 CASE STUDY NO. 3	SAF 9 CASE STUDY NO. 3	SAF 9 CASE STUDY NO. 3	DEM 10 HP 11 C	
1300	SAF 9 CASE STUDY NO. 3	SAF 9 -11-	SAF 9 -11-	SAF 9 -11-	DEM 10 -11-	
1400	SAF 9 -11-	SAF 9 -11-	SAF 9 -11-	SAF 9 -11-	DEM 10 -11-	
1445						

Item 6: 6 Item 8: 3 Item 10: 3
 Item 7: 3 Item 9: 15 Total = 30

COURSE WEEK NO. 4

(6/11 - 10/11/89)

TIME	MONDAY	TUESDAY	WEDN. DAY	THURSDAY	FRIDAY	DATE
0800	Jmm 7 PROCESSING STREAM FLOW DATA	mm 8 HYDROLOGICAL ANALYSIS	mm 8 HYDROLOGICAL ANALYSIS	Jmm 7 PROCESSING STREAM FLOW DATA	mm 8 HYDROLOGICAL ANALYSIS	
0900	Jmm 7 --	mm 8 --	mm 8 --	Jmm 7 --	mm 8 --	
1000	Jmm 7 --	mm 8 --	mm 8 --	Jmm 7 --	mm 8 --	
1045	Jmm 7 --	mm 8 --	mm 8 --	Jmm 7 --	mm 8 --	
LUNCH						
1200	Jmm 7 --	Jmm 9 CASE STUDY NO. 2	Jmm 9 CASE STUDY NO. 2	Jmm 9 CASE STUDY NO. 2	Jmm 9 CASE STUDY NO. 2	
1300	SS 6 PROCESSING HYDROMET. DATA	Jmm 9 --	Jmm 9 --	Jmm 9 --	IEM 10 HP 11C	
1400	SS 6 --	Jmm 9 --	Jmm 9 --	Jmm 9 --	IEM 10 HP 11C	
1445						

Item 6: 2 Item 8: 9 Item 10: 2

Item 7: 7 Item 9: 10

Total = 30

COURSE WEEK NO. 5 (13/11 - 17/11/89)

TIME	MONDAY	TUESDAY	WEDN. DAY	THURSDAY	FRIDAY	DATE
0800	MM 5 HYDROLOGICAL ANALYSIS	JMM 7 PROCESSING STREAMFLOW DATA	MM 8 HYDROLOGICAL ANALYSIS	JMM 7 PROCESSING STREAMFLOW DATA	MM 8 HYDROLOGICAL ANALYSIS	
0900	MM 8 - -	JMM 7 - -	MM 8 - -	JMM 7 - -	MM 8 - -	
1000	MM 8 - -	JMM 7 - -	MM 8 - -	JMM 7 - -	MM 8 - -	
1045	MM 8 - -	JMM 7 - -	MM 8 - -	JMM 7 - -	MM 8 - -	
LUNCH						
1200	SS 9 CASE STUDY NO. 4	SS 9 CASE STUDY NO. 4	SS 9 CASE STUDY NO. 4	SHM 9 CASE STUDY NO. 5	SHM 9 CASE STUDY NO. 5	
1300	SS 9 - -	SS 9 - -	SHM 9 CASE STUDY NO. 5	SHM 9 - -	SHM 9 - -	
1400	SS 9 - -	SS 9 - -	SHM 9 - -	SHM 9 - -	SHM 9 - -	
1445						

Item 7: 6 Item 9: 15
Item 8: 9

Total = 30

COURSE WEEK NO. 6 (20/11 - 24/11/89)

TIME	MONDAY	TUESDAY	WEDN. DAY	THURSDAY	FRIDAY	DATE
0800	MM 8 HYDROLOGICAL ANALYSIS	5 SPEAKERS NORAD/WMPU	MM 8 HYDROLOGICAL ANALYSIS	↑	↑	
0900	MM 8 --	5 SPEAKERS NORAD/WMPU	MM 8 --	REVIEW	REVIEW	
1000	MM 8 --	5 GUEST LECTURERS	MM 8 --	↓	↓	
1045						
LUNCH						
1200	SHM 5 WATER RESOURCES	SHM 5 WATER RESOURCES	↑ (HYDROMETEOROLOGY)	↑ (STREAMFLOW DATA)	↑ (HYDROLOGICAL ANALYSIS)	
1300	SHM 5 --	SHM 5 --	REVIEW	REVIEW	REVIEW	
1400	SHM 5 --	SHM 5 --	↓ (HYDROMETEOROLOGY)	↓ (STREAMFLOW DATA)	↓ (HYDROLOGICAL ANALYSIS)	
1445						

Item 5: 9
Item 8: 6

Total = 15 +

COURSE WEEK NO. 7 (27/11 - 1/12/89)

TIME	MONDAY	TUESDAY	WEDN. DAY	THURSDAY	FRIDAY	DATE
0800	↑	↑	↑	↑	↑	
0900	I	II	III			
1000	EXAMINATION HYDROLOGICAL DATA PROCESSING	EXAMINATION STREAM FLOW DATA PROCESSING	EXAMINATION HYDROLOGICAL ANALYSIS	COURSE EVALUATION	CLOSING SESSION	
1045				↓	↓	
LUNCH						
1200						
1300	↓	↓	↓			
1400						
1445						

APPENDIX D: EXAMINATIONS

MAJI/NORAD TRAINING COURSE FOR HYDROLOGY TECHNICIANS

EXAMINATION IN HYDROMETEOROLOGY

27 NOV. 1989 , 0800 - 1300 HOURS

NAME: _____

Examinants are allowed to use: Instruction Manual

Hand calculator

EXAMINATION IN HYDROMETEOROLOGY

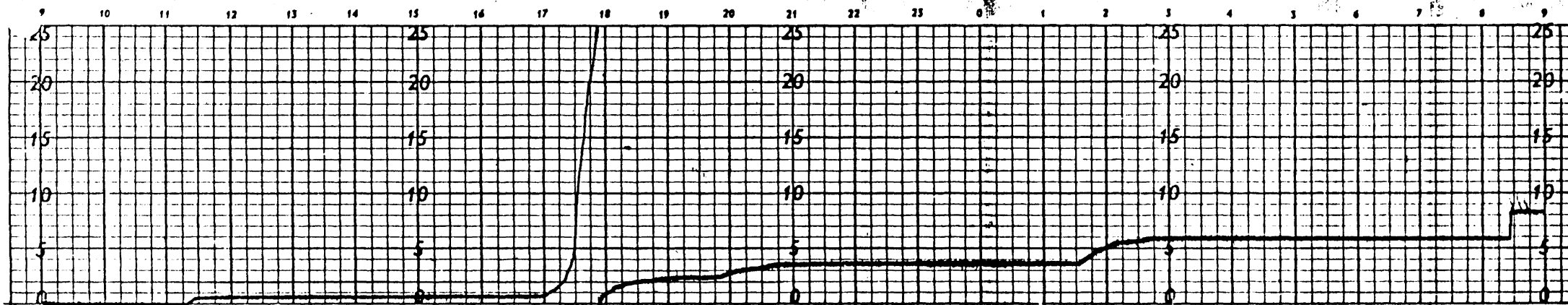
Attempt all questions

1. (a) By means of a neat diagram describe the hydrological cycle.
(b) What parameters do you expect to measure at a complete meteorological station
(c) Name the instruments used to measure each of the named parameters above

2. (a) Define the term Evaporation and explain the main cause of it
(b) Name 4 factors that affect evaporation at any given locality
(c) What do you understand by the following terms:-
 - i. Albedo
 - ii. Lapse rate

3. Given the chart (next page) from the recording rain gauge at Morning Side is to be analysed.
A. For the period from 15 hrs to 22hrs extract the information asked for below.
 1. When did rain begin?
 2. " " " cease?
 3. Duration of event (Minutes)?
 4. Amount of rain (mm)?
 5. Mean intensity (mm/hr)?
 6. Max. 60 min (1 hr) intensity?

Gauge No 965746 Year 78 Month Dec Time on 9 ~~ad~~ hrs. Time off 9 ~~ad~~ hrs. Duration of Rainfall h m.



Scale, 5 mm = 10 mm on chart

Station Melning Side...

Total 9h to 9h

Recorder mm
Check gauge mm

No. 571

700

B. From the entire chart (all 24 hrs) a number of rainfall events separated by periods of no rainfall can be separated.

Extract the information asked for below.

1. Total no. of events?

2. Total amount of rain (mm) ?

4. a) Define evapotranspiration.

b) The following information was obtained from Igawa Meteorological station for the month of July. They are average values obtained from a long period of record.

DATA: (i) Average mean temp = 20.9°C

(ii) " " RH = 56%

(iii) " " daily sunshine hrs. = 10.3

(iv) " " windrun = 233 km/day

(v) " (Tmax - Tmin) = 13°C

LOCATION: $8^{\circ} 46' \text{ S}$, $32^{\circ} 23' \text{ E}$,

ELEVATION: 1,200 M. above sea level

QUESTION:

Using the above meteorological data and tables I - X calculate evapotranspiration (E_t) using Penman formula. For ease of computation a special form is attached for you.

c) What could be the average crop water requirement in July for a field of 400 hectares in m^3/sec if you were consulted by the Ministry of Agriculture?

FAO/UNESCO/WMO AGROCLIMATOLOGY SURVEYS

POTENTIAL EVAPOTRANSPIRATION after PENMAN

Country Station Period
 Latitude Longitude Altitude

R_A mm (Land 1816)
 n
 N = $\frac{n}{N}$
 $a + b \times$ $\times 0.75 =$ (III) \times = Short wave radiation absorbed by evaporating surface = (I-a) R_G mm
 R_G cal $\times \frac{0.75}{59}$
 T_c $\rightarrow \sigma T_K^4$ (IV) \times (V) \times (VI) = Infrared effective radiation = R_B mm
 $e_{d,mb}$ $\rightarrow 0.56 - 0.079 \sqrt{e_d}$
 $e_{d,mn}$ - e_d =
 U_m/sec $\times (0.54) + 1.00$ $\times 0.26 =$ (VIII) \times = Aerodynamic term = A_T mm
 \bar{T}_{max}
 \bar{T}_{min} = If $> 12^\circ$ check with table VIII.
 $\bar{T}_{max} - \bar{T}_{min}$
 $\frac{\Delta}{\gamma} \cdot \frac{p_0}{p} =$ (X) \times \times + = = ϵ_T mm/day
 ϵ_T mm/day
 ϵ_T mm/month

Final Computation

$$\frac{\left[\frac{\Delta}{\gamma} \cdot \frac{p_0}{p} \right] \epsilon_T + A_T}{\left[\frac{\Delta}{\gamma} \cdot \frac{p_0}{p} \right] + 1} = \text{Potential Evapotranspiration (E}_T\text{)}$$

* Roman numeral indicates No. of appropriate table

MAJI/NORAD TRAINING COURSE FOR HYDROLOGY TECHNICIANS

EXAMINATION IN STREAMFLOW DATA PROCESSING

28 NOV. 1989 , 0800 - 1300 HOURS

NAME: _____

Examinants are allowed to use: Any textbooks or manuals

Notes

Hand calculator

EXAMINATION ON STREAMFLOW DATA PROCESSING

28 NOVEMBER 1989 0800 - 1300 HRS.

Use the data on discharge measurements presented on page two to answer the following questions.

QUESTION 1:

Plot the 20 discharge measurements on ordinary graph paper provided and fit a median curve through the plotted points.

QUESTION 2:

With the use of the arithmetic method, determine the value of the cease to flow level, H_o .

QUESTION 3:

Find the equation of the rating curve which has been fitted in Question 1 above using the statistical procedure.

QUESTION 4:

Determine whether the curve fitted in Question 1 above is free from bias or not-with the help of the sign test. Use 5 percent significance level.

DATA FOR THE DISCHARGE MEASUREMENTS:

NO.	GAUGE HEIGHT (m)	DISCHARGE $m^3/s.$
1	1.22	20.0
2.	1.34	23.6
3	1.42	25.6
4.	0.36	1.2
5	0.46	2.4
6	0.52	4.0
7	2.06	69.0
8	2.00	64.0
9	1.90	52.0
10	0.90	11.6
11	1.60	16.0
12	1.46	28.4
13	1.66	36.4
14	1.76	42.0
15	1.88	48.0
16	2.00	60.0
17	1.56	32.0
18	0.82	10.0
19	0.70	7.2
20	0.64	6.0

Table B.2

Table of the *t* distribution

Probability of a larger value of t, sign ignored (two-tail test)												
d.f.	.9	.8	.7	.6	.5	.4	.3	.2	.1	.05	.02	.01
1	.158	.325	.510	.757	1.000	1.376	1.963	3.078	6.314	12.706	31.821	63.657
2	.142	.289	.445	.617	.816	1.061	1.386	1.886	2.920	4.303	6.965	9.925
3	.137	.277	.424	.584	.765	.978	1.250	1.638	2.353	3.182	4.541	5.841
4	.134	.271	.414	.569	.741	.941	1.190	1.533	2.132	2.776	3.747	4.604
5	.132	.267	.408	.559	.727	.920	1.156	1.476	2.015	2.571	3.365	4.032
6	.131	.265	.404	.553	.718	.906	1.134	1.440	1.943	2.447	3.143	3.707
7	.130	.263	.402	.549	.711	.896	1.119	1.415	1.895	2.365	2.998	3.499
8	.130	.262	.399	.546	.706	.889	1.108	1.397	1.860	2.306	2.896	3.355
9	.129	.261	.398	.543	.703	.883	1.100	1.383	1.833	2.262	2.821	3.250
10	.129	.260	.397	.542	.700	.879	1.093	1.372	1.812	2.228	2.764	3.169
11	.129	.260	.396	.540	.697	.876	1.088	1.363	1.796	2.201	2.718	3.106
12	.128	.259	.395	.539	.695	.873	1.083	1.356	1.782	2.179	2.681	3.055
13	.128	.259	.394	.538	.694	.870	1.079	1.350	1.771	2.160	2.650	3.012
14	.128	.258	.393	.537	.692	.868	1.076	1.345	1.761	2.145	2.624	2.977
15	.128	.258	.393	.536	.691	.866	1.074	1.341	1.753	2.131	2.602	2.947
16	.128	.258	.392	.535	.690	.865	1.071	1.337	1.746	2.120	2.583	2.921
17	.128	.257	.392	.534	.689	.863	1.069	1.333	1.740	2.110	2.567	2.898
18	.127	.257	.392	.534	.688	.862	1.067	1.330	1.734	2.101	2.552	2.878
19	.127	.257	.391	.533	.688	.861	1.066	1.328	1.729	2.093	2.539	2.861
20	.127	.257	.391	.533	.687	.860	1.064	1.325	1.725	2.086	2.528	2.845
21	.127	.257	.391	.532	.686	.859	1.063	1.323	1.721	2.080	2.518	2.831
22	.127	.256	.390	.532	.686	.858	1.061	1.321	1.717	2.074	2.508	2.819
23	.127	.256	.390	.532	.685	.858	1.060	1.319	1.714	2.069	2.500	2.807
24	.127	.256	.390	.531	.685	.857	1.059	1.318	1.711	2.064	2.492	2.797
25	.127	.256	.390	.531	.684	.856	1.058	1.316	1.708	2.060	2.485	2.787
26	.127	.256	.390	.531	.684	.856	1.058	1.315	1.706	2.056	2.479	2.779
27	.127	.256	.389	.531	.684	.855	1.057	1.314	1.703	2.052	2.473	2.771
28	.127	.256	.389	.530	.683	.855	1.056	1.313	1.701	2.048	2.467	2.763
29	.127	.256	.389	.530	.683	.854	1.055	1.311	1.699	2.045	2.462	2.756
30	.127	.256	.389	.530	.683	.854	1.055	1.310	1.697	2.042	2.457	2.750
∞	.12566	.25335	.38532	.52440	.67449	.84162	1.03643	1.28155	1.64485	1.95996	2.32634	2.57582
d.f.	.45	.40	.35	.3	.25	.2	.15	.1	.05	.025	0.01	.005

Probability of a larger value of t, sign considered (one -tail test)

MAJI/NORAD TRAINING COURSE FOR HYDROLOGY TECHNICIANS

.. EXAMINATION IN HYDROLOGICAL ANALYSIS

29 NOV. 1989 , 0800 - 1300 HOURS

NAME: _____

Examinants are allowed to use: Instruction Manual

Hand calculator

MAJI/NORAD COURSE FOR HYDROLOGY TECHNICIANS
(1989) EXAMINATION IN HYDROLOGICAL ANALYSIS

QUESTION 1:

The precipitation falling on a catchment is sampled by six raingauges. From the measurements in Table 1 below calculate the areal rainfall for 1981.

TABLE 1.

Rain Gauge	1981 Rainfall mm	Thiessen Polygon Area km ²
1	2052	7.8
2	1915	8.3
3	1868	10.2
4	1723	11.5
5	1640	5.4
6	1510	6.8.

QUESTION II:

Tabulated below is a 30 years precipitation record for a single station and for the average of a group of 12 stations surrounding it. The figures are annual totals in centimeters.

- A: Calculate the cumulative rainfall for the single station and for the nearby stations.
- B: Plot the double mass curve on graph paper.
- C: Does the record show a break? If so when does it occur?
- D: Calculate the slope before the break and after the break.
- E: Describe briefly how the rainfall record for the single station could be adjusted.

TABLE 2:

YEAR	SINGLE STATION	12 STATION MEAN	YEAR	SINGLE STATION	12 STATION MEAN	YEAR	SINGLE STATION	12 STATION MEAN
1952	35	36	1962	36	38	1972	33	26
53	29	27	63	32	37	73	34	24
54	30	28	64	31	25	74	32	23
55	33	38	65	38	30	75	26	23
56	38	37	66	38	36	76	30	26
57	42	39	67	27	26	77	21	19
58	27	32	68	20	22	78	22	21
59	36	35	69	34	24	79	34	29
1960	30	31	1970	40	25	1980	20	17
61	45	41	71	56	38	81	39	24

QUESTION III:

The data in Table 3 are the annual maximum water levels (in centimeters) of a river as recorded in a period of 39 years.

- A: Group the data into six classes each 90 cm wide.
- B: Prepare a frequency table (Large class first) showing percentage cumulative frequencies.
- C: Draw a flow duration curve for the data.
- D: Compute the arithmetic mean and standard deviation.

TABLE 3:

YEAR	WATER LEVEL	YEAR	WATER LEVEL	YEAR	WATER LEVEL	YEAR	WATER LEVEL
1	504	11	735	21	930	31	452
2	473	12	604	22	614	32	556
3	525	13	653	23	563	33	448
4	707	14	641	24	470	34	582
5	622	15	491	25	429	35	642
6	516	16	683	26	504	36	570
7	670	17	764	27	461	37	595
8	721	18	578	28	533	38	543
9	668	19	782	29	625	39	506
10	816	20	870	30	403		

APPENDIX E: DIPLOMA, CERTIFICATE OF ATTENDANCE

**UNITED REPUBLIC OF TANZANIA
MINISTRY OF WATER, MAJI**

RWEGARULILA WATER RESOURCES INSTITUTE

**NORWEGIAN AGENCY FOR DEVELOPMENT CO-OPERATION,
NORAD**

DIPLOMA

This is to certify that

**has successfully completed the MAJI/NORAD Training Course for
Regional Hydrological Technicians in Tanzania**

**NORAD organized this course in collaboration with the
Hydrological Section of the Ministry of Water**

Venue: Dar es Salaam, Tanzania

Duration: 6 weeks

**W. Mutayoba
Principal,
Water Resources Institute**

**Bjarne Krokli
External Examiner
Norwegian Water Resources and Energy
Administration (NVE)**

Date

**UNITED REPUBLIC OF TANZANIA
MINISTRY OF WATER, MAJI**

RWEGARULILA WATER RESOURCES INSTITUTE

**NORWEGIAN AGENCY FOR DEVELOPMENT CO-OPERATION,
NORAD**

**The MAJI/NORAD Training Course for
Regional Hydrological Technicians in Tanzania**

This is to certify that

**who attended the above mentioned training course,
was awarded the following marks in the examinations
held in conjunction with the course:**

Subject:

Marks:

_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____

(All examinations were based on a possible 100 marks)

**Venue: Dar es Salaam, Tanzania
Duration: 6 weeks**

**W. Mutayoba
Principal,
Water Resources Institute**

**Bjarne Krokli
External Examiner
Norwegian Water Resources and Energy
Administration (NVE)**

Date

**UNITED REPUBLIC OF TANZANIA
MINISTRY OF WATER, MAJI**

RWEGARULILA WATER RESOURCES INSTITUTE

**NORWEGIAN AGENCY FOR DEVELOPMENT CO-OPERATION,
NORAD**

CERTIFICATE OF ATTENDANCE

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Date

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