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RESEARCH INSTITUTE FOR WATER RESOURCES
COMMISSION OF THE EUROPEAN COMMUNITIES
BUREAU DE RECHERCHES GEOLOGIQUES ET MINIERES**

**SINAI WATER RESOURCES STUDY (Phase II)
REPRESENTATIVE CATCHMENTS
EVALUATION MISSION REPORT**

SEPTEMBER 21st to NOVEMBER 2nd

by

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I. Introduction

M. THEBE's assignment, hydrologist consultant, took place from September 21st to November 2nd 1991. The reference terms of this mission were the following ones :

- state of the hydrological and meteorological data acquisition ;
- state of progress of the fieldwork ;
- basin data collect bilan ;
- hydrological program definition, within the framework of the project second stage extend.

II. General comments

We noticed, with satisfaction, an improvement in the follow-up of the meteorological stations. A certain number of defective equipments (in particular hygrographs) have been either fixed, or replaced. The station visit forms are now used nearly systematically by all the engineers and technicians. The tabulation of the recordings and the criticism of data have thus improved, even if some progress are still to be done.

A certain number of engineers are now in their trainings in foreign countries, others prepare their master in the Egyptian university environment ; this should assure some stability in the staff, and the efforts, in the local staff training, we make during each assignment should become more efficient.

During 1991, the first reliable data have been recorded, in matter of floods and simultaneously, the rainfalls that were at their origin.

The young engineers and technicians teams in charge of the follow-up of the basins begin now to have a more clear view of hydrology and of the field measurements in hydrology interest, basic for every serious study.

We must develop this knowledge and improve the quality in following-up the equipments and the data base process.

In this point of view, it is very important that the recording tabulation (rainfall, hydrometrical, meteorological records) could be done directly by the teams in charge, with a very serious criticism of each record : time shifting, height drift, mechanical defaults, aberrant values, etc. We recall that the periods during which an equipment has badly functioned and recorded wrong data must be, as far as it is possible, corrected in correlation with an adjoining station or deleted. This will be mentioned each time on the forms accompanying the follow-up of the equipments.

It is better no to have any data, than to have faulse ones, able to be used further in different models, giving thus false results.

Until now, in the absence of field data, the engineers of the institute have mainly done "estimative hydrology", searching in the literature general statistically established formulas, never verifying the adequation for the concerned area. It is more or less the case for the rainfall estimation, where the application of a general scheme about the circulation of the mass of air cannot, in any case, permit to define in a reliable and precise way the height of the rainfall that will generate a flood.

So, for instance, concerning the flood that happened from October 20th to 22nd 1990 in the Wadi WATIR, constituted by five successive waves, the estimation of the global volume that has been done (c. paragraph V.) seems us a little hazardous, as far as we have no record of the flood hydrograph, no velocity measurements have been done with enough series of floats and precise topographic plot.

All this shows that, if the statistical formulas and the models are a precious help in hydrology, we must, at a given moment, verify the adequation of their usage of the studied site. This is called "the field truth".

For that, there is only one method : intensify the observations and the measurements on the field, and take advantage, in the maximum of the available equipments.

III. Meteorological, climatological data bank

During the last consultant's assignment (January 1990) information on the criticism of the rainfall records had been dispensed. The results are now satisfying, but the recommended rules (concerning this type of equipment) must be enlarged to the other diagrams.

The entry of the climatological data is well advanced, but the delay previously got must be cleared up.

IV. Basins

4.1. GUDEIRAT basin

An important flood has been recorded on march 22nd and 23rd, 1991. Made up of three successive waves, the maximum has been reached on the 23rd during the second flood peak, with a water level at 185 cm.

Thanks to the rebuilding of the old weir, a good record of the flood has been got and, applying the "channel reach" formula (V.T. CHOW) [$Q = (1.49/n)AR^{2/3}S^{1/2}$] in which

n = MANNING coefficient (taken equal to 0.030)

A = wetted surface

R = hydraulic ray

S = slope

we obtain a maximum discharge of 121 m³/s

According to this formula, a calibration curve has been defined, permitting to draw the flood hydrograph, and to calculate its main characteristics.

Moreover we got good recordings for the rain on the whole part of the basin, and an interpretation of the rainfall-discharge relationship will be started.

The engineer SOMBOL is in charge of establishing a preliminary report on the hydrometrical and rainfall data on this basin and of beginning their interpretation. A general scheme for the writing of the preliminary reports have been done previously, and is joint to this report, in the annexes.

The flood on the 22nd and 23rd march has caused some damages to the weir (scour on the left bank and on the right bank upstream the weir, water level recording station slightly damaged). The works for repairing are estimated to 1 000 £E and must be done rapidly.

4.2. SUDR basin

An important flood happened also on march 22nd and 23rd, 1991 on this basin. We did not get any record at the water level recording station of the small basin, the rain on this sub-basin having not been very strong.

On the other hand, at the water level recording station of the old weir, a good recording of the flood has been done. Float measurements have been achieved by engineer ATHEM and his team.

The wall in right bank of the old weir has been totally destroyed, and the wall in left bank already damaged is in a worse state.

The moment, when those damages happened, appears clearly on the limnigraphs and their interpretation has been done in function of those disturbances.

Some works will be carried out on this outlet where the two embankments have been completely destroyed, and the wall of the weir must be prolonged from the left to the right bank, in order to stabilise the wadi bed.

Engineer ATHEM writes a report on that event. We took advantage of our two visits on this basin to give some advices and corrections for this work.

The outlet equipping of the upstream basin, with a rating flume (PARSHALL type), was already well advanced during our last visit. This should permit to control all the floods able to happen on this basin (see photo n°4).

4.3. SAINTE CATHERINE basin

No significant flood has been recorded on this basin. The equipping of the outlet must be quickly finished.

4.4. FEIRAN oasis

A very violent flood happened also in the FEIRAN Wadi on march 22nd, 1991. The water level recording station has been totally destroyed, it has been impossible,

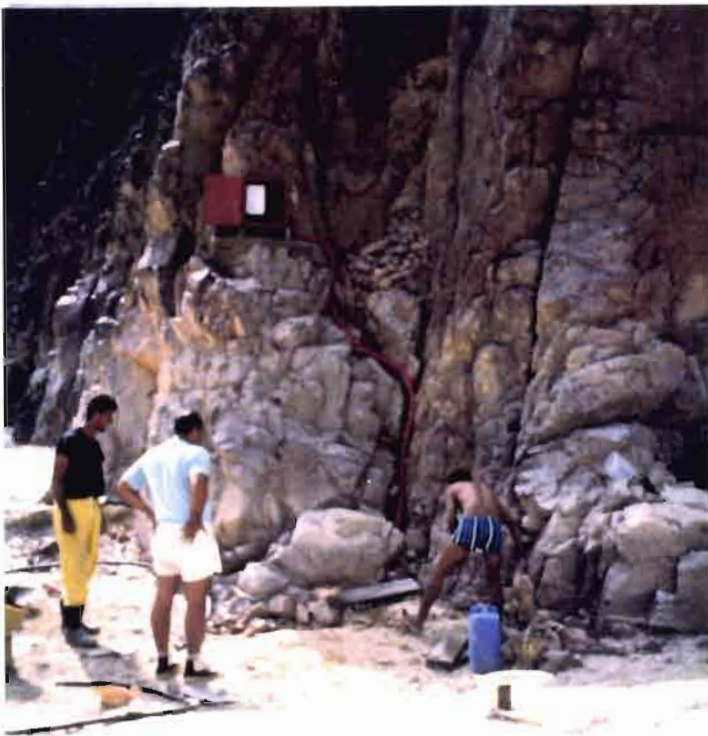


PHOTO 1

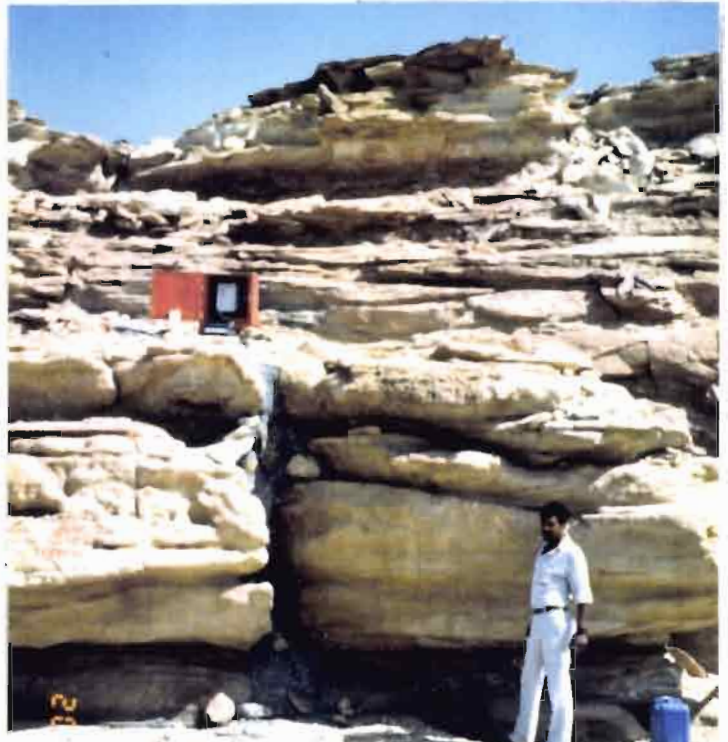


PHOTO 2

PH 1 WATER LEVEL RECORDER WADI WATIR S1

PH 2 WATER LEVEL RECORDER WADI WATIR S2

PH 3 THE ROAD IN FEIRAN OASIS AFTER A FLOOD

PH 4 WADI SUDR CATCHMENT FLUME BUILDING



PHOTO 3



PHOTO 4

though long research of the team in charge of this area, and ours during the assignment, to find any trace of the installations.

After an investigation near the fireman station, close to our measurement station site, we got the following informations :

1. the beginning of the flood happened on march 22nd at about 12 H00 ;
2. the maximum water level was recorded, on the lower part of the fireman station walls, one hour later, and the level kept stable during about 1 hour and 30 minutes ;
3. the end of the flood (flow in the wadi bed) is signaled at 16 H 30 mn.

Topographic plot (longitudinal section and cross section) have been done by the RIWR team after the flood.

From this information, we tried to draw a rough estimation of the flood volume, that could be of about 1,500,000 m³, for a maximal peak discharge estimated at 186 m³/s.

Topographic complements must be quickly done according to the indications given to Engineer DIAA. The water level recording station and the staff gauges will be reinstalled soon, as well as a water level recording station, downstream the oasis.

We must notice that this flood, particularly strong, has completely destroyed the road, on several tenth of kilometres upstream and downstream the measurement station.

V. Study of the WATIR Wadi

During the extension period of the phase II of the current project, it has been decided to begin the hydrological study of the WATIR Wadi, in which, almost every year, happens a violent flood, that provokes very serious damages to the road infrastructures. This correspond, in the scheme of the project, to the class of priorities number 2, but also, the Egyptian authorities wish to begin equipping this area.

In this aim, two electronic water level recorders, with storage of data on magnetic memory have been installed, one about 300 meters upstream the NUWEIBA-DAHAB road, close to the basin outlet, the other 41 kilometres upstream, at the limit of the sedimentary basin. These two sites had been reconnoitred during the preceding assignments, but had never been equipped (see photo).

To achieve this hydrological study, it has been decided to control the main sub-basin inflows, in particular of the AGULA-EL HEISI and QADIRA wadis, that will be equipped with electronic water level recorders, CHLOE-D type (from the ELSYDE company), as well as the two stations of the WATIR wadi, already installed.

Each one of these stations will be equipped with classical crest gauges, that will permit to know the level of the highest waters, in case the water level recorders will not work, but also in order to have a good estimation of the water surface slope.

A scheme of construction of those staff gauges (they will be manufactured in Cairo) has been established, as well as a type plan of installation, to correspond to the pre-said aims (Engineer SAFAA is in charge of this).

Four electronic rainfall recorders, with information storage on magnetic memory (OEDIPE V 4.0 type, from ELSYDE company), will be installed on the upstream part of the preceding sub-basins too, as well as in the SAWANA wadi.

This complete disposal will permit to have a precious information on the flood genesis in this wadi, flood propagation time of the wave and the available water volumes.

A location map of the proposed equipments is given in figure 1.

VI. Mission calendar

Saturday, September 21st :

Flight from Montpellier to Cairo via Paris.

Arrival in Cairo at 21 H.25, reception by Mr J.R. DAUM (B.R.G.M.)

Sunday, September 22nd.

Meeting to RIWR with Dr HASSAN IBRAHIM (Director of the Institute), engineer OUSSAMA NASSEF ; Mr J.R. DAUM (B.R.G.M.)

During this meeting, we take stock of the works achievement and the data collect since my last assignment in January 1991.

We then establish the program of the present assignment, in function of the defined priorities and of the human and material availabilities.

Sunday September 22nd to Saturday 28th.

Work with the RIWR engineers.

- interpretation, correction, entry of the climatological and rainfall data with the two engineers in charge with this sector ;
- preparation of the tour in the SINAI ;
- discussion with Mr ABDEL AZIZ, young engineer of the institute, for the definition of a study program on the SINAI.

Sunday September 29th.

- Departure for the SINAI with Mr DAUM ;
- arrival at SUDR in the end of the morning ;
- first discussion with Mr ATHEM, engineer in charge with the study of the SUDR basin ;
- visit of the basin, where a rating flume (PARSHALL type) is being built. This is an important realization, financed by the RIWR, that is supposed to permit a very good floods control on this basin. The end of the works is planned by the end of November.

Monday, September 30th.

- Pursuit of the discussion with the engineer ATHEM who is beginning a preliminary report on this basin, in particular on the study of floods for the last two years ;
- a general study scheme is defined and advices are given on the data interpretation ;
- departure in the afternoon for TABA.

Tuesday, October 1st.

- Departure from TABA in the morning, to NUWEIBA ;
- meeting with Mr ADHEL, RIWR technician, located in NUWEIBA ;

- visit of the two sites of the EEPROM memory water level recorders installation. Visit of the works site at Ain FURTAGA, where two wells are being built in purpose of the tapping of the springs (sources).

Wednesday, October 2nd.

- Manufacturing beginning of the cabin to install the Solid State Memory Water Level Recorder ;
- preparation of the equipment ;
- Solid State Memory Water Level Recorder test ;
- training of MM engineer SAFAA and ADHEL for the using of the water level recorder and of the HUSKY HUNTER computer ;
- redaction of a technical booklet for the usage of these equipments.

Thursday, October 3rd.

- visit of the SAINTE CATHERINE basin ;
- the team in charge with this basin is not there. The meteorological station does not work, and the rain-gauge recorders of the basin have been disassembled ;
- the basin outlet development is not finished yet, the wall in right bank is still to be prolonged on about 10 meters, the wall in left bank raised on about 20 centimetres, and the WRL on the right bank, inside the rating flume with an intake, the walls inside the flume will be pebble-dashed ;
- S2 station (WATIA Pass) does not work, the water level recorder is not provided with a diagram. The element 0-1 m is to be reinstalled on the Water Level Recorder pipe, as well as beacons on the float gauging section ;
- S3 station (FEIRAN Oasis) has been carried out by the flood of march 22nd, 1991 (cf. 4.4 paragraph). It will need to be reequipped, it would be better to install a SM Water Level Recorder SAB600 when this one will be removed from WATTR Wadi ;
- rainfall recording station of SAAL Wadi : the recorder is disassembled, the rain-gauge on the station "animals hospital" must be reinstalled in urgency, in correct conditions, this is not the case now.

Remark : the rings of the rain-gauge and of the Rainfall Recorder of the meteorological station of STE CATHERINE have different surface values : 200 cm² and 400 cm². This is a serious risk to commit mistakes in the readings. It would be better to install homogeneous equipments on a basin. This is a way to avoid problems in the further management of the data.

Saturday October 5th.

- Installation of the solid state memory water level recorder on WATIR Wadi, on the downstream station. Initialization of the electronic central, the functioning is correct ;
- departure in the afternoon for EL ARISH, arrival in the evening at about 18 H.00.

Sunday, October 6th.

Bank holiday in Egypt. Despite of this, we visit the GUDEIRAT basin with Mr SOHER, RIWR hydrologist technician.

The meteorological station works normally, we made the following releves :

Relative humidity :	48 %
Temperature :	28 °C
Anemometer :	wind N-NE

The evaporation pan is in a good state, a solarigraph has recently been installed and seems to work normally.

Some refection works are to be planned rapidly to the water level recording station (cf 4.2 paragraph).

Monday, October 7th, 1991.

- work in the RIWR offices at EL ARISH ;
- meeting and discussion with Engineer HASSAN, in charge of the EL ARISH office, on the organization of the hydrological team, and on the results obtained in 1991 ;
- discussion with Mr SOUNBOL, young engineer who is coming back from a training in Europe, and who is now in charge of the office in GUDEIRAT ;
- tabulation and interpretation of the data ;
- calibration of the gauging weir of the water level recording station ;
- redaction of a primarily report on that basin.

Remark : we strongly advice to install RT and RR that have the same ring surface to receive the rainfall : 200 cm² or 400 cm². Two posts having values often very different ; those that are equipped with a 400 cm² ring.

Tuesday, October 8th, 1991.

- trip EL ARISH - CAIRO ;
- Discussion with MM RASSAT (CEE) and DAUM (BRGM) in the afternoon.

Wednesday 9th to Thursday, October 17th.

- works in the RIWR offices in CAIRO ;
- 1) Work program on the rainfall regimes in the SINAI. This study will be lead by Mr ABD EL AZIZ, engineer who is preparing a master, will build a synthesis on the totality of the available rainfall information in the institute. From the results of this study, in which he will try to establish the relationships between :
 - rainfall/duration of the shower,
 - rainfall/basin surface area,
 - intensity - duration - frequency, etc.or the usage of the daily rainfall data of the GMA will be more efficient.
- 2) Work with Mr DIAA, RIWR engineer, on the data interpretation for the FEIRAN Wadi, and the writing of a primarily report.

3) Work with engineer SAFAA (in charge of the field teams) on the maintenance and the exploitation of the different type of the equipments used in the fields, in matter of hydrology. More than fifteen equipments, in particular clockwork movements, have been repaired.

Strict exploitation instructions have been defined.

Definition of a type of crest gauges that must next be manufactured in Cairo.

Instructions for installation and location of sites

Preparation of the next tour in the SINAI.

Saturday, October 19th to Friday, October 25th.

Tour in the SINAI

Saturday, October 19th.

Trip from CAIRO to NUWEIBA

Sunday, October 20th.

Visit of the two water level recording stations installed in the WATIR Wadi. Downstream central is reinstalled, after the passage of a team that is not trained for the usage of these equipments yet.

Reequipping of the pressure intake sensor.

Initialization of the upstream station.

Monday, October 21st.

Reconnaissance of the HARAMAT, HAGULA and EL AIN wadis. An excellent site for an hydrometrical station is found in that HAGULA wadi, in a rectilinear defile 5 km long, where will be easily done flood recordings and good discharge estimations. This site could be very interesting further for the construction of a dam.

Tuesday, October 22nd.

Reconnaissance of the SAWANA and ZELAGA wadies which make up the upstream part of the HAGULA wadi.

Wednesday, October 23rd.

Trip from NUWEIBA to EL TOR.

We go through SAINTE CATHERINE where no equipment has been reinstalled since our previous visit on October 3rd. The tared road running along the FEIRAN wadi has been completely destroyed on about 70 km.

This proves once more the urgency to make installations, and even before serious hydrologic studies, on the data collection and maximal exploitations of the material means available.

Thursday, October 24th.

Visit of the RIWR offices in EL TOR (South SINAI).

Training of MM Ali SHENAOUI (engineer) and ASHRAF (technician) to the usage of the electronic acquisition devices CR2M SAB600 and of the HUSKY HUNTER personal computer :

- usage of the stations ;
- data transfer ;
- advices for tabulation and criticism of the diagrams, in particular time and height drifts.

Friday, October 25th.

Departure from ELTOR, stop at SUDR, visit of the basin where the construction of the PARSHALL rating flume is continuing in good conditions.

Arrival in CAIRO in the evening.

Saturday, October 25th to Saturday, November 2nd.

RIWR offices in CAIRO.

Discussions on the pursuit of the setting up of a study program on the WATIR wadi :

- definition of the equipments to be installed (water level recorders, rain-gauge recorders, rain-gauges, crest gauges, etc.) and of the sites to be equipped ;
- definition of a first work program for Mr Ahmed HASSAN, RIWR engineer, whose Ph.D subject could be on the hydrological study of the WATIR wadi.

These discussions have been lead, mainly with Dr Hassan IBRAHIM, Engineer AWAD and Mr DAUM (BRGM).

- pursuit of the meetings with the engineers DIAA and ABD EL AZIZ on their programs, as well as with the two engineers in charge of the data acquisition ;
- settlement of a type plan for the writing of preliminary reports of the basins and the data analysis.

Saturday, November 2nd.

Synthesis meeting on the consultant assignment and on the continuation of the works for the surface hydrology.

Conclusion.

The equipments on the basins are now almost complete, some equipping are still to be finished to the outlet of the GUDEIRAT and SAINTE CATHERINE basins. The construction of the PARSHALL rating flume at SUDR is a good realization that will permit to study on a long period the floods on this basin.

The desert hydrology is a very new science in Egypt, difficult to catch and the engineers and technicians, in charge of studying the field, are not in the best conditions to be initiated to this discipline.

In spite of all, in particular in reason of the rainfalls, abundant for the region, that happened during the winter 1990-91, and of the floods they caused, we have got good quality recordings, but above all, we got a more concrete view of operational hydrology, and of the interest of the field measurements and of the more serious follow-up of the equipments used for the data collection. The motivation of the RIWR young engineers seemed me more important, and this way must be continued. This is already a very important plus of this project.

The damages caused to the roads when the floods occurred in march, prove, if it was necessary, the urgency and the interest of the hydrological studies, absolutely necessary for every equipping project.

In this view, the follow-up of the studies on small basins are of great interest and should be continued on a long term, the most longer that the floods are rare to understand the rainfall-discharge relationship in the region. Concurrently, the development of such studies to a wider scale than the one made in the WATIR wadi will constitute an indispensable complement for the results extrapolation, that have been got on small scales, and to provide pertinent data to the developers.

GENERAL SCHEME FOR THE HYDROLOGICAL PRELIMINARY REPORTS

In the purpose of the Sinai Water Resources Study project phase II final report , we suggest a general scheme for the writing of the preliminaries reports about each catchment.

I- General introduction

II- Physical surrounding

2.1- Location and physical characteristics

- location map and description
- area of the catchment
- perimeter
- compacity index
- highest point
- maximum altitude
- outlet altitude
- slope index

2.2- Geomorphology and Geology

2.3- Catchment equipments

- installation dates for the different equipments
- type of equipments
- modifications in location or type of equipments
- equipment location maps

2.4- Discharge measuring stations

- design and topographic characteristics : cross sections and longitudinal sections.

III- CLIMATOLOGICAL DATA

3.1- Generalities

3.2- Rainfall regime

3.2.1- Mean rainfall calculation on the catchment

- THIESSEN index method (in accordance with the different installation dates and the out of running periods).

- Isohyetal map

3.2.2- Daily and monthly rainfall tabulation

3.2.3- Storms characteristics

- Intensity, duration etc...

IV- FLOODS STUDY

4.1- Critical and tabulation charts

4.2- Field investigation results presentation in case of no floods records.

4.3- Detailed topographics measurements presentation after a flood and velocity measurements by floats or other way.

4.4- Proposal drawing of flood hydrograph and essential floods characteristics :

- Time to peak (T_p)
- Base time (T_b)
- Lag time (T_l)
- Maximum discharge (Q_{max})
- Base flow (Q_b)
- Total volume of the flood (V)
- Mean runoff discharge (Q_m)
- Depth of surface runoff (R_s)
- Runoff index (K_r)
- Shape index (Q_{max}/Q_m)

V- CONCLUSION

Bibliography research about results on similar areas (Israel ; Arizona...) and comparison with results in SINAI.

Thébé Bernard

Sinai water resources study (phase 2) : representative catchments evaluation mission report (september 21st to november 2nd).

Montpellier : ORSTOM, 1991, 16 p. multigr.