51753

UNITED NATIONS
ECONOMIC AND SOCIAL COUNCIL

Distr.
LIMITED
E/CN.14/CART/286
14 September 1972
Original: ENGLISH

ECONOMIC COMMISSION FOR AFRICA

Third Regional Cartographic Conference
for Africa

Addis Ababa (Ethiopia), 30 October - 10 November 1972
Provisional agenda item. 7(a)

KIGONGO-BUSISI WATER CROSSING*

Submitted by the Government of the United Republic of Tanzania

* By the Surveys and Mapping of Tanzania.

72-1479

KIGONGO-BUSISI WATER CROSSING

by the Surveys and Mapping of Tanzania

Abstract: The work involved a connection of two Intermediate Bench Marks (IBM) H/17/22 and H/17/21 which are separated by a water gap of approximately 6 kilometres across the Speke Gulf in Lake Victoria.

Instruments:
- 2 - 21" Watts Automatic Levels
- 2 - Barometers
- 2 - Thermometers
- 2 - Radio Transmitters
- 2 - Measuring Bands
- 4 - Pieces of 15 cm x 45 cm of cardboards

Method:

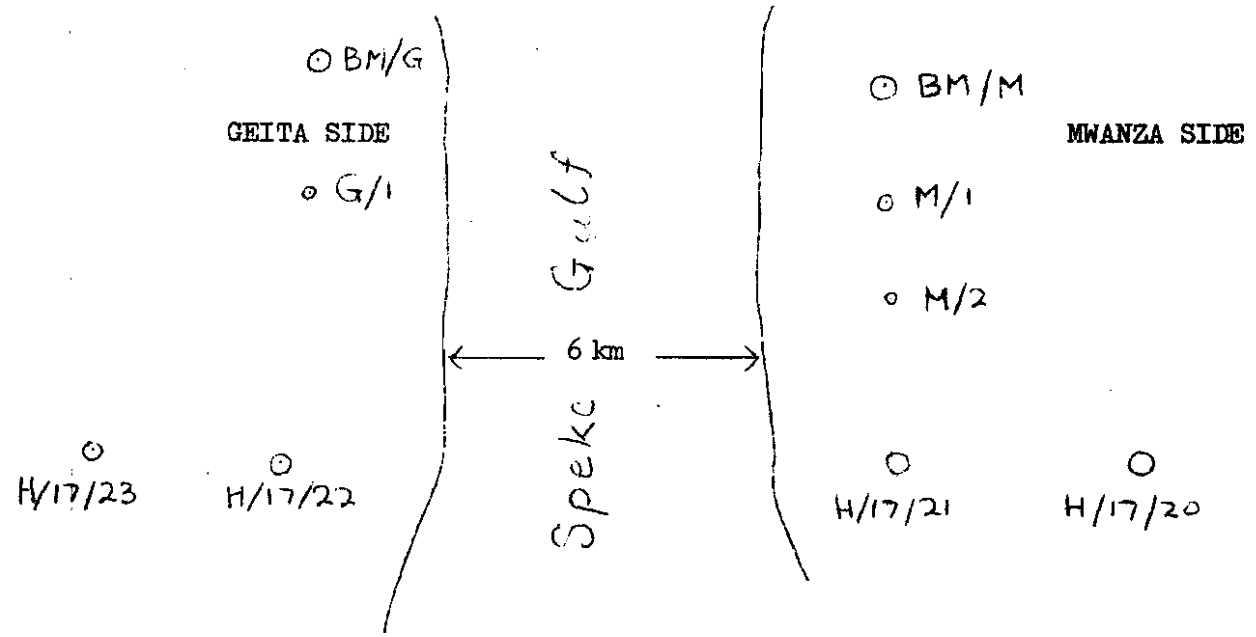

FIGURE I

Direct observation between Bench Marks H/17/22 and H/17/21 is not possible. Two hills were therefore chosen one on Mwanza side (Kigongo Hill) and the other on the Geita side (Busisi Hill) such that on them could be placed bench marks of approximately the same height above the lake level. These points were named BM/M and BM/G on Mwanza and Geita side respectively.

Several simultaneous observations were made on BM/G and BM/M from which the height difference between these points was determined. Precise levelling was then carried out to connect these bench marks with H/17/22 and H/17/21. This was done by placing extra Intermediate Bench Marks M/1 and M/2 on Mwanza side and G/1 on the Geita side between BM/M and H/17/21 and BM/G and H/17/22 respectively. It was therefore possible to obtain the height difference between points BM/G and H/17/22; BM/M and BM/G; H/17/21 and MB/M and H/17/21 and H/17/22.

Observation Procedure:

Observations were made on a target constructed from two card-boards which were carried on a pole. The construction of such a target is illustrated in Figure II. Great care was taken in plumbing these targets.

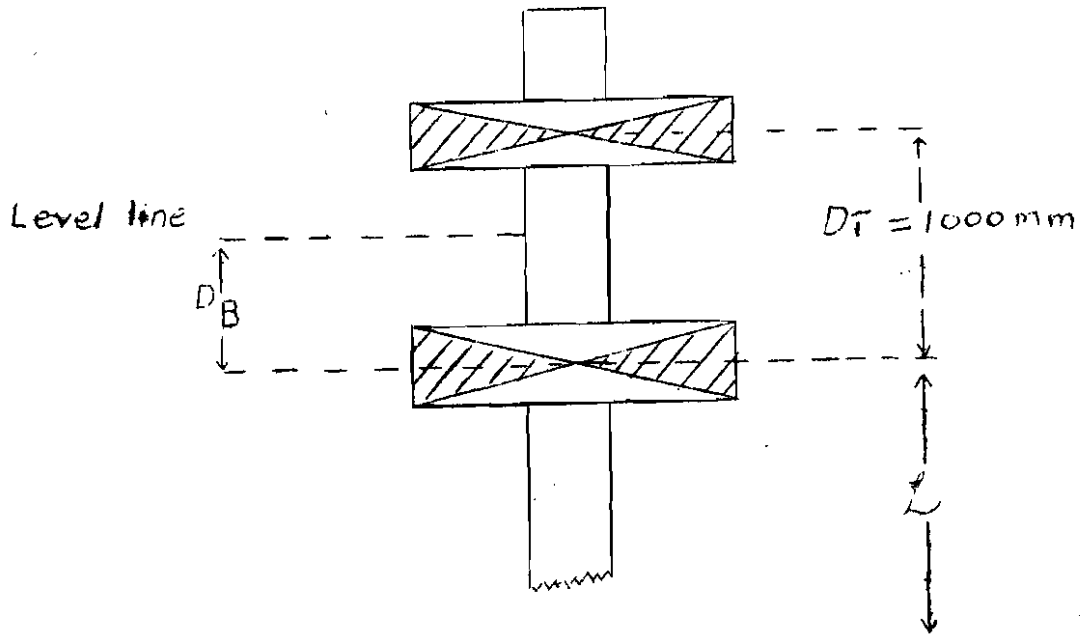

FIGURE II

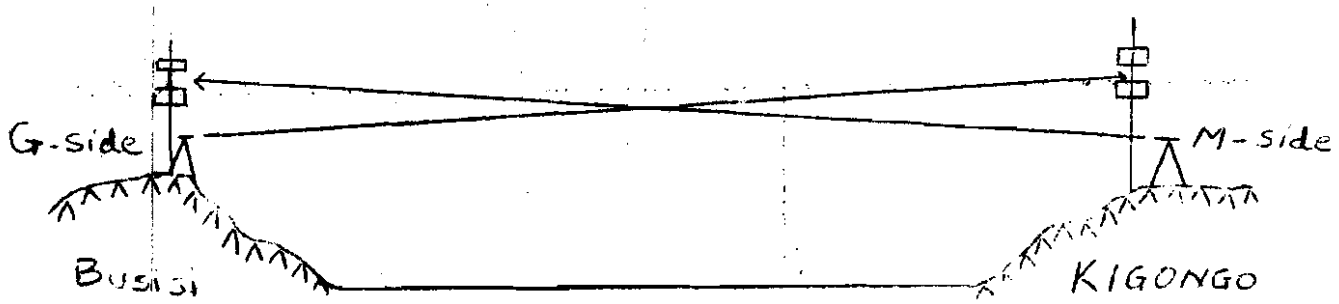

FIGURE III

The pole carrying the targets was erected vertically over each Bench Mark as illustrated in Figure III. Provisory Bench Marks were placed close to BM/G and B./M and it was from these marks that the observations were made. The target Bench Marks were placed not more than 5 metres from these instrument stations and were at right - angles to the line of sight. This ensured equal lenths of lines of sight and unvaried weather conditions during observations.

Two readings were obtained for each of the lower target, level position and the upper target for both faces of the instrument. Temperatures and pressures were also recorded as well as the time of the commencement of observations. Contact was achieved by radio transmitters.

FORM N°: ...3...

Station ...G..... Instrument N°: 65671.....
Date ...15/7/67..(EV).... Instr. Point to BM .....
Distance between targets 1000mm
Height of Instrument 4.995 = 1522.5 mm (I)
B M ...G..... to lower target 2460.3mm.
B M ...M..... to lower target 1655.7mm.

	FACE LEFT D_T = U − L D_{B_d} = B-L		FACE RIGHT D_T = U-L D_{B_d} = B-L		TIME TEMP. PRESS.
Upper	313·2	35·3	305·8	37·3	
Bubble	284·2	6·3	282·3	13·8	
Lower	277·9	178·5	268·5	370·0	883·65

FIGURE IV (Field Sheet extract)

Observations were made under four different conditions:

(a) Morning with one instrument at M and the other at G

(b) Evening with one instrument at M and the other at G

(c) Morning with both instruments and observers interchanged

(d) Evening with both instruments and observers interchanged

COMPUTATIONS:

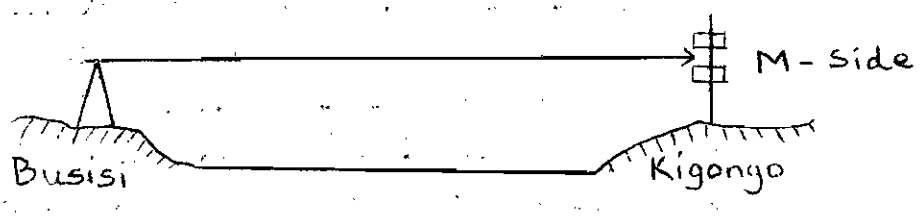

FIGURE V

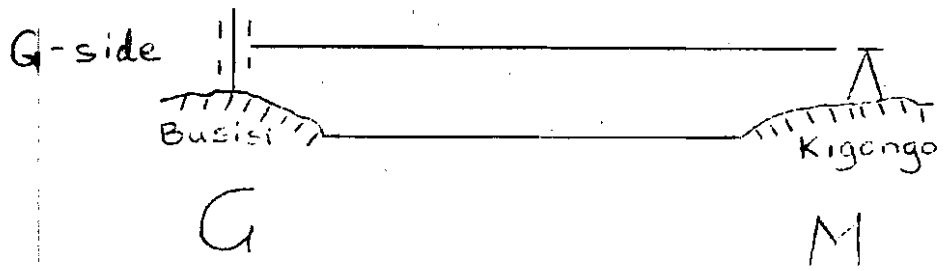

FIGURE V (cont'd)

The following notation was adopted:

D_B , D_T – Distance graduations on the level micrometer

I – Instrument

L – Lower target height from the IHM

Considering observations on Mwanza side taken on the target on Geita side:

$$S_G = \frac{\left[\left(\frac{D_B}{D_T} \times 1000\right)_M + L_G\right]_{\text{Face left}} + \left[\left(\frac{D_B}{D_T} \times 1000\right)_M + L_G\right]_{\text{Face right}}}{2}$$

Where S_G is the vertical distance from where the observed level line hits the "staff" at G to the Bench Mark at G.

Thus $H_M - H_G = S_G - I_M + R$

Where R denotes refraction

The observations at G correspondingly give:

$H_G - H_M = S_M - I_G + R$

Subtracting we get:- $H_M - H_G = \frac{\left(S_G - I_M\right) - \left(S_M - I_G\right)}{2}$

Regarding two simultaneous readings as one observation the results were grouped as follows:

(a) Instrument 71 at G morning observations
(b) Instrument " " G evening observations
(c) Instrument " " M morning observations
(d) Instrument " " M evening observations

The standard error of each group was computed from:

$$M_x = \sqrt{\frac{\sum (x - x_i)^2}{n(n-1)}}$$

The overall standard error for the case of 4 groups was obtained from:

$$m = \left[\frac{1}{16}\left(m_{x_1}^2 + m_{x_2}^2 + m_{x_3}^2 + m_{x_4}^2\right)\right]^{\frac{1}{2}}$$

Abstract of results:

Group	1	determination	790.0	±	1.6 mm
Group	2	determination	774.4	±	1.3 mm
Group	3	determination	797.6	±	1.1 mm
Group	4	determination	790.3	±	1.3 mm

Overall mean = 788.1 mm

and $M_{final} = \left[\frac{1}{16}\left(1.6^2\right) + \left(1.3^2\right) + \left(1.1^2\right) + \left(1.3^2\right)\right]^{\frac{1}{2}}$

= 0.64 mm.

+

. . Height difference between BM/M and BM/G

= 788.1 mm + 0.6 mm

Also:

Station	Mean $\triangle$ H (mm)
G	23992.1
G/I	7998.6
H/17/22	

B M/G $\longleftrightarrow$ H/17/22 = 31 990.7 mm with BM/G higher

Station	Mean $\triangle$ H (mm)
BM/M	22 709.9
M/1	5 715.7
M/2	2 806.2
H/17/21	

B M/M $\longleftrightarrow$ H/17/21 = 31 231.8 mm with BM/M higher

$\therefore$ Height of BM/M above H/17/22 = Height of G above H/17/22 + Height of BM/M above BM/G

= 31 990.7 + 788.1 mm

= 32 778.8 mm

$\therefore$ Height of H/17/21 above H/17/22 = (32 778.8 - 31 231.8)mm

= 1 547.0 mm