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IMPERIAL ETHIOPIAN GOVERNMENT

NATIONAL WATER RESOURCES COMMISSION

ETHIOPIA - FRANCE COOPERATIVE PROGRAM

WABI SHEBELLE SURVEY

IN COLLABORATION WITH

FRENCH MINISTRY OF FOREIGN AFFAIRS

NATIONAL WATER RESOURCES COMMISSION

BCEOM-ORSTOM-EDF
IGN-BDPA

III

HYDROLOGICAL SURVEY OF THE WABI SHEBELLE BASIN

1973

ORSTOM

The present report is a summary of the studies carried out from 1967 to 1971 by the Hydrological Division of the Wabi Shebelle Project.

The following scientists, engineers and head technicians from ORSTOM participated in the hydrological studies undertaken in Ethiopia :

- Daniel Bauduin, "maître de Recherches", ORSTOM, chief of the Hydrological Division of the French Mission since 1968.
- Frederic Moniod, "maître de Recherches", ORSTOM, chief of the Hydrological Division of the French Mission, from 1967 to 1968.
- Georges Bermond, hydrologist, in 1967.
- Pierre Jarre, hydrologist, from 1968 to 1969.
- Pierre Le Duc, hydrologist, since 1968.
- Joseph Robin, hydrologist, in 1970.
- Jean Sabatier, hydrologist, in 1967 and 1968. (accidental death).

The following Ethiopian head technicians also participated in the local studies :

- Haïlu Hapte, engineer, in 1967 - 1969.
- Guerma Bekcle, engineer, since 1971.
- Tesfaye Gemetchu, engineer, since 1967 ;
- Bellow Wolde Semaiate, chief of the hydrometric squad, since 1967.
- Tamire Mariam, chief of the hydrometric squad, since 1969 ;
- Kelemo Worke, in charge of the computation office, since 1967.

All the data collected during the five years of local activities were arranged in order to be compatible with systematical computer-processing facilitating statistical analysis and correlation studies which are absolutely necessary to give these data the utmost value.

All these studies were achieved, with the assistance of the Central Hydrological Office (O.R.S.T.O.M.), by Daniel Bauduin who drafted the present report. The Ethiopian engineer, Kebedde Woldeyes collaborated from November 1971 to May 1972 in this office work.

During the preliminary mission in 1965 and until the final report was drafted, the hydrological studies were conducted by Pierre Dubreuil, "directeur des Recherches" at O.R.S.T.O.M.

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CONDITIONING FACTORS OF THE HYDROLOGICAL REGIME

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CHAPTER I

GEOGRAPHICAL FACTORS

1.1 LOCATION and MAPPING (Graph. I.1)

The Basin of the Wabi Shebelle stretches from the Ethiopian High Plateaus to the Indian Ocean in Somalia and covers a total area of 280.000 km2. This crescent-shaped basin presents a main N N W - S S E direction and is located between the 9°30' N and 0°N parallels and the 38°30' E and 46° E meridians.

The present survey concerns the upstream part of the Basin which is entirely included in Ethiopia. The Basin of the Wabi Shebelle occupies 190.000 km2 in Ethiopia, i.e. : the two thirds of the total basin area. It is located in the South Eastern part of Ethiopia and covers part of the Arussi, Bale and Harar provinces between 9°30' N and 5°N parallels and 38°30' E and 45°E meridians.

The Basin is limited to the West by the Ganale Basin, to the North-West by the Rift Valley depression, to the North by the Awash basin and to the East by a desert region stretching down to Aden bay.

The main basic documents available when the Project studies began were limited to the following maps :

a) the world aeronautical map at a scale of 1/1.000.000 with contour intervals of 500 m ;

b) the map at 1/500.000 of East Africa, by the War Office, with variable contour intervals depending on the sheet ;

c) the geological map at 1/2.000.000 of the Africa Horn by Mohr 1963.

The quality of these documents at inadequate scales is poor as regards planimetry as well as altimetry.

In order to meet the needs of the various studies of the Project, the photo-interpretation Division drafted several maps at different scales using the aerial map at 1/50.000 by the U.S. Mapping Mission. The main documents are, i.e. :

- The three planimetric maps of the entire Bassin at a scale of 1/100 000, 1/250 000 and 1/1000 000,

- a planimetric map at a scale of 1/50 000 for the Lower Valley of the Wabi Shebelle.

The specialized divisions of the Project drafted several general maps using these planimetric base-maps, among which the most important are :

- a geological map at 1/1 000 000

- soil maps at 1/250 000 and at 1/1 000 000

- a map at 1/1 000 000 of the vegetation

All these old or recent maps were used to determine the characteristics of the physical factors of the Basin affecting water flow conditions.

1.2 MORPHOLOGY and RELIEF (Maps I and II)

The Basin of the Wabi Shebelle culminates at an altitude of 4 200 m but only attains 150 m at the Somalian border. The morphology of the Basin which is closely linked to the nature of the geological substratum presents very different facies.

The main morphological regions are distributed as follows :

a) Basalt mountains and plateaus

These high plateaus have a mean altitude of 2 500 m and constitute the framework of the North-Eastern end of the Basin. To the East, they form a very narrow strip along the Northern border from Minne to Hirna but Southwards this strip widens between Hirna and Girawa.

These plateaus present the aspect of large tabular areas or of gently rolling hills consisting of ash layers (at the Western end of the Basin). They are commanded by usually eroded volcanic mountains with steep slopes and forming the crest line. The highest mountains gird the Eastern end of the Basin which is occupied in its central part by the Gedeb plain. To the North of the Wabi Shebelle, they form a mountain range from Sire to Ticho, the highest peaks being : Mount Kakka (4 190 m), Ghillalo (4 036 m) and Badda (4 139 m). South of the Wabi Shebelle, these plateaus constitute the Arena mountains culminating at 4 000 m.

The basalt plateaus of the Northern border of the Basin are commanded by a relatively discontinued range of ancient volcanos which are less elevated than in the Western zone. The highest relief consists of the Gugu mountains (3 532 m), the Tita mountains (3 122 m) and the Muleta mountains (3 381 m).

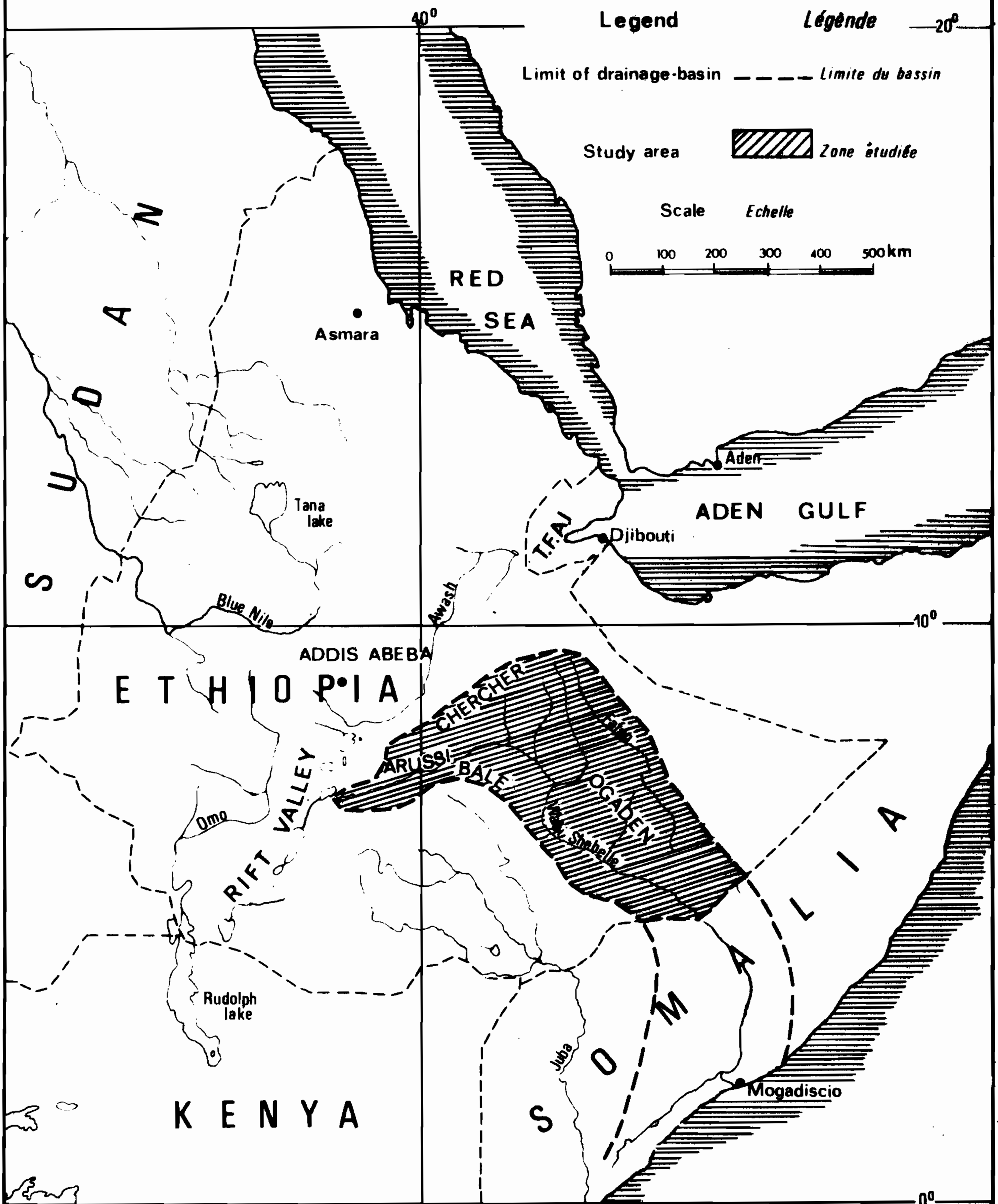
All the large perennial tributaries of the Wabi Shebelle, except the Errer, Maribo, Ulul, Siyanan, Ungwata and Ramis, originate from these old volcanos.

The slopes of the volcanos are generally steep whereas those of basalt plateaus are much smaller. Gully erosion is relatively developed.

Gr-I-1

WABI SHEBELLE BASIN / BASSIN DU WABI SHEBELLE

SITUATION MAP / CARTE DE SITUATION



b) <u>The granite mountains of the Harar region</u>

Their mean altitude is 2 000 m and they culminate at 3 000 m. They continue the volcanic plateaus of Chercher to the East, spread from Girawa to Jijiga, and reach down to Megadalola in the South. This group is deeply eroded and dismantled and presents a relatively varied morphology such as large gently rolling brow-shaped plateaus corresponding to granitic alluvial deposits (erosion glacis) between Harar and Alemaya, and bare steep hills approximately 30 to 40 m high, with a chaotic aspect and a facies of boulders typical of cristalline erosion, between Babile and Jijiga

Some residual limestone hillocks exist on this granite.

The steep slopes with a very sparse vegetation and a comparatively important rainfall are favourable to a particularly intense headward erosion.

The Errer, Daketa and Fafen originate from these granite mountains.

c) <u>Limestone plateaus in the central part of the Basin</u>

The limestone plateaus cover a very large area (45 per cent of the Basin) stretching from the North-East of the Basin (Jijiga region) to a line roughly passing through Hamero-Hedad, Danan and Kebri Dahar. These tabular plateaus regularly sloping down to the South East with a very small dip of 5° are deeply cut by the drainage pattern. The rivers flow in canyons which may attain 900 m depth in the Lege-Hida and Sheik Hussien region.

In these canyons, the alluvial zones are very weakly extended and are practically never more than a hundred meters wide.

The comparatively flat plateaus present very small slopes.

Steeply sloping areas may only be observed on the edge of these plateaus abruptly ending in valleys. These zones with their steep slopes and abundant runoff consist of limestone debris and their extension varies according to the lithological nature of limestone.

In the East of the Basin, between Jijiga and Shekosh, the more broken up limestone formation no longer forms plateaus but more or less rounded hills with slopes thickly covered with weathered material. The total runoff in these regions is greater than on plateaus. Thalwegs are not so deep (Fafen and Jerer) and the alluvial plains are larger.

On the whole, no pronounced karstic features resulting into circulation of water in the depth may be observed. The only visible signs consist of some caves isolated in the sides of thalwegs or of several depressions or "dolines" unrelated to an underground flow system.

d) <u>Gypseous zones in South Ogaden</u>

The gypsum series occupy practically all the Southern and South-Western part of the Basin and usually form not very high but very broken-up rounded hills with a "cockade" aspect. On these soft series intense erosion resulted into the formation of many closed drainage areas the most important being the Danan basin collecting the rainwater. The drainage pattern is often of endhoreic type and very well-developed. All the temporary rivers reaching the valley of the Wabi Shebelle end in large alluvial fans which confirms the fact that erosion is considerable. The alluvial deposits of the Wabi Shebelle and of the Fafen are very largely developed in these areas.

e) The Mustahil limestone bluff

To the South, the Ogaden gypsum is protected against weathering by a hard limestone bed forming a bluff.

This bluff constitutes a more or less divided plateau commanding the valleys of the Wabi Shebelle and of the Fafen from a 80 m height. The gentlè slopes of this plateau do not allow a considerable runoff.

f) The Jesoma sandstone plateaus

Sandstone formations are mainly located at the Eastern limit of the Basin between Kebri-Beyah and Degahbour and between Kebri-Dàhar and the border. They may also be observed with a lesser extension in the regions of El Kere, Duhun and in the North-West of the Basin, South of Micheta. They form previous tabular plateaus enclosing perched ground water tables.

Owing to their great permeability and gentle slopes, the drainage pattern of these sandstone plateaus is practically inexistent.

A full-page map at 1/1 000 000 in this report approximately represents the relief of the Basin (map I). This map was drafted using the only existent altimetric document : a map at 1 500 000 from the war office presenting little accuracy. Nevertheless, this map shows land forms corresponding to the great morphological entities previously described. The contour of 2 000 m corresponds, within 200 m, to the limit of the Southern extension of the volcanic zone. Above this contour, the slopes of volcanic mountains are very steep but below 2 000 m and down to approximately 700 m slopes are gentler : this zone corresponds to the limestone plateau which gradually falls to the South East. Below contour 700 m, in the gypseous zone commanded by the Mustahil limestone bluff, slopes are smaller still.

Tables 1.1 and 1.2 summarize the various morphological features of part of the 14 drainage areas of the Fafen and of the Jerer controlled at the different stream-gauging stations.

On table 1.1 are represented the areas, compacity indexes, maximum, medium and minimum elevations and the global slope indexes*

Table 1.2 gives, when possible, the hypsometric distribution for each basin. The most typical hypsometric curves are shown on graphs I.2, I.3, I.4.

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*The global slope index is the ratio between the available gradient of the drainage area between the points from 5 to 95 per cent of the surface of the hypsometric curve - and the length of a rectangle equivalent to the basin (in relation to the compacity index).

TABLE 1.1

Morphological features of the basins

Basin	Station	Surface (km2)	Compacity index	Altitude			Global slope index m/km
				max	med	min	
WABI SHEBELLE	DODOLA Road	1 260	1,48	3 000		2 500	6,4
MARIBO	DODOLA Road	260	1,37	3 800		2 500	42,0
MARIBO	Confluence	1 220	1,20	3 800		2 400	27,7
WABI SHEBELLE	MALKA WAKANA	5 290	1,31	4 100	2 950	2 300	14,0
WABI SHEBELLE	LEGE-HIDA	21 500	1,64	4 100	2 360	750	9,0
ERRER	HAMERO-HEDAD	14 200	1,21	3 400	1 220	720	15,2
WABI SHEBELLE	HAMERO-HEDAD	64 450	1,39	4 100	1 560	550	6,0
DAKETA	HAMERO-HEDAD	14 200	1,48	3 000	900	550	9,5
WABI SHEBELLE	IMI	91 600	1,49	4 100	1 380	390	5,6
WABI SHEBELLE	GODE	127 300	1,50	4 100	1 150	270	4,8
WABI SHEBELLE	KELAFO	139 100	1,51	4 100	1 050	220	4,6
WABI SHEBELLE	BURKUR	144 000	1,57	4 100	1 010	190	4,4
JERER	DEGAHBOUR	6 470	1,42	2 700	1 400	1 100	8,4
FAFEN	KEBRI-DAHAR	25 600	1,52	2 700	1 150	400	6,3

TABLE 1.2

Hypsometric distribution for each basin in percentage of the surface

Basin	Station	>4000m	4000-3500m	3500-3000m	3000-2500m	2500-2000m	2000-1500m	1500-1000m	1000-500m	< 500m
WABI SHEBELLE	MALKA-WAKANA	1	21,3	23,5	50	4	-	-	-	-
WABI SHEBELLE	LEGE-HIDA	1	3,5	13,5	27	18	22	9,5	5,5	
ERRER	HAMERO-HEDAD			0,5	1	9	20	46	23,5	
WABI SHEBELLE	HAMERO-HEDAD	0,5	1,0	4,5	9	15	24	35	11	
DAKETA	HAMERO-HEDAD				0,3	0,2	3,8	34,7	61	
WABI SHEBELLE	IMI	0,25	0,75	3	7	10	20	33,5	24	1,5
WABI SHEBELLE	GODE	0,25	0,75	2,5	5	7	15	29	32	8,5
WABI SHEBELLE	KELAFO	0,17	1	2	5	6	13	26	36	11
WABI SHEBELLE	BURKUR	0,25	0,25	2	4	7	10	26,5	35	15
JERER	DEGAHBOUR					2	34	64		
FAFEN	KEBRI-DAHAR					1,5	12	55,5	31	

From these tables and graphs the following observations may be drawn :

- The drainage areas have relatively poor compacity-indexes which, for most of them, is approximately 1,50 and reveals relatively elongated shapes.

For the Basin of the Wabi Shebelle this is due to the dissymmetry of the drainage system, the tributaries being far more developed on the left bank than on the right bank.

- The slope indexes are very high on the upper Basin of the Wabi Shebelle down to Hamero Hedad as well as on the basins of permanent tributaries. This is a favourable factor as regards the high specific discharge of floods. In the downstream part of the Basin, slopes are still steep, though at a lesser degree.

The Jerer Basin also presents very high slope indexes, greater than 6 m/km.

- At the Burkur station which controls practically all the Basin of the Wabi Shebelle, approximately 75 per cent of the basin area correspond to an altitude below 1 500 meters, the high volcanic land located above 2 500 meters only representing 6,5 per cent of the entire Basin.

1.3 DRAINAGE PATTERN (Map II)

1.3.1 General description

a) The Wabi Shebelle

The Wabi Shebelle springs from the Western end of the Basin in the ash-covered mountains of the Adaba region at approximately 2 800 m. It flows down from these mountains to a drainage area with a gentler slope : the Guedeb plain across which the Wabi Shebelle meanders. It is joined on the right and left banks by small tributaries with high gradients of slope and originating from the high volcanic mountains. The main tributary is the Maribo on the right bank.

At the exit from the Guedeb plain, the Wabi Shebelle is suddenly deeply embanked in the subjacent limestone plateaus after forming two falls each approximately 40 m high. It then flows in a very deep gorge steeply sloping down the first five kilometers (25 m/km) after which the gradient gradually decreases. This deep embanking stretches from Malka-Wacana down to 30 km to the North of Imi along 600 kilometers.

In these gorges the Wabi Shebelle first flows approximately South South-West - North North-East between Malka-Wacana and its junction with the Ramis. The Wabi Shebelle is most deeply embanked in this section and at Lege Hida it flows at a 900 m depth. It is joined on the left bank by the main perennialtributaries originating in the high volcanic mountains, the largest of these tributaries being the Ulul, Hadida, Siyanan, Ungwata and Ramis.

These tributaries present practically the same features as the upstream part of the Wabi Shebelle. Flowing from volcanic mountains, first on steep slopes, then slowly on the basalt plateaus, they finally deeply cut the limestone plateaus where they present very steep banks.

After meeting the Ramis, the Wabi Shebelle suddenly turns Southwards and the river is gradually less deeply embanked as it flows down to 30 km to the North of Imi.

In this reach, the Wabi Shebelle is joined on the left bank by two large tributaries originating from the granite mountains of the Harar-Babile region : the Errer and the Daketa. Only the Errer has a permanent flow. Two intermittent tributaries originating in the Ginir region.join the Wabi Shebelle on the right bank between Hamero-Hedad and Imi : these are the Ledae and the Darole. All these tributaries are characterized all along by steep slopes especially in the upper basin.

30 km to the North of Imi, the Wabi Shebelle, at the exit from the gorges, flows in a NNW-SSE direction in a practically straight line down to the frontier. This direction seems to be due to the presence of a fracture zone which caused the formation of a large tectonic basin.

From Imi to the frontier, the Wabi Shebelle flows in a vast alluvial plain : the Lower Valley, and its very gentle slope is only 0,25 to 0,35 m/km. The intermittent tributaries of desert type seldom directly meet the river but end in the alluvial plain. Among the tributaries joining the Wabi Shebelle, the most important is the Madiso the drainage area of which is located between Imi and Gode.

In this part of the basin covered with gypsum sediments, a distinct degradation of the drainage pattern must also be noted as well as the presence of a very pronounced endhoreism. Many rivers end in these closed drainage areas where runoff is lost through influent seepage and evaporation. The most important of these drainage areas is the Danan basin.

From the hydrographical point of view the lower valley may be divided into five large zones :

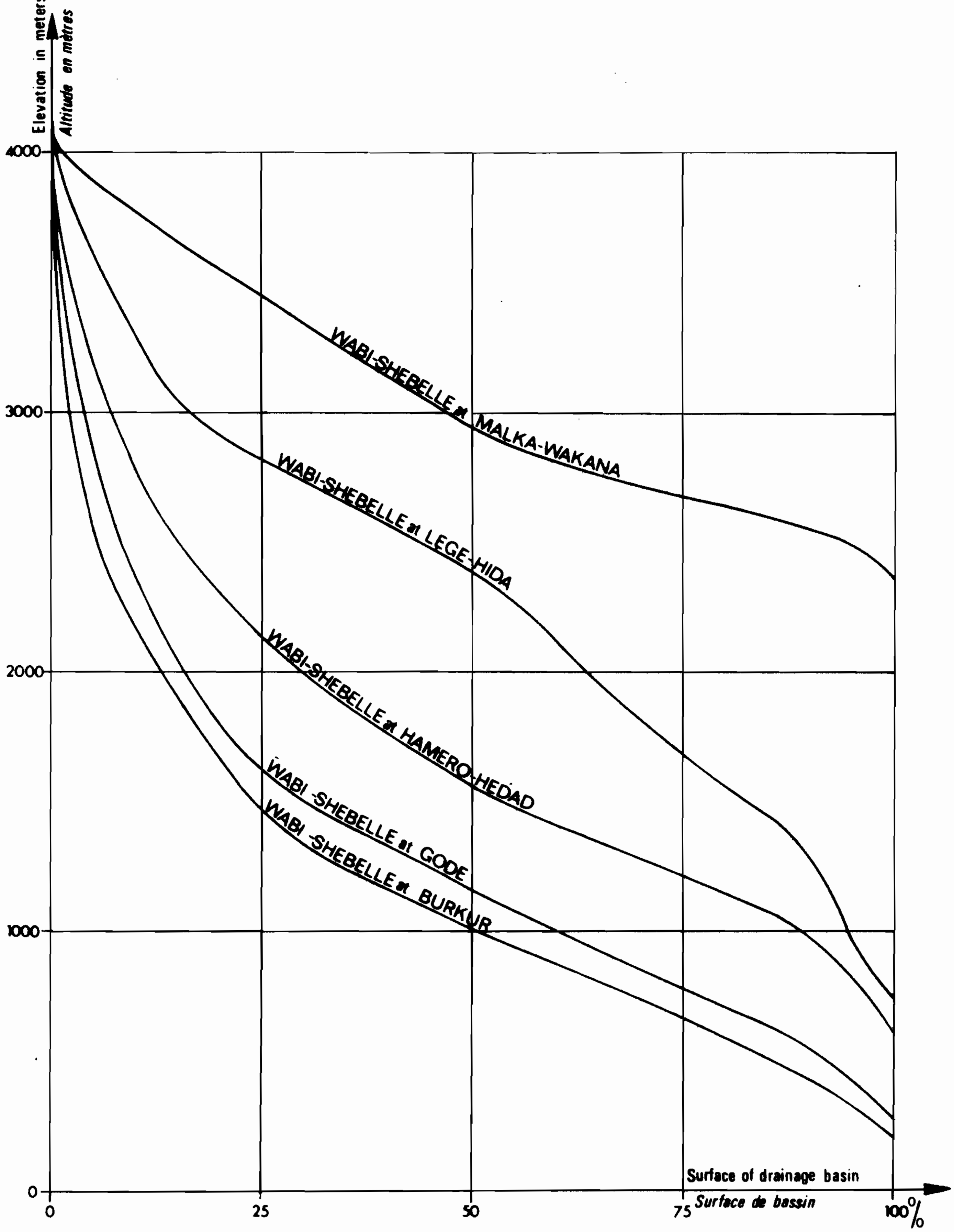
- at the exit from the gorges down to Cugno the slope is gentle, the banks are relatively low and unsteady and sedimentation is considerable. The Wabi Shebelle meanders through these alluvial deposits and overflows during the flood period. Its changing stream-flow often cross-cuts its meanders.

- From Cugno to 30 kilometers upstream from Kelafo, the Wabi Shebelle sinks several meters deep in its alluvial deposits and no longer overflows. The banks are comparatively stable.

- From Kelafo to Mustahil the river-banks are lower again and the gradient of slope decreases (0,20 m/km). The Wabi Shebelle divides into several arms overflowing in vast flood plains.

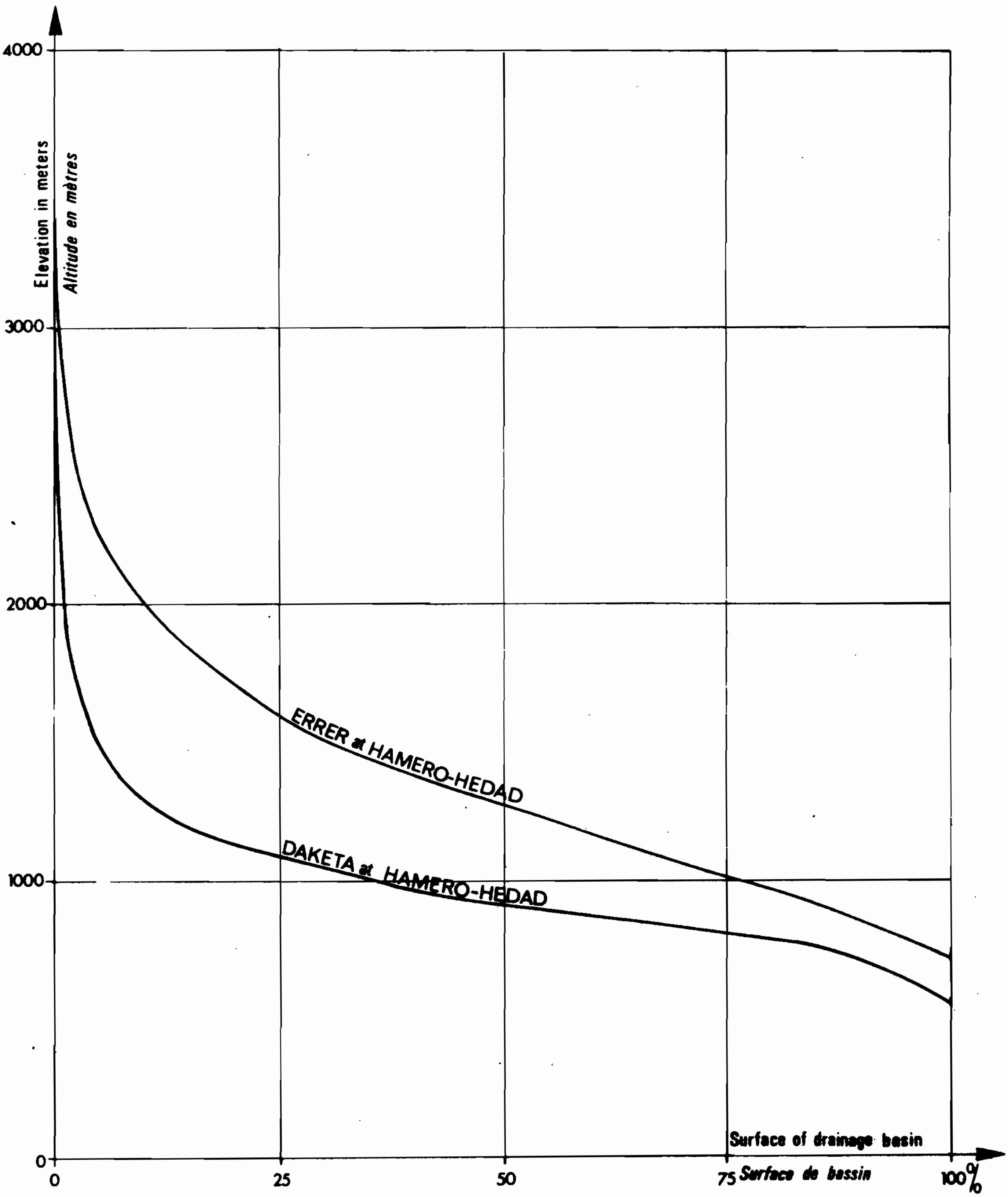
HYPSOMETRIC CURVES OF SOME WABI SHEBELLE BASINS

COURBES HYPSOMETRIQUES DE QUELQUES BASSINS DU WABI SHEBELLE



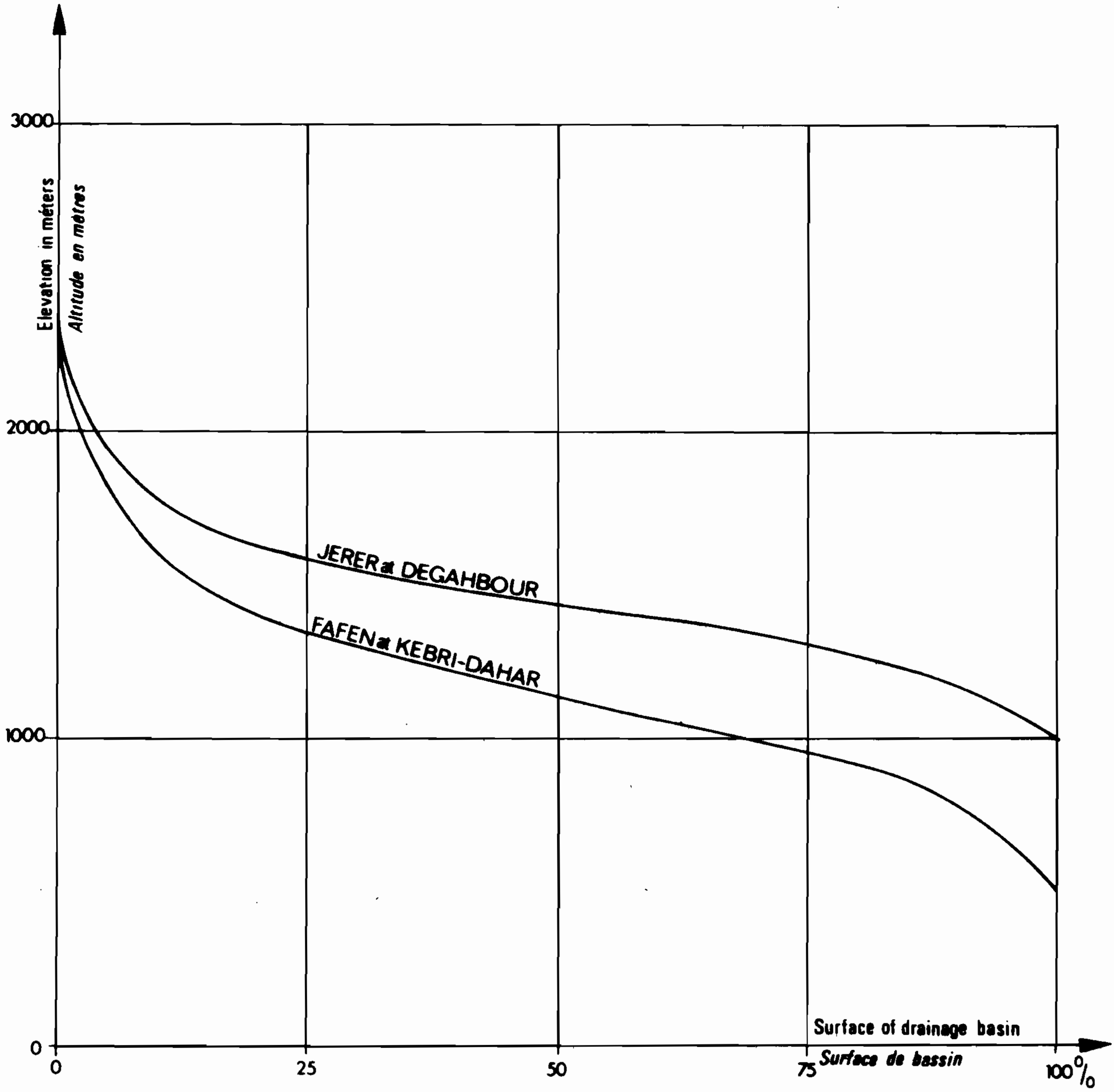
HYPSOMETRIC CURVES OF ERRER AND DAKETA BASINS

COURBES HYPSOMETRIQUES DES BASSINS DE L'ERRER ET DU DAKETA



HYPSOMETRIC CURVES OF FAFEN AND JERER BASINS

COURBES HYPSOMETRIQUES DES BASSINS DU FAFEN ET DU JERER



- from Mustahil to Burkur, the Wabi Shebelle narrows between the limestone hills and flows once again in a well marked channel.

- Downstream from Burkur, the banks are once again very low and the river overflows during the flood period.

b) The Fafen

In this survey the basin of the Fafen has been included with the basin of the Wabi Shebelle. It is nevertheless an independent basin of 42 000 km^2 with no connection with the Wabi Shebelle.

In the upper basin, the Fafen presents two main branches : the Fafen properly so-called and the Jerer. The Fafen originates in the granite mountains of Harar, to the North of Fugnanbira, whereas the Jerer comes from the limestone formations to the North of Jijiga. The Fafen and Jerer flow in a practically parallel NNW-SSE direction. They meet in the Bircot region, approximately 70 km to the South of Degahbour. The slopes of these channels are greater than 5 m/km. Less important tributaries have small drainage areas.

Downstream from the Jerer-Fafen junction and down to Korahe, the Fafen flows in the same NNW-SSE direction. The slopes are gradually gentler (approximately 3 m/km) and a 3 km wide alluvial plain stretches on either side of the river. The ephemeral tributaries do not join the Fafen but end in the alluvial plain forming alluvial fans where floods spread on vast areas.

Downstream from Korahe, the drainage pattern is distinctly degraded as it crosses the three successive spreading basins along a NS axis : the basin South of Korahe (450 Km2), the Dobowein basin (750 km2) and the Iglole plain.

In the first two basins, the Fafen bed divides into several channels and even practically disappears in some areas. The Fafen floods largely spread in these water-spreading areas. In the Iglole plain, the Fafen channel completely disappears but the river only reaches this last depression when strong floods occur.

1.3.2 Longitudinal profile of the main rivers

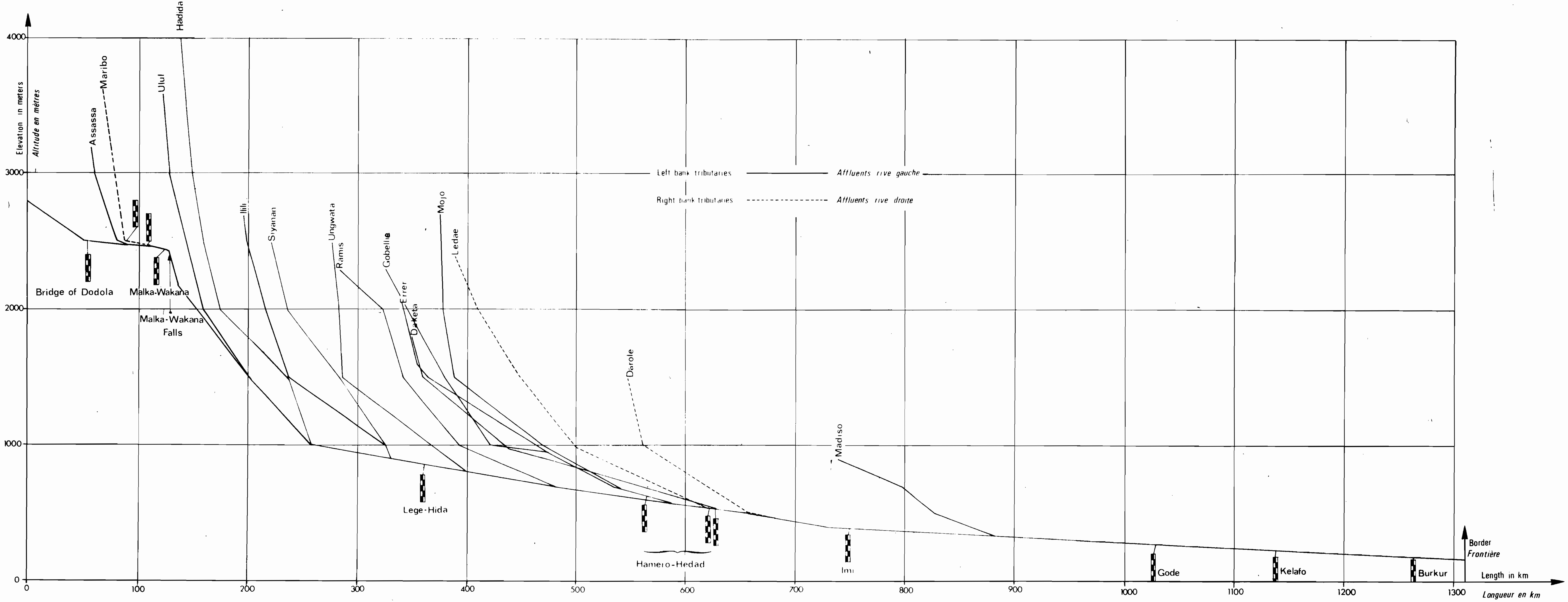
The longitudinal profiles of the Wabi Shebelle and of the Fafen are represented on graphs I.5 and I.6 using the very inaccurate topographic map at 1/500 000. The too great contour intervals do not enable knowing the details of the slopes of the various reaches. These profiles only provide a schematical vision at a small scale of medium slopes and cannot reveal all the many irregularities such as cascades and falls all along the rivers. The length of thalwegs has nevertheless been measured accurately on the planimetric base map at 1/250 000.

The downstream part of the Wabi Shebelle between Hamero-Hedad and Burkur is represented on a special topographic map presenting a suitable density of points (approximately one point every 7 kilometers). The longitudinal profile derived from this survey is shown on graph 1.7.

Gr-I-5

WABI-SHEBELLE LONGITUDINAL PROFILE *PROFIL EN LONG DU WABI-SHEBELLE*

(From map 1/500 000 of WAR OFFICE) *(D'aprés la carte au 1/500 000e du WAR OFFICE)*



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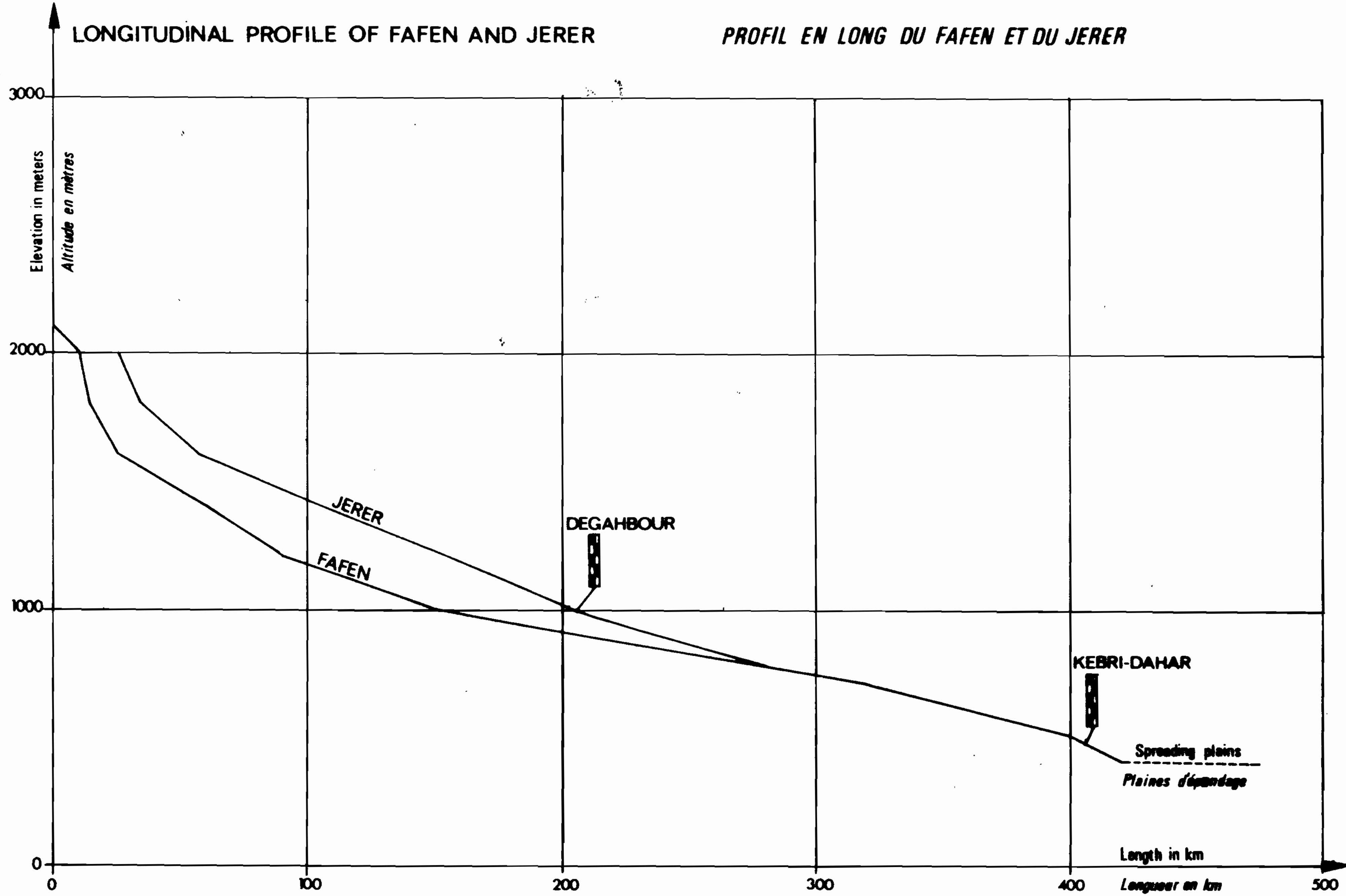

Gr-I-6

Gr-I-7

WABI SHEBELLE LONGITUDINAL PROFILE FROM HAMERO-HEDAD TO THE BORDER

PROFIL EN LONG DU WABI SHEBELLE D'HAMERO-HEDAD A LA FRONTIERE

(From the levelling of the topographic section)

(D'après le levé réalisé par la section topographique)

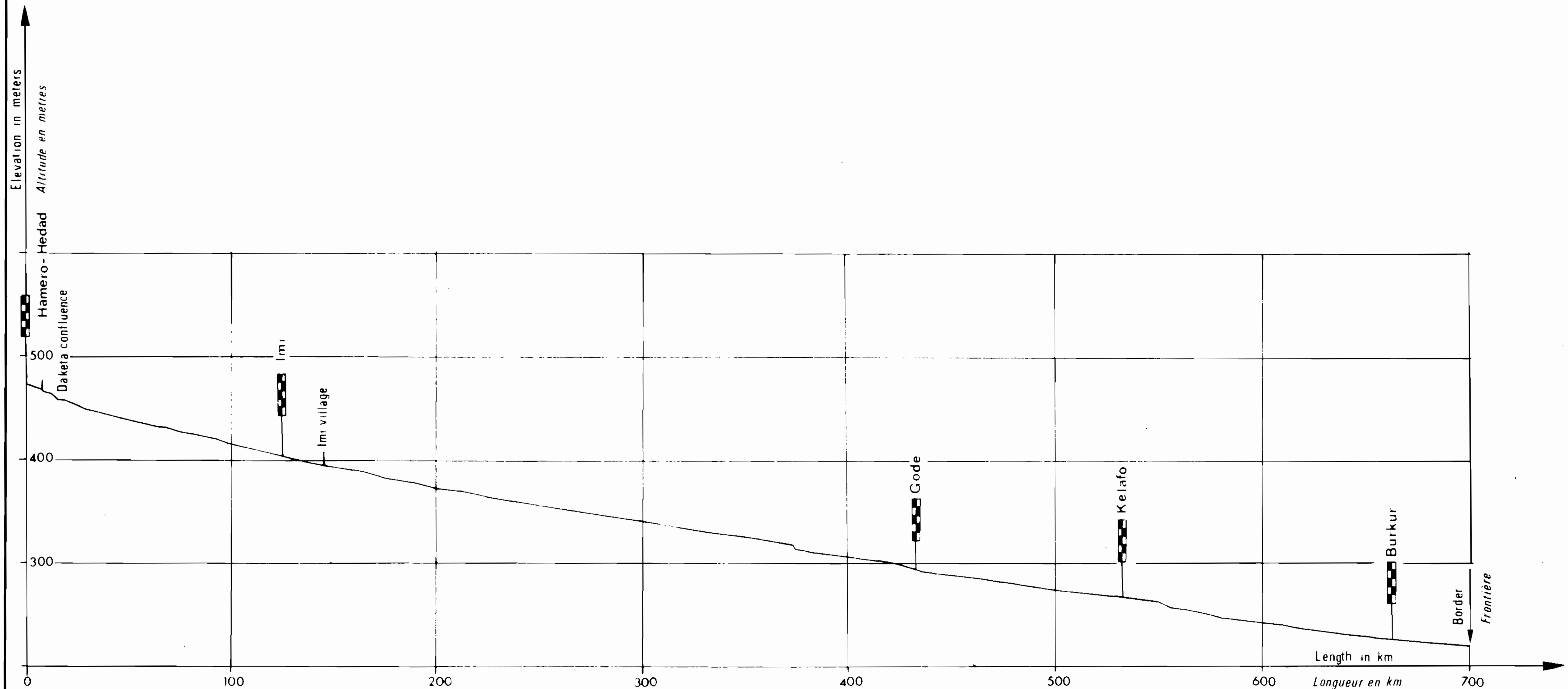

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TABLE 1.3

Mean slopes of the main rivers of the Basin of the Wabi Shebelle

River	Reach	Length of the reach (km)	Mean slope (m/km)
WABI SHEBELLE	Upstream from MALKA-WACANA	130	5,4
	MALKA-WACANA - LEGE-HIDA	230	5,0
	LEGE-HIDA - HAMERO-HEDAD	265	1,2
	HAMERO-HEDAD - IMI	125	0,56
	IMI - GODE	307	0,35
	GODE - KELAFO	100	0,27
	KELAFO - BURKUR	129	0,32
ASSASSA		35	29
MARIBO		45	36
ULUL		85	30
HADIDA		120	25
SIYANAN		110	14,5
UNGWATA		122	14
RAMIS		200	8
ERRER		245	6,2
LEDAE		230	8,1
DAKETA		280	4,5
DAROLE		135	7,6
MADISO		145	3,9
FAFEN	before junction with JERER	275	4,8
JERER	before junction with FAFEN	250	4,7
FAFEN	from junction with JERER to KEBRI-DAHAR	130	3,1

The result of the computation of the mean difference of levels may be seen in table 1.3. Owing to the bad quality of the topographic documents, it is useless to attempt finding the gradient of slope for each different altitudinal section. Hence, only the mean slope for each characteristic portion of the Wabi Shebelle and of the Fafen are represented and, for the main tributaries, the mean global gradients of slopes.

All the rivers flowing from the basalt mountains have an important mean slope greater than 8 m/km. The steepest slopes are approximately 30 m/km in the upper basins and all these rivers present torrential conditions of flow with successive rapids and falls.

The tributaries originating in the granite mountains of Harar as well as the tributaries flowing on gypsum have smaller mean slopes from 8 to 4 m/km. The flow still presents a torrential character.

The slopes of the Wabi Shebelle are smaller for an equivalent drainage area. From its source to Malka-Wacana the mean slope is very moderate (2,5 m/km) owing to the presence of the Guedeb plain. The steepest slopes are located in the Malka-Wacana - Lege-Hida section owing to the presence of important falls such as Malka Wacana after which the channel continues sloping steeply along several kilometers. A local topographic survey shows that, from the upper part of the falls down to 8 km downstream, the difference of level is 300 m. The slope then gently decreases until the river flows into the alluvial plain. In the alluvial plain the mean slopes are small : between 0,35 and 0,27 m/km.

The Fafen before flowing into the drainage areas where it disappears, still presents (like its main tributary : the Jerer) steep slopes greater than 3 m/km.

1.4. GEOLOGY

The geology of the basin is described in detail in the hydrogeological survey. Two maps are drafted : one at 1/1 000 000 for the whole Basin, the other at 1/250 000 for the downstream part of the Basin corresponding to Ogaden. The main geological formations are described in the notes accompanying these maps.

Herein, the geological series are envisaged from the point of view of their suitability for runoff.

Four important types of formations may be observed, i.e. :

a) The Precambrian base consisting of granite and metamorphic rocks occupying 3 per cent of the basin,*

b) The Miocene volcanic series of the upper basin corresponding to 10 per cent of the basin,

c) The sedimentary soils of secondary origin representing 82 per cent of the entire basin,

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*Percentages for the total area including the Basin of the Wabi Shebelle and the Fafen Basin.

d) the Quaternary alluvial and colluvial deposits occupying 5 per cent of the basin.

The exact location of these geological formations may be found on the geological map at 1/1 000 000 of the basin issued together with the hydrogeological study.

1.4.1 The Precambrian base is located in the North West of the basin in the Harar-Babile region. It consists of granite, granitic migmatite and gneiss. This cristalline substratum is impervious and favourable to runoff. However, the deep weathering of this formation resulted into thick permeable colluvial deposits where runoff is moderate. These deposits are particularly developed in the West of the formation.

1.4.2 The Tertiary formations or Trapp series result from the volcanic activity of the Miocene age. They command the sedimentary formations to the West and North of the basin and mainly consist of basalt flows, ash deposits and volcanic tuff.

The ash deposits are largely spread at the Western limit of the basin and present a high permeability : the importance of influent seepage in this ash layer leads to the formation of ground water tables revealed by springs. These ash deposits are favourable to a high base discharge of most of the rivers. The Wabi Shebelle originates from these formations. Nevertheless, runoff still exists owing to the steepness of slopes and to the high rainfall in these regions.

Basalt forms vast impervious plateaus where runoff is comparatively important.

1.4.3 The Secondary sedimentary series occupying over 4/5 of the Basin may be grouped into four great units :

a) The Kebri-Dahar limestone outcrops on over more than half of the basin. It is located between the basalt plateaus constituting the Northern and Western limit of the basin and the gypsum series in the South.

This series mainly consists of thick, hard limestone layers with some marl, gypsum and sandstone intercalations. To the monotonous structure of the series with a small dip of a few degrees to the South-East, is due the formation of vast plateaus deeply cut by the drainage system.

Runoff is weak on the plateaus but becomes more pronounced on the very steep slopes of thalwegs.

On the bare plateaus water seeps through cracks and diaclases. Ground water tables are very deep.

b) The gypsum series occupies practically all the Southern part of the basin and, to the North, it extends as far as 7°30' N. This series consists of alternated marl, clay, gypsum, dolomites and saline layers. Being particularly soft, it is deeply eroded and covered with a thick impervious layer of weathering material. Here, runoff is considerable.

c) The Mustahil limestone covers the gypsum series in some places in the South of the Basin. It forms an unbroken plateau South of the Wabi Shebelle between Gode and Mustahil and stretches to the Western limit of the basin. Between the Wabi Shebelle and the Fafen it constitutes isolated plateaus dislocated by weathering. Lastly, to the East of the Fafen, it forms an unbroken plateau but is often overlain with Ferfer gypsum and Jessoma sandstone.

This formation is only approximately 30 m thick and consists of chalky layers surmounted with a hard dolomitic layer forming a bluff.

On these plateaus where rainfall is low, runoff is not considerable.

d) The sandstone series is scattered throughout the basin. It stretches more or less largely up to the North-East under the basalt flows of the Trapp series. The largest outcroppings may be seen at the Eastern limit of the Basin where they form a plateau crossed by the drainage divide.

This series consistsof coarse sandstone and is very pervious. Rainwater is directly infiltrated and supplies perched ground water-tables which may reappear at the contact with limestone (region of El Kere). The drainage pattern is inexistent and no surface runoff may be observed.

1.4.4 The quaternary alluvial and colluvial deposits result of the weathering of cristalline and sedimentary volcanic soils. They constitute a soft sandy-clay material which is more or less pervious depending on its location.

These deposits are mainly located in the lower valleys of the Wabi Shebelle and of the Fafen and on the gypsum series where they form depressions collecting rainwater. They are unfavourable to runoff but as most of them are easily flooded, these deposits enclose ground water-tables connected with the drainage pattern.

To summarize, the most favourable soils for runoff are the volcanic soils, the Kebri-Dahar limestone in areas presenting very steep slopes, and the gypsum soils.

The distribution in percentages of the drained surface of the various geological series has been computed for each surveyed basin (table 1.4).

1.5 SOILS

Soil is an important factor as regards the hydrological conditions since it constitutes areas collecting rainwater and affects the latter as to its future role.

TABLE 1.4

Geological distribution for each basin in per cent of the surface

River	Station	Volcanic soils			Cristalline soils	Sedimentary soils				Alluvial and colluvial deposits
		Ash	Tuff	Basalt		Kebri-Dahar limestone	Gypsum	Mustahil limestone	Sandstone	
WABI SHEBELLE	Route DODOLA	78	2	20						
MARIBO	Route DODOLA			100						
MARIBO	Confluence		5	95						
WABI SHEBELLE	MALKA-WAKANA	19	21	60						
WABI SHEBELLE	LEGE-HIDA	5	5	55		28			7	
ERRER	HAMERO-HEDAD			4	21	75				
WABI SHEBELLE	HAMERO-HEDAD	2	2	26	4	62			4	
DAKETA	HAMERO-HEDAD				7	91	2			
WABI SHEBELLE	IMI	1	1	19	4	63	9	3		
WABI SHEBELLE	GODE	1	1	13	3	50	25	2	3	2
WABI SHEBELLE	KELAFO	1	1	12	3	47	26	4	3	3
WABI SHEBELLE	BURKUR	1	1	12	3	45	28	4	3	3
JERRER	DEGAHBOUR			1		75			19	5
FAFEN	KEBRI-DAHAR				8	71			10	11

The soil is closely related to the geological conditions and, at a lesser degree, to the climatic and especially to the rainfall conditions as the latter change with the relief. The pedological Division of the Project drafted a detailed map of the basin at a scale of 1/1 000 000. In this report, only the main types of soils presenting different hydrodynamic characteristics are described, referring to the classification provided by the pedological Division.

1.5.1 Soils on volcanic ash : brown mesotropic soils

These sandy soils are very pervious at the surface. The existence of impervious intercalations in the depth is favourable to a considerable lateral flow (many springs). The water-holding capacity is insignificant.

1.5.2 Soils on basalt

Several types of soils exist in relation to the altitude and land forms.

a) At the top of volcanic mountains :

- andosols in Arussi and North-Bale. These shallow soils (0,50 to 100 m) are scarcely pervious and their water-holding capacity is high.

- the basalt tops of Chercher and Harar are overlain with more pervious "sols brunifiés" (20 to 60 cm thick) presenting a weaker water-holding capacity.

b) On the mountain slopes above 2 700 m.

These deep (more than 3 m) ferrallitic soils with a sandy-clay texture present a suitable permeability and a medium water-holding capacity.

c) On basalt plateaus (mean altitude : 2.500 m) :

These black vertisols are very clayey and deep.

These soils absorb the first rainfalls very well since they present a superficial system of shrinkage cracks formed during the dry season. The soilsthen become completely impervious and are favourable to a considerable runoff. The water-holding capacity of these soils is very high.

1.5.3 Soils on volcanic tuff and basalt : Tchernozem

These deep sandy-clay soils located in the Guedeb plain are very permeable. The drainage pattern is relatively diversified and runoff is probably weak.

1.5.4 Soils on granite mountains

On the granite mountains of the Harar-Babile region three main types of soils may be distinguished :

a) Fersiallitic and ferrallitic soils :

These sandy-clay soils developed on gently rolling plateaus consist of granite, sandstone and limestone (glacis) colluvial deposits. Their permeability is medium to high. Headward erosion is very strong.

b) Granite chaos and colluvial soils on granite :

These soils are mostly located between Babile and Jijiga ; they consist of coarse sand and are very pervious.

c) Calci-magnesic soils :

They are only represented by some limestone residual hillocks on the granite mountains. They are clayey but shallow and their water-holding capacity is weak.

1.5.5 Soils on limestone

Climate is the main factor determining the differenciation of soils developed on limestone.

Two main soil categories may be determined depending on the altitude and rainfall, i.e. :

a) Soils of the Northern part of the Kebri Dahar limestone.

These soils correspond to a rainfall slightly higher than 500 mm.

On the plateaus stretch black limestone vertisols with a medium depth (60 cm to 1 m). These soils are very well-developed on the plateau between Babile and Fik, in the Jijiga and Lege Hida regions. They present a weak permeability and a high water-holding capacity but since the relief is inexistent, runoff is weak.

On the steep slopes of plateaus, weakly developed calcic-magnesic soils resulting from weathering may be observed. These shallow soils have a weak water-holding capacity and runoff is considerable.

Lastly, and still on limestone, large zones exist corresponding to the spreading of sandstone colluvial deposits derived from the weathering and transportation of the Jessoma sandstone. These spreadings are very well-developed at the Western limit of the Basin near Mount Auatu (near Ginir), in the Sheik-Hussien region and to the North East of the Basin between Kebri-Beyah and Degahbour.

Soils formed on these colluvial deposits present a calcareous differenciation (powdery lime). They are very pervious and their water-holding capacity is weak. Runoff is not considerable.

b) Soils on the limestone of Lower-Ogaden

These soils are developed on the Kebri Dahar limestone as well as on the layer of Mustahil limestone and correspond to a mean rainfall less than 500 mm. These soils present a calcareous differenciation with heaps and nodules. They are not very thick on the plateaus and become very thin on the slopes. They are very permeable. Runoff on these soils depends on the relief ; it is weak on the plateaus and relatively intense in zones where the limestone plateau is broken up (Shekosh region and zone between the Wabi Shebelle and the depressions of the Fafen).

1.5.6 Soils on gypsum formations

These soils are classified as soils with a gypsum differenciation and their thickness varies depending on their location on gypsum hills or on the colluvial and alluvial deposits of foot slopes. They present a weak permeability and runoff is intense except to the South of Kelafo and down to the Somalian border where they form vast and flat stretches.

1.5.7 Soils on quaternary sediments

These soils are mostly represented in the South of the basin on the alluvial deposits of the Wabi Shebelle and of the Fafen and in the water-spreading depressions of overland flow on gypsum series. They are very heterogeneous and their texture is variable depending on the origin of the deposits.

a) On the alluvial deposits of the Lower Valley of the Wabi Shebelle, three main types of soils are represented, i.e. :

- Soils with a gypsum differenciation. These are the most largely spread and they occupy most of the non-flooded alluvial plains. Their texture is clayey sand or sandy and they are generally very pervious.

- non-organic hydromorphic soils characterize non-flooded areas. They exist in the region of Imi and farther South between Kelafo and Mustahil. They are clayey and present a weak permeability to which are due the permanent pools and swamps of these soils.

- Vertisols and vertic soils. These soils correspond to the alluvial fans of the main tributaries of Ogaden. They form the limit of the soils with a gypsum differenciation previously mentioned. These very clayey soils have a weak permeability and a suitable water-holding capacity. They are temporarily flooded by water from the temporary rivers of Ogaden.

b) Soils on the alluvial deposits of the Fafen have a very variable texture ; from fine sandy to clayey.

In the easily flooded zones of the Korahe and Dobowein basins and on the alluvial fans of the Fafen tributaries, soils are more clayey and mainly consist of vertisols.

c) The soils of spreading basins located at the exit of endhoreic systems on gypsum series are very thick clayey vertisols. The formation of temporary pools on the soil surface during the rainy season is due to their very weak permeability.

These soils are mainly located in the Duhun basin and to the North of Danan as well as in the last Fafen depression or Iglole plain.

From this general pedological description, the following conclusions may be drawn as regards flow conditions :

a) vertisols are dominant in the upper basin, North of isohyet 500 m. They cover the basalt plateaus as well as the limestone formations. These clayey soils are saturated with water during the first rainfalls and then become impervious and suitable for intense runoff. These soils allow the formation of very high floods upstream from Hamero-Hedad ;

b) soils on the limestone of Lower Ogaden are more pervious. Besides, they receive less rainfall (less than 500 mm). Runoff on these soils should be moderate.

c) soils on gypsum are generally impervious and favourable to runoff. Yet, the general morphological structure of gypsum soils as well as the arid climate resulted into the formation of closed endhoreic basins unrelated to the general pattern.

Runoff is collected in closed basins where it evaporates and seeps into the soil forming local ground-water tables. The really active areas partly supplying the Wabi Shebelle are small.

d) Soils on volcanic ash of the upper basin are very permeable and favourable to a high base discharge on the Wabi Shebelle.

1.6 VEGETATION

The very contrasted relief as well as the great variety of climates and of the geological substratum, determines very different types of vegetation, from the dense forest to the short steppe, all intermediate forms being also represented.

Besides, owing to the relative density of the settlement on the high fertile plateaus, large zones have been practically completely cleared. The botanist on his map at 1/1 000 000 determines 13 categories of vegetation corresponding to the dominant species. As to us, we divide the vegetation in 6 main classes representing the different densities of the vegetative cover. Runoff is checked in proportion as the vegetation is thicker. Using this classification, several zones have been determined :

- zones with a dense forest,
- cleared and cultivated high plateaus,
- zones with a low forest,
- medium limestone plateaus with shrubs,
- steppes with thorny thickets,
- low valleys and water spreading basins with gramineae.

The first three classes correspond to high elevations (above 1 700 m) and the three last classes to mean and low elevations (less than 1 700 m).

a) The dense forest only remains on the steep slopes of the high mountains to the West and North-West of the basin, as well as on the Gara Muleta to the West of Harar, and only occupies 1 per cent of the basin.

b) At the foot of this dense forest, the high plateaus with moderate or inexistent slopes are practically entirely cleared and under cultivation. They are mainly cropped to wheat, sorghum, teff* and peas. The hills are covered with a herbaceous carpet grazed by livestock.

This cultivated zone extends from the West of the basin to the East of Harar and represents approximately 8 per cent of the entire basin.

c) The low forest roughly stretches between 2 500 m and 1 700 m. This secondary forest consisting of numerous deciduous species is very fragmentary and it is cut here and there by crops. These crops are distinctly different from those grown on the High Plateaus and consist of maize, sorghum, "chatt"** and coffee-trees. As the population becomes denser, land-clearing increases in this zone which represents approximately 14 per cent of the basin.

d) The mean limestone plateaus with a shrubby vegetation. This zone extends between 1 700 m and 1 200 m and occupies approximately 10 per cent of the basin. The general aspect of the vegetation corresponds to a loose thicket with numerous shrubs, 5 to 6 m high (Acacia). This type of vegetation only slightly affects runoff conditions.

e) Steppes with thorny thickets occupy 2/3 of the basin below 1 200 m. In this region, species vary with the base-rock but the cover remains comparatively homogeneous on the whole area and mainly consists of small (1 to 2 m) and sparse bushes. The thicket is denser on the foot-slopes and in the basins. Soil, when it is not too thin, is covered with poorly-developed gramineae.

These steppes scarcely prevent runoff.

f) In the lower valley of the Wabi Shebelle and in the spreading basins of the Fafen and of the Danan region, the vegetation is still sparser : bushes have practically disappeared and the density of the herbaceous carpet depends on the humidity of soils.

On the banks of the Wabi Shebelle grows a fringing forest covering relatively large areas in the Imi region and South of Mustahil where a shallow ground water-table exists.

Zones covered with these types of vegetation occupy approximately 5 per cent of the basin. The cultivated areas are almost entirely limited to the Kelafo region (irrigation through open canals during floods), and Imi (cultivation when floods subside) but tend to extend.

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*Teff : cereal growing in the High Plateaus of Ethiopia.

**Chatt : a shrub the shoots of which provide a stimulant.

CHAPTER II

CLIMATIC FACTORS

2.1 GENERAL CLIMATIC FEATURES OF THE BASIN

The basin of the Wabi Shebelle is located between 5° and 9°30' North parallels and presents an equatorial type of climate with the following seasonal variations, i.e. :

- a long dry season during the winter of the Northern hemisphere,
- a first rainy season,
- a second more or less pronounced dry season,
- a second rainy season.

The abundance of rainfall and the comparative length of each season is deeply influenced by the latitude and relief as will be seen in the chapter on rainfall.

The equatorial climate of the basin may be roughly presented as follows :

- The South of basin tends to aridity with two short rainy seasons of equal length and two long dry seasons also of equal length.

- In the Northern part of the basin where rainfall is more abundant, the second dry season occurring in May is less pronounced ; it only lasts one month and is sometimes inexistent. The first and short rainy season is considerably less abundant than the second.

Between these extreme conditions, all intermediate forms may be observed.

The very pronounced relief of the Northern part of the Basin deeply affects the climatic factors. It is responsible for the marked aridity in the South of the Basin which is an unusual feature under these latitudes.

These seasonal variations may roughly be explained by the yearly movements of the "Intertropical Front" separating the equatorial oceanic air (monsoon) from tropical continental air, these movements being followed by rainfall in the area where the two air-masses meet.

a) During winter in the Northern hemisphere the "FIT" is in the South hemisphere ; the basin is under the influence of the continental air-masses of the North East originating from the high pressures of Egypt. The long dry season is due to this cold current from the desert.

b) In March, the "FIT" moves to the Northern hemisphere ; the basin is affected by the humid equatorial air of the South East (trade winds from the Indian Ocean). The formation in the basin of a more or less lagging rainy season is due to this Northward movement of the FIT.

c) In May the FIT remains stable ; a short dry season occurs on the High Plateaus and a longer dry season in the South of the Basin.

d) From June until September, the FIT progresses Northwards and the basin is occupied by humid air-masses from the South West (monsoon) to which is due the long rainy season of the High Plateaus.

e) In September, the high pressures from Egypt drive the FIT back Southwards and the dry continental air returns on the basin. The Southwards movement of the FIT brings about the formation of a second rainy season (October-November) in the South or the Basin.

2.2 CLIMATIC INSTALLATIONS IN THE BASIN

In order to analyse the climatic elements which are the determining factors of hydrological conditions, it proved necessary to collect all the observation data concerning the longer possible periods. In this view, an inventory was made of the weather and rainfall data existent apart from those of the Project.

The main informations were provided by :

- a study by Amilcare Fantoli : "Contributo alla climatologia d'ell Ethiopia". This study gives all the data available before 1940. Unfortunately, the observations made in this work are generally very short and only a few rainfall stations could be used :

- The Imperial meteorological serviee. Meteorological and rainfall data provided by this Service mainly concern stations operating after 1952. These data are often poor and incomplete. Besides, the weather stations are mostly located on the High Plateaus and very few exist in the Middle Basin and in the Lower Valley.

After a critical survey of the data thus obtained, nine weather-stations and twenty one rain-gauge stations, located either in the basin or in the close vicinity, were selected and used for various informations concerning the study of climatic factors. They are specified in the following paragraphs.

In order to acquire a more accurate knowledge of the climatic conditions of the basin, six weather stations and fourty-eight rain-gauge stations were installed, most of them in 1968, and operated permanently until 1972. In tables 2.1 and 2.2 the list of these stations, their location and the date of the starting of observations is given. They also figure on the separate map of installations N° II.

The type-installations of the recent weather-stations include :

a) a weather-shelter with :

- a conventional thermometer,
- a maximal thermometer,
- a minimal thermometer,
- a psychrometer,
- a barograph,
- a Piche evaporometer.

b) a sunked evaporation pan, surface : 1 m2 (square pan of the ORSTOM type).

c) accumulative anemometer,

d) an heliograph,

e) a recording rain-gauge,

f) an Association rain-gauge,

g) a ground-level rain-gauge (in order to correct evaporation).

Observations are carried out in these stations three times a day, at 6 a.m., 12 a.m. and 6 pm (local time).

TABLE 2.1

Weather stations

Stations	Coordinates		Approximate altitude in meters	Starting of observations
	N latitude	E longitude		
Sector Arussi Bale				
ADABA	7°00'	39°16'	2 480	July 1968
TICHO	7°48'	39°18'	2 980	August 1968
Sector : Harar				
GIRAWA	9°08'	41°43'	2 560	August 1968
MEDAGALOLA	8°47'	42°07'	1 450	May 1968
HAMERO HEDAD	7°31'	42°09'	650	May 1968
Sector lower Valley				
GODE	5°58'	43°30'	260	July 1968

TABLE 2.2

Installations for the measurement of rainfall

N°	Station	Coordinates		Approximate altitude in meters	date of installation	Equipment
		Latitude N	Longitude E			
	Sector ARUSSI-BALE					
1	ADELE	7°48'	40°02'	2 500	Nov. 1968	tot.
2	AGAFRA	7°17'	39°42'	2 140	June "	pluvio.
3	ASSASSA	7°09'	39°12'	2 340	Febr. "	pluvio, + tot.
4	BOKOJI	7°31'	39°10'	2 840	Nov. "	" + "
5	BILLA	7°19'	40°13'	(2 130)	Nov. "	tot.
6	CARA BIROLE	6°48'	39°14'	3 220	Febr. "	tot.
7	KORE	7°14'	38°46'	2 750	Febr. "	pluvio. + tot.
8	DIXIS	8°06'	39°31'	(2 500)	Febr. "	tot.
9	DJARA	7°27'	40°36'	1 800	Jular "	pluvio + tot.
10	IBANO	6°53'	38°40'	2 700	Nov. "	" + "
11	GASSARA	7°22'	40°08'	2 350	June "	pluvio
12	GINIR	7°08'	40°40'	1 750	June "	"
13	GOBESSA	7°37'	39°29'	2 420	Nov. "	pluvio + tot.
14	INDETU	7°34'	39°49'	2 450	Nov. "	" "
15	LEGE-HIDA	7°53'	41°01'	1 580	Jular "	tot.
16	MERARO	7°22'	39°10'	2 990	June "	pluvio + tot.
17	ROBI	7°53'	39°34'	2 440	Febr. "	" + "
18	SEBRE-DOLLO	7°13'	40°31'	2 090	June "	pluvio
19	SADIKA	7°43'	39°40'	2 530	Febr. "	pluvio + tot.
20	SERU	7°44'	40°10'	2 500	Febr. "	" + "
21	SHEK HUSSIEN	7°45'	40°39'	1 490	Jular "	" + "
22	STELLA UGUE	7°03'	39°35'	3 670	Febr. "	tot.

- pluvio. = daily observed rain-gauge.
- tot. = totalizer or accumulative rain-gauge.

TABLE 2.2

Installations for the measurement of rainfall

N°	Station	Coordinates Latitude N	Coordinates Longitude E	Approximate altitude in meters	Date of installation	Equipment
	HARAR Sector					
23	BABILE	9°15'	42°18'	(1 650)	Apr. 1968	pluvio.
24	BEDENO	9°03'	41°34'	2 320	Jan. 1969	"
25	BEDESSA	8°54'	40°40'	1 760	Jan. 1968	pluvio. + tot.
26	BURKA	9°15'	41°15'	2 010	May 1969	pluvio
27	COMBOLCHA	9°25'	42°06'	2 130	Jan. 1968	"
28	DEGAHBOUR	8°13'	43°43'	1 130	August "	"
29	DEGAH-MEDO	7°58'	43°01'	970	Jular "	"
30	DEDER	9°18'	41°18'	2 530	Febr. "	"
31	DUHUN	7°12'	42°37'		June 1969	"
32	FADIS	9°07'	42°02'	1 770	Apr. 1968	"
33	FIK	8°08'	42°12'	1 140	March "	"
34	GELEMSO	9°20'	40°30'	1 810	Jan. "	"
35	GOLOLCHA	8°12'	40°04'	1 670	Jan. 1969	pluvio. + tot.
36	FUGNANBIRA	9°22'	42°16'	1 980	Jan. 1970	pluvio
37	HARAR	9°18'	42°05'	1 860	Jan. "	"
38	HIRNA	9°13'	41°04'	2 250	Jan. 1968	"
39	JIJIGA	9°20'	42°44'	1 640	Febr. "	"
40	KEBRI-BEYAH	9°08'	43°05'	1 730	Jular "	"
41	MECHARA	8°36'	40°20'	1 750	Jan. "	pluvio. + tot.
42	SEGEG	7°38'	42°43'	(900)	Jular "	pluvio
	Lower Valley Sector					
43	KELAFO	5°36'	44°08'	230	Sept. 1968	pluvio. + tot.
44	DANAN	6°30'	43°30'	400	Sept. "	" + "
45	FERFER	5°05'	45°05'	180	Oct. "	" + "
46	KEBRI-DAHAR	6°45'	44°11'	420	Oct. "	" + "
47	IMI	6°26'	42°06'	360	Oct. "	" + "
48	MUSTAHIL	5°15'	44°39'	190	Oct. "	" + "

- pluvio. = daily observed rain-gauge
- tot. = totalizer or accumulative rain-gauge

2.3 WIND CONDITIONS

Wind conditions depend on the movements of air-masses described previously.

The directions of the main winds have been observed at several stations of the Imperial Meteorological Service. They vary considerably especially at a high altitude where they depend on the location of the station and its position on slopes. In general, on the High Plateaus, the dominant wind blows from the E.N.E from October to May, and from the SW, from June to September (Monsoon). In Ogaden, the South-West wind blows during six months : from May to October, whereas from November to April, the North West wind is dominant.

The mean velocity of wind has been observed at the six weather-stations of the Project. The averages for three years are given in table 2.3. The mean velocity is always high and relatively steady throughout the year in the North-Eastern part of the Basin (Adaba, Ticho). In the South of the Basin and in the Lower Valley of the Wabi Shebelle, the mean velocity of the South-East wind is considerably higher than that of the North-East wind. As will be seen later, these winds deeply influence evaporation conditions.

TABLE 2.3

Mean velocity of wind on the ground in m/s (1969-1971)

Station	J	F	M	A	M	J	J	A	S	O	N	D	Yearly Average
ADABA	1,7	2,0	2,1	<u>2,2</u>	1,9	1,7	1,6	1,6	1,7	2,0	2,0	2,0	1,9
TICHO	1,4	1,5	1,4	1,5	1,6	<u>1,7</u>	1,5	1,5	1,5	1,5	1,5	1,5	1,5
GIRAWA	3,1	2,9	3,0	3,1	3,2	<u>4,5</u>	4,1	4,2	3,0	2,2	2,4	2,4	3,2
MEDAGALOLA	2,5	2,6	1,9	1,8	2,2	2,1	2,1	2,0	2,0	1,9	2,5	<u>3,3</u>	2,3
HAMERO-HEDAD	2,3	2,0	2,2	2,3	2,1	3,5	4,1	<u>4,4</u>	3,2	2,2	2,1	2,1	2,7
GODE	2,7	3,3	2,9	2,3	3,2	5,0	5,5	<u>5,5</u>	4,4	2,3	2,6	2,8	3,6

Maximal monthly data are underlined.

2.4 INSOLATION

The monthly variations of insolation at the six stations of the Project (3 years observation-period) are given in table 2.4.

Nebulosity increases with altitude. If the number of insolation hours for the year is compared to the number of hours of daylight, it may be noted that insolation corresponds to approximately 50 to 55 per cent of the total duration of daylight in high altitude and to 70 per cent in the South of the basin.

At a monthly scale, July is the month with the minimum insolation. representing 35 to 55 per cent of daylight,according to the altitude. December has a maximum insolation (65 to 90 per cent of daylight).

TABLE 2.4

Monthly and annual mean insolation in hours (1969-1971)

Station	J	F	M	A	M	J	J	A	S	O	N	D	Total for the year
ADABA	220	223	212	206	228	174	147	150	180	193	254	289	2 476
TICHO	180	200	129	178	196	190	159	173	200	150	194	241	2 190
GIRAWA	216	221	190	187	185	152	125	135	156	229	266	291	2 353
MEDAGALOLA	259	225	215	222	221	216	207	197	235	252	272	298	2 819
HAMERO-HEDAD	301	272	262	247	263	224	235	228	266	231	282	293	3 104
GODE	307	284	299	251	231	199	199	207	258	222	287	324	3 068

The maximal and minimal monthly data are underlined.

2.5 AIR TEMPERATURE UNDER SHELTER

Except for the Project stations which can provide data for approximately three and a half year, observations are available from the nine stations of the Imperial Meteorological Service (5 to 18 years). The list of these stations located in the basin or in the vicinity is given in table 2.5.

For each of these stations and for the six Project stations, the following characteristic values are computed, i.e. :

mean T : mean monthly and annual temperatures

max T : mean monthly and annual maximal day-temperatures

min T : mean monthly and annual minimal day temperatures

max T - min T : mean monthly and annual differences of day-temperatures.

Tables 2.6 and 2.7 give the data for all the stations observed.

These tables as well as graph II.1 show up a decrease of mean annual temperatures with increasing altitude.

The thermometric gradient in the whole basin is approximately 0,63° C for 100 m difference of level. Above 1 700 m, the relation is not so good since temperatures are affected by the position of the station with regard to slopes.

The fluctuations of the mean monthly temperatures are given in graph II.2 on which a double variation of temperatures appears. A first maximum in May for altitudes higher than 1 700 m and in March for altitudes less than 1 000 m. A secondary maximum appears in Secondary or October for all these stations. The coolest months are December and January, during the dry season.

As regards maximal temperatures, the highest are usually observed during the last months of the long dry season, in February and March. The lowest minimal temperatures generally occur in December or January. These temperatures may be very low when altitude is high and above 2 500 m, they are often under 0°C during the winter months.

These differences of day-temperatures steadily vary during the year from 20°C to 12°C with a minimum in the dry season (December and January).

TABLE 2.5

List of the weather stations of the Meteorological Service

Station	Approximate altitude in meters	Coordinates	
		N Latitude	E Longitude
DODOLA	2 540	6°58'	39°11'
KOFELE	2 680	7°04'	38°47'
SIRE	1 980	8°17'	39°29'
ASSELA	2 450	9°52'	39°08'
GOBA	2 740	7°01'	39°59'
DIRE DAWA	1 200	9°36'	41°52'
ALEMAYA I	2 125	9°00'	42°03'
HARAR	1 860	9°18'	42°05
KEBRI-DAHAR	420	6°45'	44°11'

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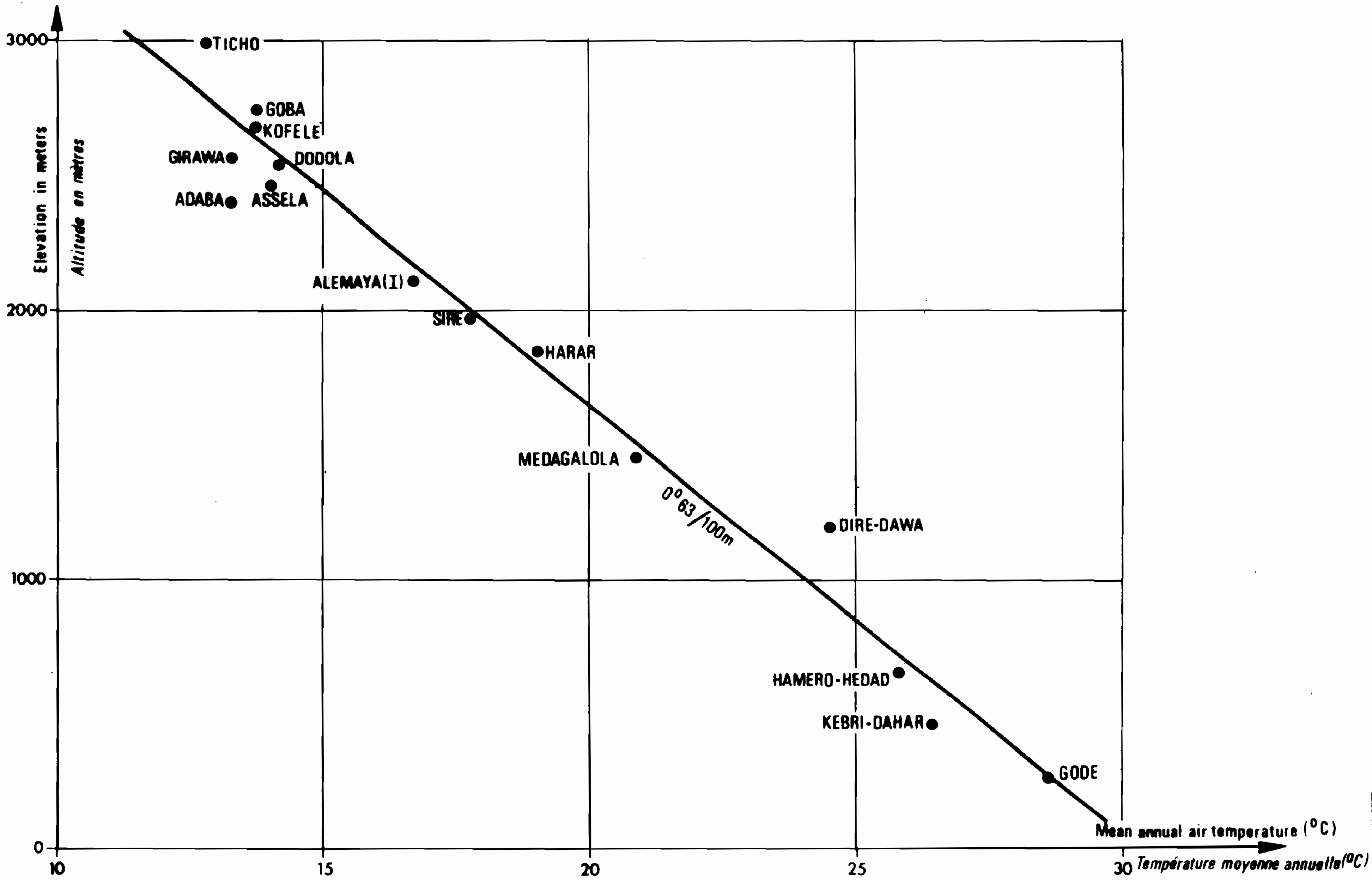
ETR-291764

VARIATION OF MEAN ANNUAL AIR TEMPERATURE WITH ELEVATION

VARIATION DE LA TEMPERATURE MOYENNE ANNUELLE EN FONCTION DE L'ALTITUDE



Gr-II-1

Gr-II-2

VARIATIONS OF MEAN MONTHLY AIR TEMPERATURE

VARIATIONS DE LA TEMPERATURE MOYENNE MENSUELLE

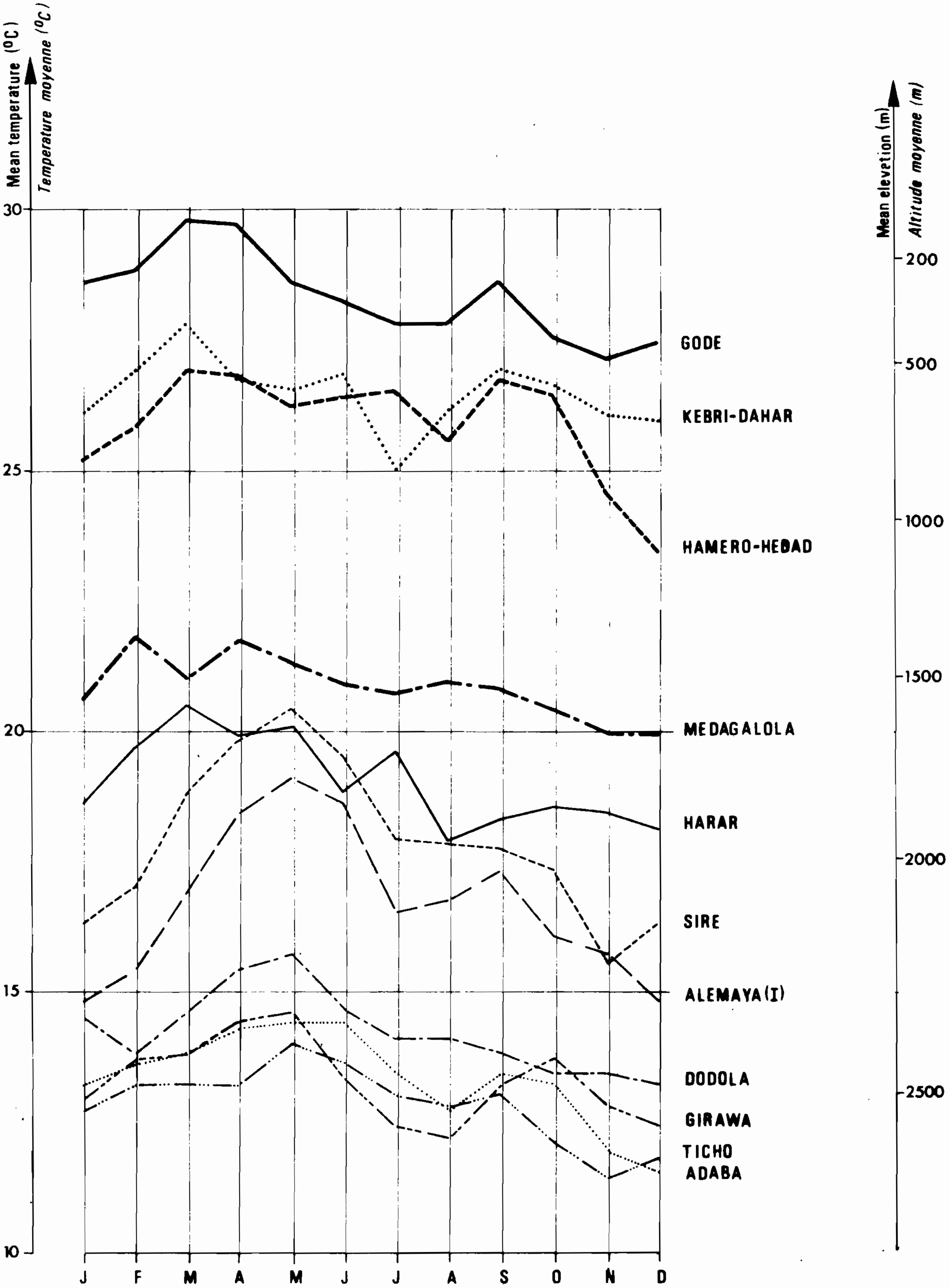


TABLE 2.6

Temperatures in °C

Meteorological stations of the Imperial Meteorological Service

Station	J	F	M	A	M	J	J	A	S	O	N	D	Yearly average
DODOLA (8 years)													
mean T	14,5	13,8	14,6	15,4	15,7	14,7	14,1	14,1	14,1	13,8	13,4	13,2	14,2
max T	24,5	23,8	24,7	25,0	25,6	24,7	22,5	22,5	21,8	22,1	23,5	23,6	23,7
min T	4,6	3,8	4,5	5,8	5,8	4,8	5,7	5,7	5,8	4,8	3,3	2,8	4,8
T max - T min	19,9	20,0	20,2	19,2	19,8	19,9	16,8	16,8	16,0	18,3	20,2	20,8	18,9
KOFELE (6 years)													
mean T	13,6	14,4	14,7	14,8	14,6	14,9	12,9	13,3	13,7	13,5	12,5	12,8	13,8
max T	22,7	22,2	23,2	21,6	22,4	21,5	18,1	18,8	20,0	20,9	20,6	20,0	21,1
min T	4,6	6,7	6,3	8,0	6,8	7,3	7,8	7,8	7,4	6,1	4,3	3,7	6,4
T max - T min	18,1	15,5	16,9	13,6	15,6	14,2	10,3	11,0	12,6	14,8	16,3	18,3	14,7
SIRE (8 years)													
mean T	16,3	17,0	18,8	19,8	20,4	19,5	17,9	17,8	17,7	17,3	15,5	16,3	17,8
max T	24,7	25,5	26,2	26,0	28,1	27,5	25,0	24,3	24,7	24,5	23,3	24,3	25,3
min T	7,8	8,4	11,5	12,7	12,8	11,5	10,8	11,3	10,8	10,2	7,7	8,3	10,3
T max - T min	16,9	17,1	14,7	13,3	15,3	16,0	14,2	13,0	13,9	14,3	15,6	16,0	15,0
ASSELA (5 years)													
mean T	12,5	14,4	14,7	15,0	15,4	14,2	13,6	13,3	13,2	14,1	12,1	12,3	14,0
max T	20,3	22,1	21,5	21,8	22,1	20,0	18,4	18,1	18,2	20,3	18,4	20,4	20,2
min T	3,7	6,7	7,8	8,3	8,7	8,4	8,8	8,6	8,3	8,0	5,8	4,3	7,3
T max - T min	17,6	15,4	13,7	13,5	13,4	11,6	9,6	9,5	9,9	12,3	12,6	16,1	12,9
GOBA (12 years)													
mean T	12,7	13,8	14,5	14,6	15,3	14,5	14,0	13,5	13,8	12,7	12,0	12,9	13,8
max T	21,6	22,1	22,1	21,4	22,5	21,5	20,9	20,2	20,3	18,9	18,7	20,2	20,9
min T	3,8	5,5	6,8	7,8	8,1	7,1	7,2	6,8	7,4	6,8	5,4	5,7	6,6
T max - T min	17,8	16,6	15,3	13,6	14,4	14,1	13,7	13,4	12,9	12,1	13,3	14,5	14,3
DIRE-DAWA (18 years)													
mean T	20,7	22,1	23,8	25,1	27,7	27,5	26,3	27,5	26,3	24,9	22,4	20,7	24,5
max T	27,9	28,1	30,2	31,4	34,3	33,9	32,7	31,6	32,4	31,9	29,3	27,5	30,9
min T	14,6	16,0	17,5	19,5	21,2	21,2	20,0	19,9	20,2	17,9	15,6	14,0	18,1
T max - T min	13,3	12,1	12,7	11,9	13,1	12,7	12,7	11,7	12,2	14,0	13,7	13,5	12,8
ALEMAYA I (7 years)													
mean T	14,8	15,4	16,9	18,4	19,1	18,6	16,5	16,7	17,3	16,0	15,7	14,8	16,7
max T	21,4	22,1	23,4	23,8	24,7	24,5	21,8	22,2	23,0	23,3	22,8	21,5	22,9
min T	8,3	8,7	10,3	13,1	13,4	12,8	11,1	11,3	11,6	8,8	8,6	8,2	10,5
T max - T min	13,1	13,4	13,1	10,7	11,3	11,7	10,7	10,9	11,4	14,5	14,2	13,3	12,4
HARAR (5 years)													
mean T	18,6	19,7	20,5	19,9	20,1	18,8	19,6	17,9	18,3	18,5	18,4	18,1	19,0
max T	24,5	25,6	26,5	24,8	25,5	23,7	24,4	22,3	23,2	23,9	23,8	23,5	24,3
min T	12,7	13,8	14,6	15,0	14,7	13,9	14,9	13,5	13,4	13,2	13,1	12,7	13,8
T max - T min	11,8	11,8	11,9	9,8	10,8	9,8	9,5	8,8	9,8	10,7	10,7	10,8	10,5
KEBRI-DAHAR (9 years)													
mean T	26,1	26,9	27,8	26,7	26,5	26,8	25,0	26,1	26,9	26,6	26,0	25,9	26,4
max T	33,8	35,1	34,8	32,2	32,5	32,5	28,7	31,4	32,4	32,3	32,1	33,1	32,6
min T	18,4	18,8	20,8	21,2	20,6	21,1	21,2	20,8	21,5	20,8	20,0	18,6	20,3
T max - T min	15,4	16,3	14,0	11,0	11,9	11,4	7,5	10,6	10,9	11,5	12,1	14,5	12,3

TABLE 2.7

Temperatures in °C

Meteorological stations of the Imperial Meteorological Service

Station	J	F	M	A	M	J	J	A	S	O	N	D	Yearly average
ADABA (3 years)													
mean T	13,2	13,6	13,8	14,3	14,4	14,4	13,4	12,7	13,4	13,2	11,9	11,5	13,3
max T	22,5	23,4	22,2	22,3	23,2	23,3	20,7	19,9	20,7	20,9	21,7	22,5	22,0
min T	5,2	5,3	7,3	7,6	7,4	7,1	8,2	8,1	7,7	6,7	3,1	0,9	6,2
T max - T min	17,3	18,1	14,9	14,7	15,8	16,2	12,5	11,8	13,0	14,2	18,6	21,6	15,8
TICHO (3 years)													
mean T	12,7	13,2	13,2	13,2	14,0	13,6	13,0	12,8	13,0	12,1	11,4	11,8	12,8
max T	19,8	20,9	19,6	20,0	20,7	20,8	19.6	19,0	19,3	19,0	19,4	20,7	19,9
min T	6,5	6,8	8,0	8,5	8,5	7,7	8,0	8,0	7,9	7,2	5,0	4,0	7,2
T max - T min	13,3	14,1	11,6	11,5	12,2	13,1	11,6	11,0	11,4	11,8	14,4	16,7	12,6
GIRAWA (3 years)													
mean T	12,9	13,7	13,8	14,4	14,6	13,3	12,4	12,2	13,2	13,7	12,8	12,4	13,3
max T	18,7	19,3	19,1	19,3	19,5	18,1	17,1	17,1	18,2	18,5	18,1	18,0	18,4
min T	9,1	9,7	10,3	10,8	10,8	9,6	8,8	9,0	9,5	9,8	9,0	9,0	9,6
T max - T min	9,6	9,6	8,8	8,5	8,7	8,5	8,3	8,1	8,7	8,7	9,1	9,0	8,8
MEDAGALOLA (3 years)													
mean T	20,6	21,8	21,0	21,7	21,3	20,9	20,7	20,9	20,8	20,4	19,9	19,9	20,8
max T	28,2	30,1	28,5	28,9	29,2	28,0	27,4	27,8	27,8	27,5	27,8	28,8	28,3
min T	15,2	14,6	16,0	17,0	16,2	16,1	15,5	15,5	15,1	15,5	13,5	13,0	15,3
T max - T min	13,0	15,5	12,5	11,9	13,0	11,9	11,9	12,3	12,7	12,0	14,3	15,8	13,0
HAMERO-HEDAD (3 years)													
mean T	25,2	25,8	26,9	26,8	26,2	26,4	26,5	25,5	26,7	25,4	24,5	23,4	25,8
max T	33,9	34,5	34,2	34,1	32,8	32,2	31,5	31,9	33,6	33,0	33,2	33,5	33,2
min T	17,2	17,4	19,3	19,7	19,1	20,0	20,4	20,6	22,3	19,2	15,7	12,9	18,7
T max - T min	16,7	17,1	14,9	14,4	13,7	12,2	11,1	11,3	11,3	13,8	17,5	20,6	14,5
GODE (3 years)													
mean T	28,6	28,8	29,8	29,7	28,6	28,2	27,8	27,8	28,6	27,5	27,1	27,4	28,6
max T	35,2	36,1	36,4	35,8	33,9	33,4	32,9	33,0	34,0	33,2	34,0	35,0	34,4
min T	23,5	22,5	24,0	24,6	24,1	23,6	23,4	23,4	23,4	23,4	21,3	20,8	23,1
T max - T min	11,7	13,6	12,4	11,2	9,8	9,8	9,5	9,6	10,6	9,8	12,7	14,2	11,3

2.6 RELATIVE HUMIDITY

The averages of monthly relative humidity have been computed at 6 am, 12 am and 6 pm for five stations of the Meteorological Service and for six stations of the Project. Tables 2.8 and 2.9 present the results in per cents.

The relative humidity is maximum at 6 am and minimum at 12 am, except for the stations in the South (Gode and Kebri Dahar) where the minimum is recorded at 6 pm.

Relative humidity increases with elevation.

On the upper basin (altitude higher than 1 700 m), relative humidity presents a maximum in August, in the middle of the long rainy season and a minimum at the end of the dry season (February-March).

In the middle Basin and in the Lower Valley, two maximums may be observed corresponding to the two rainy seasons, the first in May, the second in October. The minimal relative humidity also occurs in February-March.

TABLE 2.8

Relative humidity in %

Stations of the Imperial Meteorological Service

Station	Time	J	F	M	A	M	J	J	A	S	O	N	D	Yearly Average
GOBA (7 years)	06	78	77	74	83	82	80	83	85	86	85	87	81	70
	12	48	49	50	61	59	56	63	62	64	65	67	54	58
	18	56	54	59	71	71	71	72	77	79	76	73	64	69
ALEMAYA I (5 years)	06	74	74	79	73	83	79	83	84	82	77	72	75	78
	12	59	61	60	59	61	62	68	74	69	49	60	55	61
	18	63	62	71	62	66	67	70	75	71	53	65	62	66
DIRE-DAWA (8 years)	06	74	69	64	66	57	58	61	63	59	55	59	63	62
	12	50	48	46	48	37	38	43	47	43	35	41	43	43
	18	47	46	47	51	40	40	45	51	49	37	42	42	45
JIJIGA (7 years)	06	76	68	68	75	80	74	78	78	75	71	70	74	74
	12	53	51	45	53	54	57	64	63	57	52	44	53	54
	18	58	51	49	61	60	60	63	63	64	61	56	62	59
KEBRI-DAHAR (11 years)	06	72	72	73	78	82	77	77	74	75	84	81	79	77
	12	51	48	50	59	64	61	60	57	56	62	58	50	56
	18	45	42	43	54	59	49	53	52	52	60	55	47	51

TABLE 2.9

Relative humidity in %

Stations of the Wabi Shebelle Project

Station	Time	J	F	M	A	M	J	J	A	S	O	N	D	Yearly average
ADABA	06	86,7	83,7	81,7	83,8	87,5	89,0	91,0	90,7	88,5	91,3	89,8	87,8	87,6
	12	52,3	47,2	55,7	55,7	52,9	55,4	64,7	70,4	69,6	65,6	54,6	47,4	57,6
(3 years)	18	59,3	51,9	65,8	66,7	63,3	65,1	81,2	82,9	75,1	68,0	58,7	50,4	65,7
TICHO	06	85,2	81,5	87,3	89,5	87,6	89,5	92,2	93,1	91,0	88,4	84,4	76,6	87,2
	12	67,8	62,5	72,6	71,8	66,0	67,3	78,4	79,6	73,7	72,0	64,6	58,2	69,5
(3 years)	18	73,5	70,3	80,4	82,1	76,7	73,8	85,1	84,6	83,2	85,6	76,7	63,6	78,0
GIRAWA	06	68,8	61,0	72,5	81,5	82,9	94,7	93,0	94,7	93,2	75,2	65,6	54,7	78,2
	12	52,3	47,0	57,7	65,3	68,9	79,5	84,5	87,9	79,0	62,9	54,6	46,0	65,5
(3 years)	18	63,3	53,0	61,9	65,7	69,1	79,3	81,5	84,6	74,4	61,6	55,6	55,1	67,1
MEDAGALOLA	06	76,8	72,8	80,6	85,2	87,9	87,9	89,0	89,3	91,6	84,0	75,3	64,6	82,1
	12	51,4	45,0	53,7	51,5	64,8	66,7	68,1	72,1	70,2	49,5	50,6	46,4	57,5
(3 years)	18	54,7	45,8	54,1	59,8	70,1	64,3	62,1	67,7	70,3	61,3	52,0	50,0	59,4
HAMERO-HEDAD	06	71,0	73,8	81,5	82,9	86,2	83,5	80,8	80,0	83,3	86,6	83,2	82,0	81,2
	12	53,0	55,9	61,0	62,0	66,6	67,2	69,8	74,7	71,1	70,0	65,5	60,3	64,7
(3 years)	18	51,2	54,7	62,0	64,4	64,7	68,3	71,2	73,9	72,6	72,9	67,3	60,9	65,3
GODE	06	63,9	60,2	66,5	75,2	79,9	71,6	67,6	65,5	66,5	80,7	74,1	62,4	69,5
	12	42,4	40,9	45,4	50,1	53,1	50,5	48,4	45,4	47,1	57,6	53,0	42,7	48,0
(3 years)	18	31,9	26,2	34,7	45,9	53,0	44,5	43,1	43,0	41,9	55,2	45,2	33,5	41,5

2.7 EVAPORATION

The only available evaporation data concern the six weather stations of the Project. These stations only provide recordings for three years and a half. They are equipped with a class A evaporation pan (surface : 1 m2) and a sheltered Piche evaporometer. The average data computed from these recordings (3 1/2 years) are given in table 2.10.

The annual depth of evaporation measured on the Piche evaporometer is systematically smaller for all the stations than that measured on pan. It is however impossible to find a relation between the results achieved and these two different instruments. Under these conditions, the results of evaporation pan should be used to estimate evaporation on a large free groundwater table.

The annual depths of evaporation decrease very distinctly with elevation under the influence of various climatic factors. The difference between the maximal and minimal values observed attains 1 800 mm (1 411mm of annual evaporation at Ticho and 3 203 mm at Gode). These results show that the mean evaporation gradient for the basin corresponds to 70 mm for each difference of level of 100 m.

TABLE 2.10

Evaporation on pan in mm (average data for 3 years)

Station	J	F	M	A	M	J	J	A	S	O	N	D	Total for the year
ADABA	147	149	165	155	168	154	118	118	127	148	165	179	1 793
TICHO	114	129	110	117	131	121	109	109	103	98	132	138	1 411
GIRAWA	195	173	152	134	162	121	102	109	99	121	152	181	1 701
MEDAGALOLA	189	189	184	195	158	150	138	145	148	142	169	188	1 995
HAMERO-HEDAD	270	260	301	264	226	243	257	270	288	208	222	251	3 060
GODE	336	325	343	271	254	310	349	375	363	242	262	323	3 203

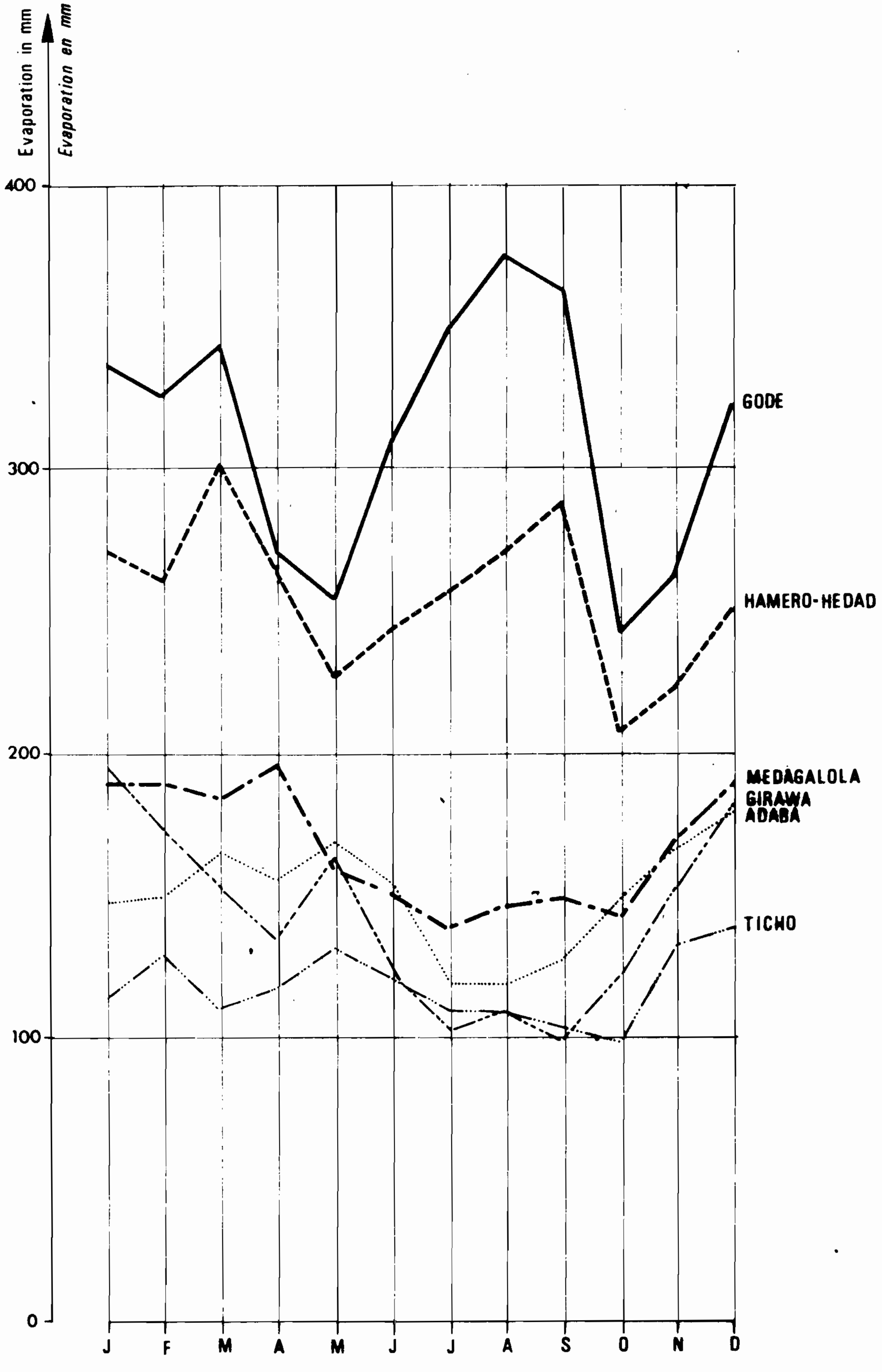
Evaporation on Piche in mm (average data for 3 years)

Station	J	F	M	A	M	J	J	A	S	O	N	D	Total for the year
ADABA	134	131	126	94	104	91	49	48	72	107	153	183	1 292
TICHO	75	89	59	46	68	61	43	40	51	57	81	100	770
GIRAWA	109	113	98	77	68	35	30	27	46	92	136	152	983
MEDAGALOLA	218	217	156	117	121	130	145	137	111	126	178	280	1 936
HAMERO-HEDAD	200	184	159	137	146	165	214	171	194	156	201	251	2 178
GODE	262	272	240	178	183	268	324	323	356	168	181	238	2 993

N.B. The monthly results for all the observation period are available in annexe II (table 2.20) -

MONTHLY VARIATIONS OF PAN EVAPORATION

VARIATIONS MENSUELLES DE L'EVAPORATION SUR BAC



Monthly evaporation varies with elevation. This may be observed on graph II.3.

For the stations located above 1 400 m, minimal evaporation occurs during the long rainy season in July-August and September and is approximately 3,3 to 4,5 mm per day.

For the stations below 1 400 m, the very distinct scission between the two rainy seasons gives two minimums, the first in May and the second in October. The mean minimal data fluctuate from 6,7 to 8,0 mm per day. This is also true for maximums : the first in March and the second in September or October, the maximal data being from 9,7 to 12,0 mm per day.

The preponderating influence of the high South-West wind on the second maximum evaporation must be noted.

In order to estimate the evaporation losses on a large free water surface, a reduction factor taking into account the geographical position of the station must be used when computing the results. It appears from the surveys carried out in West Africa, that a reduction factor of 0,8 could be applied for the part of the basin located in an arid zone (elevation higher than 1 400 meters).

Taking into account these reduction factors we have computed the mean monthly data acceptable for the dam-projects at Malka Wacana and at the entrance of the Lower Valley. These data given in mm per day are presented in the following table. For the Malka-Wacana dam, they were achieved at the Adaba station 25 km away from the site and for the other dam, at the Hamero-Hedad station 60 km to the North.

Dam	Evaporation in mm/day											
	J	F	M	A	M	J	J	A	S	O	N	D
MALKA-WAKANA	4,1	4,5	4,6	4,3	4,6	4,3	3,4	3,3	3,6	4,1	4,4	4,8
Entrance of the Lower Valley	7,0	7,4	7,7	7,1	5,8	6,5	6,6	7,0	7,6	5,4	5,9	6,5

The evaporation data thus obtained are respectively 1 500 and 2 400 mm for each dam.

2.8 RAINFALL CONDITIONS

2.8.1 Annual depth and monthly distribution of rainfall (see map III)

In order to characterize the annual depth of rainfall on the basin, all the data were collected from the rain-gauging stations presenting long enough observation periods. Apart from the three stations of Dire-Dawa, Harar and Bacacsa presenting records anterior to 1938, most of the Meteorological Service stations only started operating between 1953 and 1956. Besides, all the records are incomplete and finally, only few data are available and correspond for each station to very different periods. In order to acquire more data for a common period, an attempt was made to relate the annual depth observed at stations presenting the longer series of data (Dire-Dawa, Bacacsa, Harar Jijiga) with the annual depths of the station of Addis-Ababa (61 years recordings). The results are scarcely significant and do not provide a better knowledge of rainfall from year to year. This absence of a characteristic relation may be due to the influence of relief and to the long distance between the stations of the basin and those of Addis-Ababa. Nevertheless, the type of rainfall at Addis Ababa is similar to that of the High Plateaus of the Basin. In paragraph 2.8.2 may be found the characteristic statistical distribution data of the series of annual rainfalls observed at Addis-Ababa.

The long-term average data for 21 stations in the basin or its outskirts are given in table 2.11. They are computed from unprocessed data and may only be used for guidance, considering the incompleteness and variable character of observation periods. In this table, only 8 stations present observations for at least ten years. Most of the stations are located at the Northern limit of the basin above 1 750 m ; 4 stations only, presenting less than 8 years observations, are located in the Southern part of the basin. For all the central part, no observation point exists.

Owing to the low density of rain-gauge stations in the basin-area, to the very broken-up relief and to the short number of data collected, it is impossible to draw up a long-term isohyet system as the latter would be too inaccurate. Consequently, the basin was merely divided into large areas, each area presenting homogeneous features as regards annual depth and monthly distribution.

In order to characterize the monthly distribution of rainfall on the basin, the monthly coefficients were computed in percentage of the mean annual rainfall. These coefficients are presented in table 2.12.

Five large zones with homogeneous rainfall were determined from observations previously made during the Project survey, and also taking into account the relief of the basin. These zones may be seen on map III at 1/2 000 000 added to this report. For each zone, one or several graphs represent the monthly distribution.

a) - Zone I : It occupies the large volcanic groups and the high surrounding plateaus, around the Arena mountains and the Ticho and Minne-Gololcha mountains.

The mean depth of rainfall varies from 1 300 to 1 800 mm with the elevation and direction of slopes. Rainfall is uninterrupted from March to November. The short intermediate dry season is practically inexistent. The dry season occurs in December, January and February. This is a mountainous tropical climate.

b) - Zone II occupies the high basalt plateaus of Arussi, Bale and Chercher but the Guedeb plain is included in zone III. The annual depth of rainfall varies from 1 300 to 900 mm and is distributed in two seasons : a short season in March, April and May and a second longer season in July, August, September and October. These two seasons are separated by a small dry season in May or June. The long dry season lasts four months from November to February. This type of distribution characterizes an equatorial transition climate.

TABLE 2.11

Mean annual depth of rainfall (mm)

Station	Elevation (m)	Coordinates		Observation period	Number of years of complete observations	Mean annual rainfall
		N latitude	E longitude			
KOFELE	2 680	7°04'	38°47'	1955-1970	5	1 095
ADABA	2 480	7°00'	39°16'	1955-1970	10	804
ASSELA	2 450	9°52'	39°08'	1958-1970	7	1 216
GOBA	2 740	7°01'	39°59'	1953-1971	14	914
DODOLA	2 540	6°58'	39°11'	1954-1966	3	842
SIRE	1 980	8°17'	39°29'	1953-1968	3	936
GOLOLCHA	1 500	8°12'	40°04'	1930-1940	7	1 194
BACACSA	1 600	8°34'	40°12'	1920-1934	13	1 730
MINNE	1 700	8°19'	40°02'	1930-1934	5	1 713
GELEMSO	1 800	9°20'	40°30'	1953-1971	10	1 143
DEDER	2 340	9°18'	41°18'	1955-1971	13	1 083
DIRE-DAWA	1 200	9°36'	41°52'	1931-1937 1953-1971	26	617
ALEMAYA	2 125	9°00'	42°03'	1960-1969	6	857
HARAR	1 860	9°18'	42°05'	1914-1939 1962-1971	18	880
FUGNANBIRA	2 050	9°22'	42°16'	1957-1971	6	611
BABILE	(1 650)	9°15'	42°18'	1938-1939 1970-1971	4	628
JIJIGA	1 645	9°20'	42°44'	1952-1971	13	672
DEGAHBOUR	1 130	8°13'	43°33'	1955-1971	5	314
KEBRI-DAHAR	420	6°45'	44°11'	1958-1971	8	277
GODE	260	5°58'	43°30'	1967-1971	5	335
KELAFO	230	5°36'	44°08'	1957-1971	6	210

TABLE 2.12

Monthly coefficients of rainfall in % of the annual total rainfall

Station	J	F	M	A	M	J	J	A	S	O	N	D	Annual rainfall in mm
KOFELE	2,3	3,5	8,7	12,9	6,9	8,7	12,8	12,9	14,6	9,1	5,5	2,1	1 095
ADABA	0,9	3,5	6,3	7,9	4,0	7,7	22,4	21,0	13,9	6,7	3,4	2,3	804
ASSELA	2,3	1,0	7,7	3,6	7,9	11,4	15,5	18,5	21,1	5,0	4,8	1,2	1 216
GOBA	1,4	3,4	3,3	16,8	10,7	4,5	11,3	15,0	10,4	11,1	9,8	2,3	914
DODOLA	3,0	3,5	5,5	10,2	4,5	8,9	20,6	19,5	12,8	6,7	2,5	2,3	842
SIRE	0,4	1,0	9,2	9,3	5,9	9,4	16,9	21,3	17,8	5,3	3,0	0,5	936
GOLOLCHA	5,9	4,3	11,8	9,5	8,7	11,4	13,7	11,3	11,2	7,8	3,3	1,1	1 194
BACACSA	2,3	3,4	8,0	11,3	15,1	10,4	12,1	10,9	11,8	7,4	5,8	1,5	1 730
MINNE	5,8	4,9	12,3	11,8	7,2	9,6	13,7	7,8	13,0	7,4	4,4	2,1	1 713
GELEMSO	2,2	2,3	6,1	15,4	8,1	10,0	18,3	12,7	14,2	5,3	3,9	1,5	1 143
DEDER	2,5	2,6	7,5	12,8	4,3	8,9	19,2	21,6	16,0	3,2	1,2	0,2	1 083
DIRE-DAWA	3,0	7,0	8,5	13,5	4,3	3,5	17,5	24,8	10,9	1,7	3,7	1,6	617
ALEMAYA I	3,7	1,8	8,9	11,3	8,2	7,5	17,6	17,8	14,8	4,8	1,9	1,7	857
HARAR	1,2	3,6	6,8	12,3	13,6	11,4	16,0	15,3	11,0	5,2	2,6	1,0	880
FUGNANBIRA	2,7	2,1	5,2	13,7	11,0	7,6	14,9	17,1	14,8	6,9	4,0	0	611
BABILE	1,9	5,9	5,7	10,0	9,7	10,7	19,0	15,2	11,3	8,1	2,4	0,1	628
JIJIGA	1,4	1,8	5,6	13,5	11,4	9,8	11,3	19,4	12,1	9,4	2,9	1,4	672
DEGAHBOUR	1,7	0	8,7	19,0	23,7	7,5	0,9	3,4	12,8	18,0	4,1	0,2	314
KEBRI-DAHAR	0,7	1,0	10,9	26,5	19,5	0	0,4	0,1	2,5	27,9	9,6	0,9	277
GODE	0	2,9	5,1	23,6	23,4	0,2	0	0	0	25,2	17,9	1,7	335
KELAFO	0	0	1,5	34,9	16,1	0	0,4	0	1,8	19,9	22,9	2,5	210

c) - Zone III occupies the Guedeb plain which is hemmed in by mountains and receives but a small amount of rainfall.

The annual depth of rainfall varies from 900 to 700 mm. The distribution of rainfall is identical to that of zone II but with a less abundant first rainy season. This is also an equatorial climate of Northern transition type.

d) - Zone IV continues zone III to the South and occupies the Northern area of the limestone plateau as well as the granite group of Harar.

The annual depth of rainfall varies from 900 to 500 mm and decreases with elevation from North to South.

The two rainy seasons are separated by a short dry season in June which grows longer as one goes Southwards. This is an equatorial climate of Northern transition type.

e) - Zone V occupies all the Southern area of the basin.

The annual depth of rainfall, from 500 to 150 mm decreases from the North to the South and this zone distinctly tends to aridity.

The two shorter rainy seasons (two months each) are equally abundant and are separated by two dry seasons of equal length. The first rainy season always occurs in April as in the Northern part of the basin and the second occurs later in October and November.

This distribution of rainfall allows to consider that this zone presents an arid equatorial climate.

From these general considerations on rainfall, the following conclusions may be drawn :

a) The relief plays a preponderating part on the annual depth of rainfall. To this relief is due the high rainfall gradient in all the basin. In fact, the annual depth of rainfall varies from 1 900 mm on the highest peaks to 150 mm in the Southern extremity of the Lower Valley. The distribution of rainfall which mainly depends on the movement of air-masses is also modified by the presence of a mountainous relief. The long and single rainy season on high mountain peaks is gradually replaced with two short and very distinct rainy seasons in the Southern part of the Basin.

b) The wettest zones with a rainfall greater than 900 mm (zones I and II) only occupy 15 per cent of the entire basin. Nonetheless, these zones condition the abundance of runoff in the basin of the Wabi Shebelle.

The map of zones presenting homogeneous rainfall and the planimetric map on which the limits of catchment basins are shown give a first schematical vision of the amount and periods of runoff for each basin. The tributaries of the upper basin down to the Errer have part of their drainage basins included in zones I and II, hence they are the most abundant and present a permanent runoff. The basins of the tributaries of the Wabi Shebelle, downstream from the Errer and the Fafen basin, stretch in zones IV and V and are therefore not so abundant. Runoff takes place during two distinct periods separated by a drying-up period.

As a rule, the abundance of runoff decreases from the upstream part to the downstream part of the basin.

2.8.2 Interannual variability of rainfall

The study of the statistical distribution of annual rainfall is available for seven stations presenting complete recordings for at least 10 years.

These seven stations are, as follows :

Zone I	: Bacacsa	(13 years)
Zone II	: Deber	(13 years)
	Goba	(14 years)
Zone III	: Adaba	(10 years)
Zone IV	: Dire-Dawa	(26 years)
	Harar	(18 years)
	Jijiga	(13 years)

No data for long enough periods are available for zone V.

Table 2.13 sums up the characteristic data of the distribution of annual rainfall for the seven stations.

TABLE 2.13

Characteristic data of the statistical rainfall distribution

Station	Distribution law	Mean annual rainfall (mm)	Standard deviation (mm)	Variation coefficient	Noticeable values for F=			
					0,90	0,80	0,20	0,10
BACACSA	GAUSS	1 730	303	0,18	1 341	1 475	1 985	2 118
DEDER	GAUSS	1 083	132	0,12	913	971	1 194	1 252
GOBA	GAUSS	914	145	0,15	729	792	1 036	1 100
ADABA	GAUSS	804	154	0,19	607	674	933	1 001
DIRE-DAWA	GAUSS	617	130	0,21	451	508	726	783
HARAR	PEARSON III	880	261	0,30	586	671	1 075	1 202
JIJIGA	PEARSON III	672	211	0,31	443	510	825	924

The small number of recordings studied allows to give only a very approximate value to the figures presented in this table. The distribution curves fitted to the recordings are the usual curves as regards zones I, II and III, and the Pearson III law for zones IV (except for Dire Dawa).

Nevertheless if one refers to the rain-gauge station of Addis Ababa for which 61 observation-years are available, it seems that the annual depths of rainfall on the High Plateaus also obey a dissymetrical law of the Pearson III type. The assymetrical character of distribution gradually increases when the annual depth of rainfall decreases.

For guidance, the typical values of the rainfall distribution at Addis-Ababa computed from the samples for 61 years (1898 to 1971) are given below. Though there is no distinct relation to the rain-gauge stations of the Wabi Shebelle, these data give an idea of the interannual irregularity on the High Plateaus.

Adjustment law	: Law Pearson III
Average	: 1 197 mm
Standard deviation	: 220 mm
Coefficient of variation	: 0,18
Wet 100 year frequency	: 1 750 mm
Wet 10 year frequency	: 1 477 mm
Median frequency	: 1 197 mm
Dry 10 year frequency	: 933 mm
Dry 100 year frequency	: 756 mm

The interannual variation of rainfall may be characterized by the coefficient of variation which is the ratio between the standard deviation and the mean annual rainfall.

In zones I, II and III the coefficient of variation is between 0,15 and 0,20. It increases in zone IV where it is approximately 0,30. In zone V, representative rain-gauge stations presenting long enough observation periods do not exist. However, an examination of the records available at four stations tend to prove that the interannual irregularity is still greater. For these four stations, the maximal and minimal depths are given below with references as to the observation periods.

Degahbour	(5 years)	max R = 393 mm,	min R = 226 mm
Kebri-Dahar	(8 years)	max R = 469 mm,	min R = 156 mm
Gode	(5 years)	max R = 431 mm,	min R = 292 mm
Kelafo	(6 years)	max R = 292 mm,	min R = 99 mm.

The coefficient of variation is probably between 0,40 and 0,50.

2.8.3 Daily rainfall

a) Character and intensity of rainfall.

The characteristics of rainfall vary with the various zones presenting homogeneous rainfall.

In zones I, II and III corresponding to the wettest high regions, the most frequent rains present a monsoon type characterized by a very long storm body and a weak intensity which seldom exceeds 50 mm/h. These monsoon rains may be interrupted by swifter and more violent rainstorms. The latter present a relatively short intense body (thirty minutes to one hour) followed by a slower tail which sommetimes lasts several hours. The typical hyetographs of these two types of rain are represented on graph II 4. They are derived form rainfall recordings from the Ticho station.

In zones IV and V, daily rainfall consists of intense rainstorms with a body lasting from thirty minutes to two hours and a very weak tail. The typical hyetographs of these zones concerning the Hamero-Hedad and Gode stations are presented on graph II.5.

The variation of the ratio intensity-duration may not be known accurately since rainfall recordings for a long enough period are lacking. A qualitative information may be gathered from the five recording rain-gauges of the Project : rainfall intensity increases when annual rainfall decreases, for equal daily rainfall depths.

b) Mean monthly and annual number of rainy days.

Table 2.14 sums up the mean monthly and annual number of rainy days for 16 rain-gauge stations of the basin. The data where computed using all the complete monthly recordings available for periods stretching from 5 to 22 years.

This table shows that, in zones II and III corresponding to the High Plateaus, the annual number of rainy days is approximately 150 days in Arussi and Bale and only 110 days in Chercher.

From the observations made at the rain-gauge stations of the Project, this number should be approximately 200 days in zone I.

In zone IV and V, this number gradually decreases from 100 to 20 days as one goes Southwards.

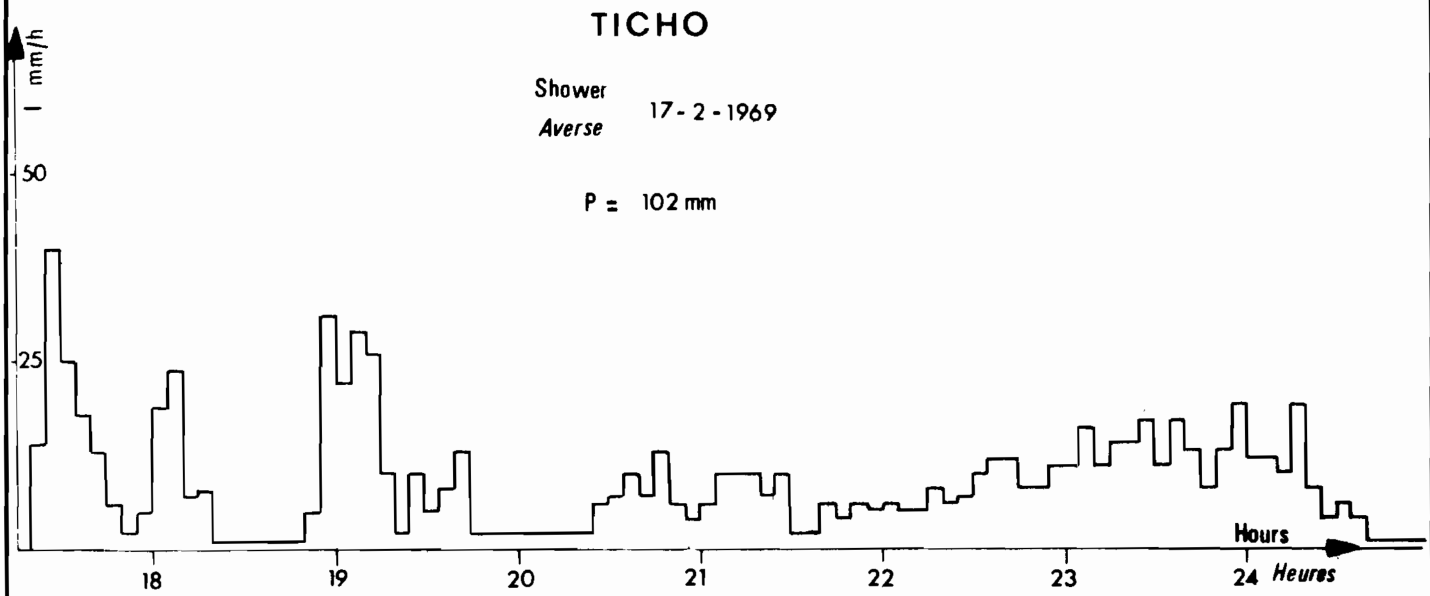
c) Exceptional rainfall for 24 hours

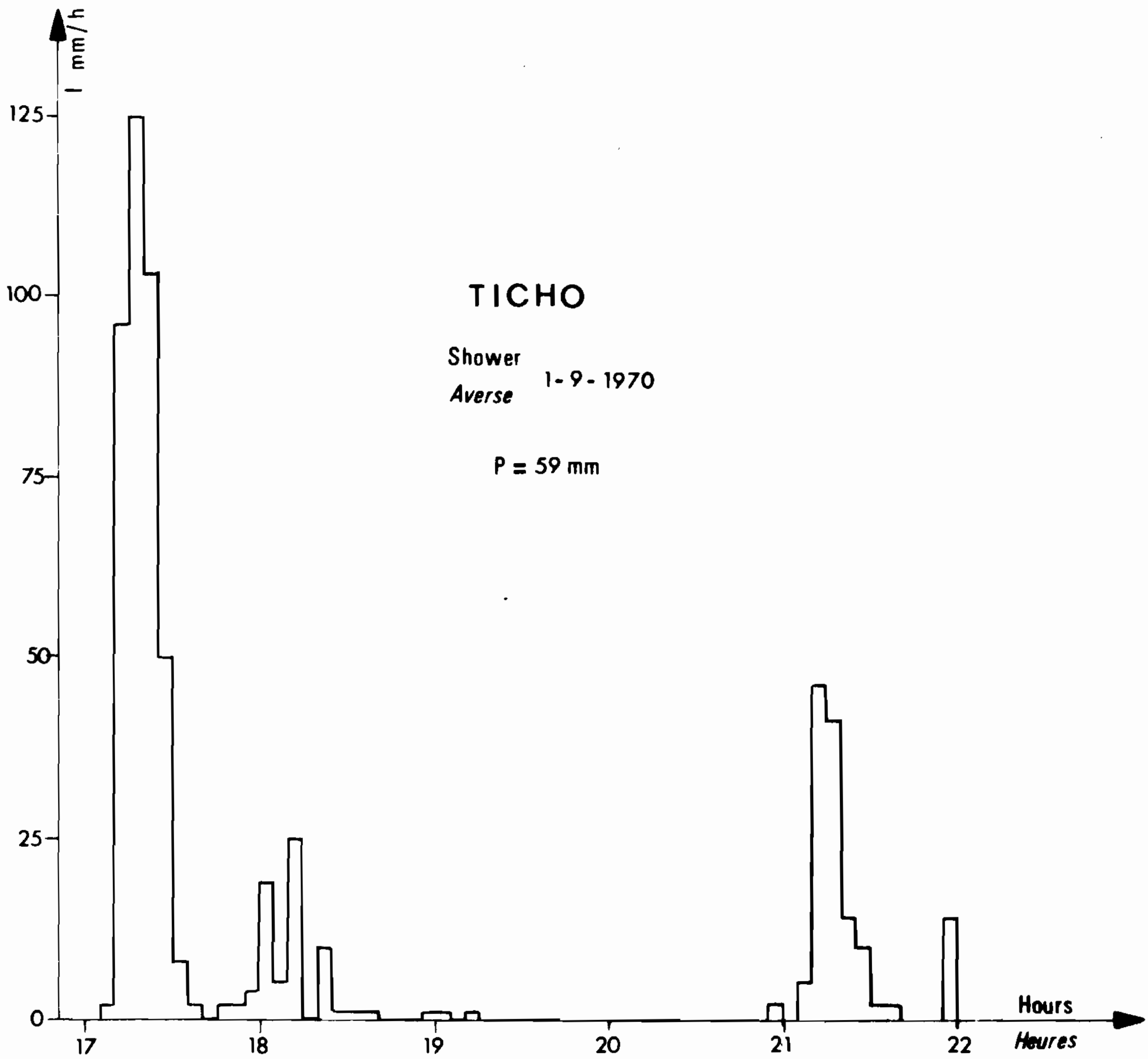
It is relatively difficult to determine daily rainfall presenting an exceptional frequency since only one rain-gauge station in the basin (Jijiga) has complete daily recordings concerning an adequate number of years. The station of Addis-Ababa, though it is outside the basin, may nevertheless be useful for the characterization of exceptional rainfall on the High Plateaus since it is located at a comparable altitude (2 450 m) and

ZONES I . II . III .

TYPICAL STORM INTENSITY PATTERNS

HYETOGRAMMES CARACTERISTIQUES

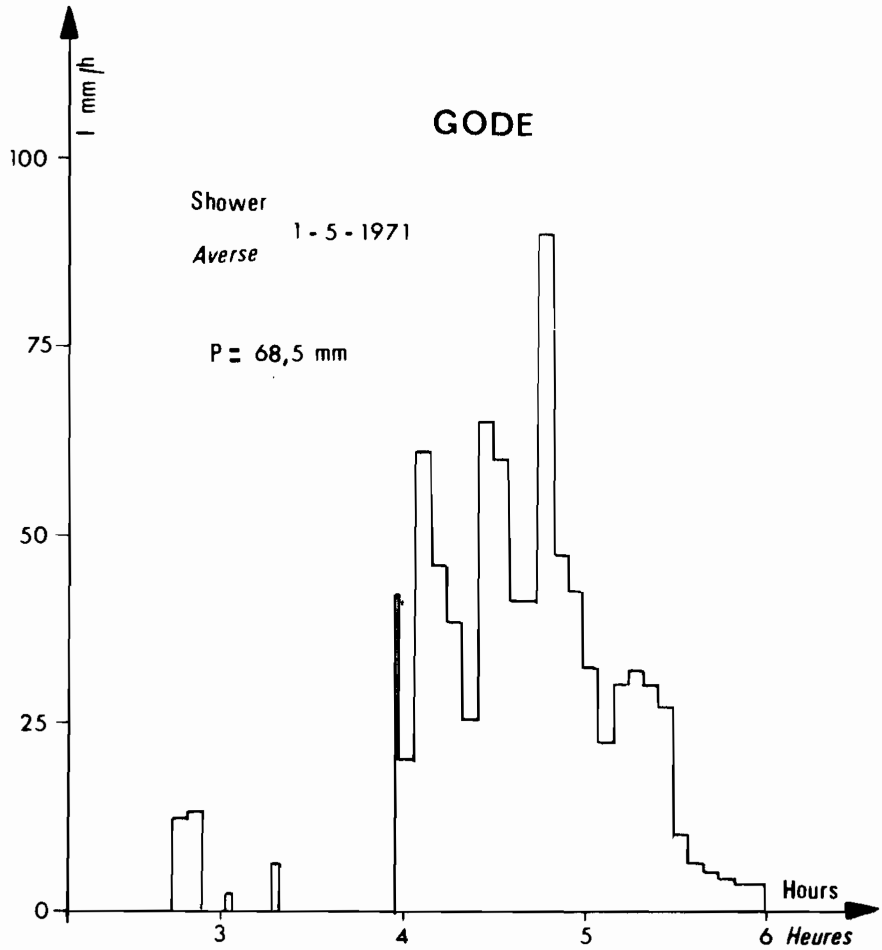




ZONES IV et V

TYPICAL STORM INTENSITY PATTERNS

HYETOGRAMMES CARACTERISTIQUES



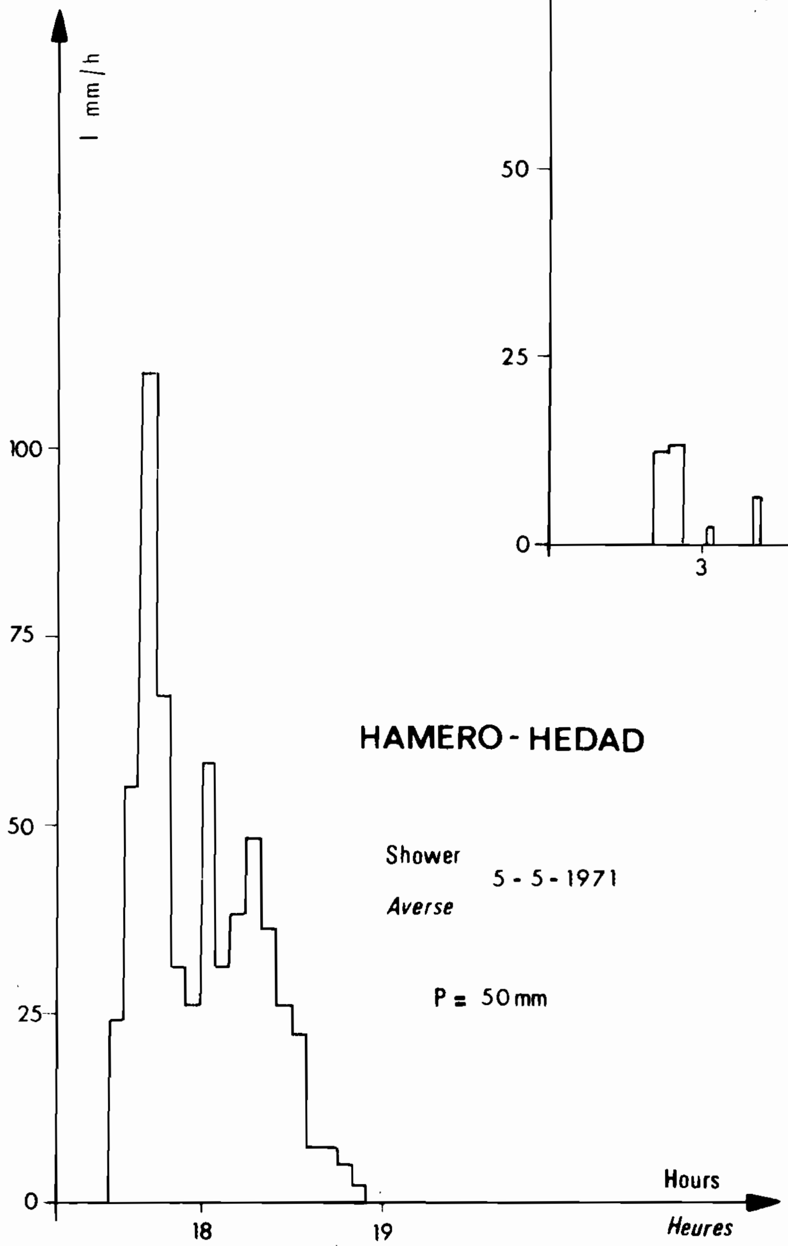


TABLE 2.14

Mean monthly and annual number of rainy days

Station	J	F	M	A	M	J	J	A	S	O	N	D	Annual total number
Zone II													
KOFELE	6	9	12	15	17	21	26	25	27	15	10	4	187
SIRE	3	2	8	9	6	12	17	19	19	5	3	1	104
ASSELA	5	10	12	10	10	19	24	25	21	9	6	1	152
GOBA	3	5	10	16	13	12	16	18	20	16	13	4	146
GELEMSO	3	3	8	12	11	14	18	14	17	9	4	2	115
DEDER	3	4	8	13	6	10	17	18	16	5	3	1	104
Zone III													
ADABA	4	4	10	13	11	14	26	26	22	8	6	2	146
DODOLA	6	5	8	15	8	15	23	24	20	11	6	4	145
Zone IV													
HARAR	2	4	6	11	11	11	15	17	15	6	3	1	102
DIRE-DAWA	2	4	6	9	3	4	11	14	9	2	2	1	67
JIJIGA	2	2	5	10	9	8	10	13	12	4	3	1	79
FUGNANBIRA	2	3	4	8	7	6	12	12	11	4	2	1	72
Zone V													
DEGAHBOUR	0	1	4	8	8	2	1	1	6	7	2	1	41
KEBRI-DAHAR	0	0	1	7	4	0	0	0	1	8	3	1	25
GODE	0	1	2	7	4	0	0	0	0	8	5	1	29
KELAFO	0	0	1	4	4	0	0	0	1	5	4	1	20

presents the same rainfall characteristics : interannual depth : 1 200 m, monthly distribution, number of rainy days and identical nature of rains. Consequently, the statistical distribution of daily rainfall was studied at these two stations. The fitting of a truncated frequency curse of Pearson III to the classified recordings of daily rainfall give the following results :

Station	Number of years	Daily rainfall in mm of recurrence intervals						
		1 year	2 years	5 years	10 years	20 years	50 years	100 years
ADDIS-ABABA	25 years	43,5	50,0	55,5	63,8	69,9	76,2	84,4
JIJIGA	11 years	51,2	61,6	74,2	84,5	95,0	95,0	120

The results obtained through the fitting of a frequency curve of Pearson III compared with the observation data for the same recurrence intervals show that this curve presents slightly lower values for Addis-Ababa. A better fitting might have been obtained with a truncated log-normal law.

By using the depths of rainfall observed during 25 years at Addis-Ababa, the following results are achieved :

Annual daily rainfall	45,6 mm
once in two years	53,0 mm
once in five years	60,8 mm
once in ten years	72,6 mm

We will adopt these data.

In order to evolve the meaning of these results compared to those concerning the basin in general, the maximal rainfall recording were used for 15 stations of the basin corresponding to 12 to 22 observation years. These rainfall depths are presented in table 2.15 and the reference period is also mentioned. These data are only for guidance as many gaps exist and the values observed are probably often lower than the real maximal rainfall for the same period.

It may be noted, after considering the data presented in the table and the observation periods, that the daily rainfall for a determined recurrence interval tends to increase from the West to the East of the Basin.

The stations on the High Plateaus of Arussi and Bale present smaller daily rainfall depths than at the stations of the Chercher plateaus and of zones IV and V.

In a first approximate estimate, it seems that the daily rainfall data for a given recurrence interval obtained at Addis Ababa may roughly be applied to the High Plateaus of Arussi and Bale (zones I and III and Western part of zone II), and that the daily rainfall depths for Jijiga may be considered as valid for the rest of the basin.

2.8.4 Rainfall 1969 to 1972

Tables 2.16, 2.17 and 2.18 sum up the observations made at the rain-gauge stations of the Project during the three water-years : 1969 - 1970, 1970 - 1971 and 1971 - 1922 : a water-year stretching from February to January. For these tables, the stations are classified according to the areas presenting homogeneous rainfall such as has been previously described.

These observations enable to draw annual isohyets for the three years (maps IV, V and VI added to this report). From these isohyets the mean annual rainfall was computed for each basin. The results are given in table 2.19.

The lack of serious information concerning annual rainfall does not allow characterizing the rainfall of these three water-years compared to the long-term average rainfall.

Comparing these three water years to one another brings out the following qualitative features :

- Rainfall for 1969 - 1970 and 1970 - 1971 is comparable.
- Rainfall for 1971 - 1972 is less (10 per cent) than during the first two water-years.
- The dry season of the 1970 - 1971 water-year was very pronounced throughout the basins and lasted approximately four whole months.

TABLE 2.15

Maximal rainfall for a 24 hours period

Station	Maximal daily rainfall in mm	Observation periods (gaps included)	Annual total of years
Zone II			
KOFELE	58,0	1955-1970	14
SIRE	76,0	1953-1968	15
ASSELA	80,0	1958-1970	11
GOBA	56,2	1953-1971	17
GELEMSO	116	1953-1971	14
DEDER	98,0	1952-1970	15
Zone III			
ADABA	100	1956-1971	13
DODOLA	55,0	1954-1966	13
Zone IV			
HARAR	100	1923-1940 1955-1970	22
DIRE-DAWA	73,0	1952-1971	20
JIJIGA	105	1952-1971	20
FUGNANBIRA	117	1954-1971	16
Zone V			
DEGAHBOUR	89,0	1954-1971	13
KEBRI-DAHAR	90,0	1957-1971	13
KELAFO	54,0	1954-1971	12

TABLE 2.16

Monthly and annual rainfall (in mm)

Water-year : 1969-1970

zone	Station	F	M	A	M	J	J	A	S	O	N	D	J	Annual total R.
I	BOKOJI	126,5	119,2	83,7	47,6	142,9	251,0	351,9	91,3	24,6	15,6	0,3	136,8	1 391,4
	TICHO	424,2	334,4	164,6	78,1	108,8	151,4	131,6	95,2	36,4	53,6	0	202,6	1 780,9
	GOBESSA	256,8	305,1	156,5	59,8	73,2	135,5	162,9	93,7	46,0	52,7	0	195,2	1 537,4
	AGAFRA	126,7	108,9	98,6	87,2	62,6	124,4	82,2	93,5	22,1	76,8	0	143,4	1 026,4
	CARA-BIROLE													(1 350)
	STELLA-UGUE													(1 600)
	GOLOLCHA	191,2	98,7	231,5	161,2	164,5	237,7	117,9	93,9	17,7			85,5	(1 400)
II	IBANO	157,9	123,2	127,6	188,1		(127,1)	115,2	81,3	58,7	94,1	14,9	198,9	(1 400)
	KORE	142,6	168,0	95,1	34,7	79,8	217,5	155,0	174,4	48,6	26,5	8,3	63,6	1 214,1
	MERARO	117,9	79,9	105,5	44,7	77,5	161,4	210,6	111,2	12,4	15,2	0	84,1	1 020,4
	INDETU	123,9	78,9	126,6	143,6	60,1	145,0	110,4	62,7	11,9	38,7	0	85,5	987,3
	SADIKA	90,0	109,2	127,9	97,6	64,6	138,4	120,8	83,9	15,5	58,5	0	11,3	917,7
	SERU	252,9	109,7	143,7	200,4	77,0	105,8	57,4	156,1	40,8	58,5	0	125,0	1 327,3
	ROBI	206,4	122,7	101,7	92,3	133,1	123,8	131,6	102,2	17,4	36,4	0	113,3	1 180,9
	GASSARA	71,3	94,9	127,6	146,0	156,1	73,2	75,0	123,8	59,3	47,5	0	72,2	1 046,9
	SEBRE-DOLLO	136,9	88,0	153,9	184,4	88,8	56,2	51,2	178,2	76,1	62,9	1,3	75,7	1 153,6
	GINIR	125,2	70,5	92,1	121,8	29,0	5,2	5,9	62,8	134,8	109,5	0	123,7	881,0
	DJARA	57,8	58,9	131,4	155,9	43,3	53,5	28,5	115,0	49,3	0	38,5	83,8	815,9
	MECHARA	116,6	115,6	102,5	139,9	102,8	110,5	84,6	106,5	25,3	26,3	0	157,1	1 087,7
	GELEMSO	129,5	71,8	139,5	176,9	47,2	175,4	102,4	131,5	22,5	8,0	0	148,2	1 152,9
	BEDESSA	131,1	141,4	131,3	184,4	71,4	185,4	118,5	79,1	26,0	21,8	0	32,3	1 122,7
	HIRNA	43,0	84,9	88,6	74,8	47,7	124,2	198,1	234,9	2,5	0	0,5	15,7	914,9
	BURKA				56,8	94,7	32,5	68,9	46,3	63,2	20,3	0	3,0	
	DEDER	90,0	87,5	100,8	131,7	39,7	170,6	244,2	73,4	35,5	0	0	58,0	1 031,4
	BEDENO	73,8	91,5	215,1	74,3	157,2	72,3	193,7	99,8	47,3	6,0	1,6	59,5	1 092,1
	GIRAWA	121,2	91,9	112,7	74,3	85,2	132,3	230,5	51,3	29,2	10,2	0	72,7	1 011,5

TABLE 2.16

Monthly and annual rainfall (in mm)

Water-year : 1969-70

Zone	Station	F	M	A	M	J	J	A	S	O	N	D	J	Annual Total R.
III	ASSASSA	130,3	35,3	31,8	25,9	59,4	192,7	161,7	29,3	8,1	1,7	11,5	102,8	790,4
	ADABA	4,2	26,8	97,3	45,1	58,7	162,7	155,7	60,8	8,4	7,9	1,1	105,4	734,1
IV	SHEK-HUSSIEN	113,8	69,7	101,9	146,1	91,9	21,9	20,5	46,0	27,2	43,3	0	77,0	759,3
	COMBOLCHA	85,5	35,4	89,8	53,7	68,2	87,6	150,5	83,7	9,4	14,1	0	71,7	749,6
	HARAR		76,4	96,8	54,6	42,8	87,5	131,4	82,7	9,0	11,2	0	71,5	(664)
	BABILE	106,9	32,8	76,5	36,0	124,0	92,0	124,0	91,0	14,0	0	0	40,0	737,2
	FADIS	145,7	78,8	116,5	102,1	44,2	51,6	105,3	45,2	14,7	9,0	0	84,4	797,5
	JIJIGA	69,8	48,5	83,3	49,3	45,9	85,1	59,5	18,2	14,0	6,5	0	28,2	508,3
	FUGNANBIRA	141,5	20,8	25,6	28,8	97,8	64,7	101,3	69,4	0,6	2,0	73,2	37,3	663,0
	MEDAGALOLA	76,4	65,3	54,6	103,9	70,3	55,5	55,7	79,8	57,3	49,5	0	96,3	764,6
	KEBRI-BEYAH	80,0	14,0	38,2	61,5	37,3	23,9	69,3	64,3	35,7	0	5,2	55,8	485,2
V	FIK	89,5	51,7	100,5	137,8	100,5	5,4	0	15,6	104,8	24,7	0	43,1	673,6
	DEGAHBOUR	67,9	41,0	12,4	46,1	0	0	0	31,8	5,0		0	0	
	DEGAH-MEDO	69,4	10,2	28,1	80,8	4,0	0	3,8	28,0	39,0	56,7	0	21,5	341,5
	SEGEG	24,9	37,4	19,4	83,2	0	0	0	14,0	0	86,9	0	28,0	293,8
	DUHUN					0,4	0	0	22,8	44,5	44,9	0	15,5	
	HAMERO-HEDAD	35,1	20,5	20,1	60,4	5,5	2,3	0	10,4	41,8	7,8	0	32,9	236,8
	IMI	3,4	29,9	3,4	34,7	0	0	0	0	30,4	38,5	0	6,2	146,5
	DANAN	8,6	37,7	14,0	35,8	6,9	0	0	0,2	17,7	18,7	0	0,3	139,9
	KEBRI-DAHAR	21,0	21,6	0	166,6	0	0	0	0	64,0	134,4	0	14,5	422,1
	GODE	4,2	26,8	23,8	57,4	2,7	0	0	0	112,1	32,8	0	0	259,8
	KELAFO	0	17,0	0	74,1	5,2	0	0	0	89,5	64,2	0	0	250,0
	MUSTAHIL	5,6	20,2	26,4	109,5	0,3	0	0	17,2	81,3	53,0	0	0	313,5
	FERFER	0	3,7	18,0	22,6	0,8	0	0	2,4	101,8	21,6	0	0	170,9

TABLE 2.17

Monthly and annual rainfall (in mm)

Water-year : 1970-1971

Zone	Station	F	M	A	M	J	J	A	S	O	N	D	J	Annual Total R
I	BOKOJI	169,7	144,5	143,5	61,3	114,1	221,9	255,6	130,9	147,2	1,2	40,3	28,9	1 459,1
	TICHO	54,4	353,9	129,4	102,4	48,2	214,9	237,9	204,7	129,0	0	22,3	12,2	1 509,3
	GOBESSA	60,7	236,6	144,8	61,4	37,5	169,4	263,5	134,4	170,8	0	0	12,0	1 318,1
	AGAFRA	0	167,1	193,7	98,5	35,7	112,6	131,8	95,5	176,8	0	8,8	3,1	1 024,1
	CARA-BIROLE													(1 230)
	STELLA-UGUE													(1 040)
	GOLOLCHA	76,5	233,2	290,5	20,5	85,0	188,2	78,5	165,9	86,7	0	0		(1 225,0)
II	IBANO	66,0	191,4	153,8	121,2	93,9	121,3	215,2	170,1	119,2	10,0	1,0	60,0	1 323,1
	KORE	26,0	219,1	99,0	74,3	30,7	176,3	245,7	145,0	177,3	15,4	0	0	1 208,8
	MERARO	46,9	111,6	136,9	29,0	41,1	154,0	128,9	79,1	37,3	0	0	8,7	773,5
	INDETU	18,0	195,3	166,2	52,9	53,1	175,4	177,3	160,9	89,9	0	0	0	1 089,0
	SADIKA	83,1	136,2	31,3	63,1	3,0	182,4	296,0	132,8	48,1	0	0	1,0	977,0
	SERU	26,8	350,3	135,7	54,2	15,3	126,9	226,6	184,0	127,6	8,1	0	0	1 235,5
	ROBI	16,2	206,4	113,9	65,0	47,1	238,9	240,6	72,2	65,2	0	3,2	0	1 068,7
	GASSARA	0	220,4	155,2	82,7	15,9	84,8	116,4	59,0	166,0	35,7	0	0	900,4
	SEBRE-DOLLO	19,3	192,1	211,5	67,3	56,1	53,4	110,9	119,9	205,8	0,1	0	0	1 036,4
	GINIR	6,4	161,7	202,8	144,1	21,8	18,5	40,3	155,7	253,5	5,1	0	0	1 009,9
	DJARA	12,1	157,5	90,8	126,7	15,2	42,9	81,1	130,9	138,5	12,0	0	0	807,7
	MECHARA	7,9	393,7	82,6	70,3	77,3	165,9	160,9	118,4	35,4	0	0	0	1 112,4
	GELEMSO	5,5	163,0	68,0	98,1	23,7	208,9	246,1	177,3	78,6	0	0	0	1 069,2
	BEDESSA	37,3	60,2	21,0	28,8	23,5	156,4	247,0	130,2	57,3	0	0	0	761,7
	HIRNA	38,5	220,6	54,6	20,4	51,0	229,3	194,1	164,8	21,4	0	0	0	994,7
	BURKA	7,4	92,5	89,9	67,7	37,3	35,8	88,8	161,1	111,5	0	0	0	692,0
	DEDER	109,3	101,4	107,4	19,1	29,3	151,3	289,8	183,7	2,6	0	0	0	993,9
	BEDENO	11,5	93,8	75,9	29,1	15,8	154,2	160,9	147,0	39,0	0	0	0	727,2
	GIRAWA	38,5	146,6	135,2	61,6	18,4	108,4	291,1	133,8	60,7	0	0	0	994,3

TABLE 2.17

Monthly and annual rainfall (in mm)

Water-year : 1970-1971

Zone	Station	F	M	A	M	J	J	A	S	O	N	D	J	Annual Total R
III	ASSASSA	43,9	72,4	68,7	23,4	61,1	122,3	185,5	90,7	28,8	0	26,1	24,1	747,0
	ADABA	49,2	130,3	20,2	23,1	60,1	234,1	247,8	87,1	27,0	0	7,9	23,4	910,2
IV	SHEK-HUSSIEN	40,7	131,0	65,0	92,9	29,4	53,4	50,2	89,9	91,7	0	0	0	644,2
	COMBOLCHA	19,9	101,0	71,6	64,0	30,2	117,2	201,6	126,2	13,0	0	0	0	744,7
	HARAR	12,9	109,4	122,0	42,9	13,7	62,2	153,3	133,6	92,1	0	0	0	742,1
	BABILE	17,0	27,0	16,0	62,0	11,0	165,2	134,7	59,8	87,8	0	0	0	580,7
	FADIS	39,9	67,8	95,0	49,6	68,1	96,5	175,0	166,8	42,6	0	0	0	801,3
	JIJIGA	0	87,5	33,0	14,0	3,3	39,7	114,2	113,1	0	0	0	0	404,8
	FUGNANBIRA													
	MEDAGALOLA	26,7	104,4	58,0	55,6	37,9	71,4	60,2	133,5	140,2	0	0	0	687,9
	KEBRI-BEYAH	24,9	123,2	24,7	100,4	28,3	58,3	77,9	121,0	31,4	0	0	0	590,1
V	FIK	8,8	95,9	108,6	83,5	41,3	24,2	3,0	79,6	119,3	0	0	0	564,2
	DEGAHBOUR	0,2	46,0	100,7	45,9	28,7	0	7,7	21,7	95,2	0	0	0	346,1
	DEGAH-MEDO	0	96,5	75,3	25,5	17,7	2,1	2,9	94,4	116,7	0	0	0	431,1
	SEGEG	8,7	145,9	96,5	23,1	10,1	0	1,3	51,5	50,4	0	0	0	387,5
	DUHUN	0	62,3	166,8	69,5	0	0	0	20,6	59,4	0	0	0	378,6
	HAMERO-HEDAD	1,9	113,6	111,3	76,3	5,9	0	0,7	33,7	34,6	0	0	0	378,0
	IMI	0	20,2	56,0	71,4	0	0	0	5,2	90,3	0	0	0	243,1
	DANAN	0	52,3	162,4	5,5	0	0	0	0	136,9	0	0	0	357,1
	KEBRI-DAHAR	0	3,0	172,2	6,7	0	0	0	28,4	77,2	0	0	0	287,5
	GODE	0	50,7	150,7	34,6	0	0	0	0,8	54,7	0	0	0	291,5
	KELAFO	0	0	150,8	11,3	0	0	0	0	51,4	5,7	0	0	219,2
	MUSTAHIL	0	8,5	83,4	25,4	0	0	0	2,2	15,8	1,7	0	0	137,0
	FERFER	0	4,0	122,7	34,3	0	0,1	0,5	0	51,7	2,4	0	0	215,7

TABLE 2.18

Monthly and annual rainfall (in mm)

Water-year : 1971-1972

Zone	Station	F	M	A	M	J	J	A	S	O	N	D	J	Annual Total R.
I	BOKOJI	0	140,0	58,7	76,6	178,1	242,3	372,7	78,4	78,4	15,6	13,7	21,2	1 275,7
	TICHO	1,4	85,1	184,5	173,9	120,3	181,3	150,3	97,5	100,3	111,2	36,4	5,6	1 247,8
	GOBESSA	5,4	79,0	283,3	146,4	82,0	126,3	273,4	102,4	142,7	94,1	12,7	0	1 302,7
	AGAFRA	11,8	35,7	105,4	109,7	61,3	86,8	172,2	63,3	167,8	41,7	40,1	1,4	897,2
	CARA-BIROLE													
	STELLA-UGUE													
	GOLOLCHA	0	93,6	123,5	216,0	229,7	139,1	102,9	43,0	116,5	93,0			
II	IBANO	23,9	159,6	150,0	186,4	107,1	232,2	206,1	135,3	160,8	130,2	63,8	67,1	1 622,5
	KORE	36,4	145,7	111,2	71,9	92,0	171,8	149,8	157,0	154,0	47,5	22,8	22,7	1 182,8
	MERARO	29,7	36,9	95,3	90,5	136,6	168,3	103,5	94,2	49,4	(6,9)	(28,4)	9,0	(848,7)
	INDETU	0	83,5	133,3	111,7	94,6	53,3	199,5	66,2	35,0	(59,3)			
	SADIKA	0	59,7	83,4	125,6	107,0	106,6	198,6	74,4	81,7	52,3	2,2	0	891,5
	SERU	0	45,7	112,2	112,7	219,8	49,7	124,8	34,9	144,5	159,2	0	15,5	1 019,0
	ROBI	0	62,6	172,2	157,5	137,8	129,7	123,7	72,5	45,1	31,0	21,2	8,1	961,4
	GASSARA	10,5	94,9	204,2	164,7	121,7	90,3	147,3	76,6	180,6	71,5	0	2,2	1 164,5
	SEBRE-DOLLO	0,5	96,3	111,5	118,5	126,6	35,8	175,3	63,2	139,0	80,8	0	7,0	1 054,5
	GINIR	10,3	67,1	135,3	189,5	14,6	0	69,3	117,1	206,4	130,5	3,4	23,4	966,9
	DJARA	0	56,9	88,0	62,6	130,9	20,3	124,1	89,8	123,2	95,8	0,8	0	792,4
	MECHARA	0	107,3	112,7	153,1	151,8	186,4	193,2	53,7	107,7	71,4	21,0	0	1 158,3
	GELEMSO	0	48,7	144,0	145,6	78,9	264,0	271,6	54,4	62,1	83,8	0	0	1 153,1
	BEDESSA	0	33,5	189,8	124,5	118,0	84,2	270,0	97,0	71,0	74,0	8,0	6,3	1 076,3
	HIRNA	0	49,6	70,6	145,7	50,9	89,5	239,0	124,1	5,4	40,1	2,8	2,3	820,0
	BURKA	0	13,4	90,7	177,6	84,9	70,2	87,6	98,3	77,9	25,3	1,2	0	(727,1)
	DEDER	1,5	73,6	152,6	151,0	74,7	174,2	289,1	145,9	2,2	48,9	0	4,6	1 118,3
	BEDENO	0	76,0	33,8	240,5	121,7	99,5	220,8	201,2	73,1		17,4	28,3	(1 112)
	GIRAWA	0	34,2	79,7	225,1	108,2	98,1	181,8	57,7	38,1	35,3	17,1	18,6	893,9

TABLE 2.18

Monthly and annual rainfall (in mm)

Water-year : 1971-1972

Zone	Station	F	M	A	M	J	J	A	S	O	N	D	J	Annual Total R
III	ASSASSA	0,9	20,1	57,4	67,0	127,1	160,3	297,2	90,4	24,4	1,3	21,1	0,3	867,5
	ADABA	0,8	62,4	74,0	95,9	(100)	137,2	144,5	79,8	19,2	10,2	15,7	0	(739,7)
II	SHEK HUSSIEN	0	72,3	65,1	134,4	51,2	35,2	132,6	17,5	49,9	110,5	0	0	668,7
	COMBOLCHA	0	14,9	129,3	80,9	49,3	122,0	94,2	86,8	30,0	(64,4)	11,7	38,5	(722,0)
	HARAR	0	32,2	80,8	152,1	77,0	166,0	127,6	109,1	65,3	57,4	4,2	16,5	888,2
	BABILE	0	59,4	117,6	104,9	90,0	138,8	59,5	87,0	68,3		2,0	2,0	
	FADIS	0	47,4	43,2	142,9	40,2	105,5	194,2	60,3	97,3	13,0	4,0	3,7	751,7
	JIJIGA	0	47,7	121,3	118,3	7,6	57,0	139,4	149,2	33,5	33,9	5,2	0	713,1
	FUGNANBIRA													
	MEDAGALOLA	0	46,6	33,3	(57,7)		(42,1)	61,6	52,8	31,7	16,3	6,5		
	KEBRI-BEYAH	0	39,7	115,1	(158,8)	87,0	50,8	59,3	88,0	58,1	28,0	2,1	7,3	694,2
V	FIK	0	63,7	68,7	113,1	58,3	0,2	24,8	(5,5)	60,5	43,5	6,2	57,2	(501,7)
	DEGAHBOUR	0	6,6	61,7	116,3	14,1	0	29,2	24,2	80,7	30,6	0	0	363,4
	DEGAH-MEDO	0	32,9	20,5	73,6	30,8	0	0	69,2	56,2	57,6	0	5,7	346,3
	SEGEG	0	23,3	92,4	83,7	9,0	0	2,7	17,8	72,5	23,2	0	0	324,6
	DUHUN	0	11,3	65,9	184,3	6,6	0	0	9,2	132,1	70,1	0	0	479,5
	HAMERO-HEDAD	0	35,8	37,0	132,0	19,9	0	9,9	18,5	63,0	23,0	3,2	0	342,3
	IMI	0	10,6	17,7	27,8	0	0	0	0	50,7	20,5	0	0	127,3
	DANAN	0	0	39,3	34,0	0	0	0	0	39,5	21,3	0	0	134,1
	KEBRI-DAHAR	0	0,7	127,0	43,2	0	0	0	0	58,0	33,0	0	0	261,9
	GODE	0	2,6	10,3	152,8	0	0	0	0	112,3	13,5	0	0	291,5
	KELAFO													
	MUSTAHIL	0	30,2	131,0	120,9	0	0	0	3,4	111,6	30,0	0	0	427,1
	FERFER	0	0	16,2	33,2	6,1	7,0	0	0	68,3	34,9	0	0	165,7

TABLE 2.19

Mean annual rainfall for each drainage basin

Basin	Station	Mean annual depth of rainfall (in mm)		
		1969-1970	1970-1971	1971-1972
WABI SHEBELLE	DODOLA	1 225	1 100	1 160
-"-	MALKA-WAKANA	1 075	965	1 040
-"-	LEGE-HIDA	1 075	1 025	910
-"-	HAMERO-HEDAD	900	800	800
-"-	IMI	700	690	690
-"-	GODE	590	600	580
-"-	KELAFO	550	550	500
-"-	BURKUR	530	535	470
ERRER	HAMERO-HEDAD	780	670	650
DAKETA	HAMERO-HEDAD	490	460	410
JERER	DEGAHBOUR	465	475	640
FAFEN	KEBRI-DAHAR	415	390	380

S E C O N D   P A R T

HYDROLOGICAL OBSERVATION DATA.

CHAPTER III

HYDROMETRIC INSTALLATIONS AND MEASUREMENTS

Before 1967 the hydrometric equipment of the basin only consisted of a staff gauge at KELAFO bridge in the Lower Valley. The observations made on the staff gauge were limited to weekly recordings from 1957 to 1959. Three measurements of middle flow were made at this station by the Yugoslav "Elektro-project".

In 1967 before the arrival of the French Mission for the study of the Wabi Shebelle, the Water-Ressources Department placed thirty-two staff-gauges in the upper basin and one staff-gauge in the Lower Valley at Gode, but the latter was never observed.

Most of the staff-gauges of the upper basin being of a small size and located at the outlet of the basins consequently present but small import. Nonetheless, four of these are used for the general survey of the basin.

The Wabi Shebelle Project began the first installations during the second half-year 1967 and these were continued until the beginning of 1969.

17 hydrometric stations have been installed, 9 of them being equipped with water-level recorders. In 14 of the stations discharge measurements have been carried out.

On map II (separate map) the hydrometric stations are indicated as well as the limits of the basins they control.

The next paragraphs present a list of the operating hydrometric stations and their main characteristics. For each station, the following informations are given, i.e :

a) Surface of the controlled basin. These surfaces were obtained through planimetric base maps at 1/250 000 drafted by the project. Through the limits of the basins cannot be determined accurately owing to the lack of altimetric informations, these documents were used rather than the maps of the War Office, the latter being scarcely reliable as regards planimetry and altimetry. Despite this inconvenient, the relative error concerning areas should not exceed 5 per cent. It may be noted that downstream from Imi, the really active areas of the catchment basins are smaller than the mentioned areas owing to runoff of endhoreic type on the gypsum formations.

b) Geographical setting of the basin controlled by the station, specific hydrographic features and nature of flow.

c) Location and history of the station.

d) Presentation and critical examination of the water-level recordings.

For the present survey we have used all the records existent since the station was installed and until January 1972 as this month corresponds to the end of the 1971-1972 water-year. Recording is of course still proceeding at all the stations but, taking into account the time required for drafting, we were compelled to fix this time-limit.

e) Calibration of the station with the list of the discharge measurements and the corresponding rating curves.

In order to convert automatically depths into discharge data by computer-processing and using the transformation programs (P Ø H 301,327 and 310) of the Central Hydrological Office of ORSTOM, the rating curves were put down in equations and for this purpose were cut into sections of general equation parabolas :

$$Q = C_{(1,L)} (H - L)^2 + C_{(2,L)} (H - L) + C_{(3,L)}$$

in which :

Q = is the discharge in m3/s for the height H
L = is the lower limit (in meters) of the parabola segment
H = is any height on the parabola segment

$C_{(1,L)}$, $C_{(2,L)}$ and $C_{(3,L)}$ = are the coefficients of the parabola section, these coefficients being computer-processed (P Ø H 301)

The results are presented in tables, each line of the table giving the equation parameters of a parabola segment.

The first column gives the lower limit of the segments and the three following columns, the equation coefficients of the parabola segment. Code "E" is a form of writing of power 10 (for instance 0,003 E 02 means $0,003.10^2$ or 0,3).

3.1. The basin of the Wabi Shebelle

The hydrometric network includes eight stations on the Wabi Shebelle and four stations on the tributaries.

Four of eight stations of the Wabi Shebelle are located in the upper basin and four in the alluvial plain generally called the Lower Valley.

3.1.1. The Wabi Shebelle at the Bridge-Road of Dodola (1260 km^2)

The first station of the Wabi Shebelle is located at the entrance of the river into the Guedeb plain. The relief of the basin is very pronouced and the stream-flow is permanent owing to numerous springs rising from thick ash layers.

The station is located at approximately 500 m dowstream from the bridge of the Shaslemane-Dodola road and its coordinates are : 6° 59' N and 29° 03' E.Altitude is approximately 2 500 meters.

The station consists of four metric staff units and was installed on January 30. 1967 and has not been modified. From 30.1.1967 to 31.1.1971 recordings of water-level were made interruptedly twice a day.

Rating

The station is equipped with a fixed cable allowing high flow measurements.

Rating was carried out using eighteen gaugings distributed between elevations 0,52 and 1,12 m, the minimum and maximum flows observed being respectively 0,54m and 2,80 m.

The eighteen measurements made between 1967 and 1971 enabled plotting a univocal curve (graph II 1) revealing the stable character of the station which is located on rocky outcroppings.

For high flow, extrapolation was necessary. The latter resulted from the extrapolation of the sections of the flow and mean velocities measured at the same time as discharges, these measurements being often carried out at different sites. The Manning-Strickler formula for stream flow was used. This formula enables estimating the discharges above 1,20 m with an accuracy of approximately ± 20 per cent.

The extrapolation of the curve gives the following results :

H = 1,50 m   Q = 28,0 m3/s

H = 2,00 m   Q = 53,0 m3/s

H = 2,50 m   Q = 54,0 m3/s

H = 3,00 m   Q =123,0 m3/s

The coefficients of calibration equations are, as follows :

L (m)	C (1,L)	C (2,L)	C(3,L)
0.50	0.1555556 E + 02	0.1199999 E + 02	0.6000000 E + 00
0.80	0.1000007 E + 02	0.2199997 E + 02	0.5600000 E + 01
1.20	0.2500064 E + 02	0.3249977 E + 02	0.1600000 E + 02
1.50	0.1666650 E + 02	0.4166675 E + 02	0.2800000 E + 02
2.00	0.1600000 E + 02	0.5400000 E + 02	0.5300000 E + 02
2.50	0.2222072 E + 02	0.6666705 E + 02	0.8400000 E + 02
2.80			

Table 3.1

List of measurements of the WABI SHEBELLE AT DODOLA

N°	Date	Height (m)	Discharge (m^3/s)	N°	Date	Height (m)	Discharge (m^3/s)
1	12- 7-1967	1.04	10.4	10	77- 4-1969	0.82-0.81	5.80
2	10-11-1967	0.83	6.43	11	6- 5-1969	0.70-0.70	3.30
3	31- 1-1968	0.56	1.54	12	10- 5-1969	0.98-1.05	11.3
4	26- 5-1968	0.73-0.75	4.58	13	4- 6-1969	0.73-0.72	4.02
5	27- 6-1968	0.96-0.99	9.90	14	7- 6-1969	0.72	4.02
6	21-11-1968	0.60	2.19	15	18- 7-1969	1.12-1.11	13.8
7	28-11-1968	0.58	1.90	16	9-10-1969	0.76	5.26
8	27-12-1968	0.56-0.55	1.27	17	22-10-1969	0.66-0.66	2.95
9	25- 2-1969	I.12	13.4	18	8- 3-1971	0.54	0.84

3.1.2. The Wabi Shebelle at Malka-Wakana

This hydrometric station was installed in order to know the regime of flow at the Malka-Wakana falls which is a suitable site for an electric dam. The basin controlled by the station receives many permanent tributaries, the biggest originating from the Kakka mountains in the North and from the Arena mountains in the South (Maribo).

The station is located at approximately one kilometer upstream from the first fall and its coordinates are 7° 13' N and 39° 24' E. The approximate elevation of the station is 2 485 m.

A first staff-gauge (with recordings twice a day) was installed on the 22nd of July 1967 and includes four metric units. A weekly water-level recorder was installed on January 6. 1968 at approximately 200 m downstream from the first staff-gauge. This water-level recorder is completed with a staff-gauge with four metric units. The evaluation of the zero of the scale is placed at 4,217 m below the bench mark. The correspondence between the first staff-gauge and the water-level recorder was obtained by reading both scales simultaneously. All the water-level recordings anterior to January 6. 1968 have been related to the new staff-gauge of the water-level recorder.

From July 22. 1967 to January 5. 1968 recordings were made twice a day since January 6. 1968 ; water-level automatic recordings are available. The very few gaps in the automatic recording during the first quarter 1968 were filled

WABI SHEBELLE AT BRIDGE ROAD OF DODOLA

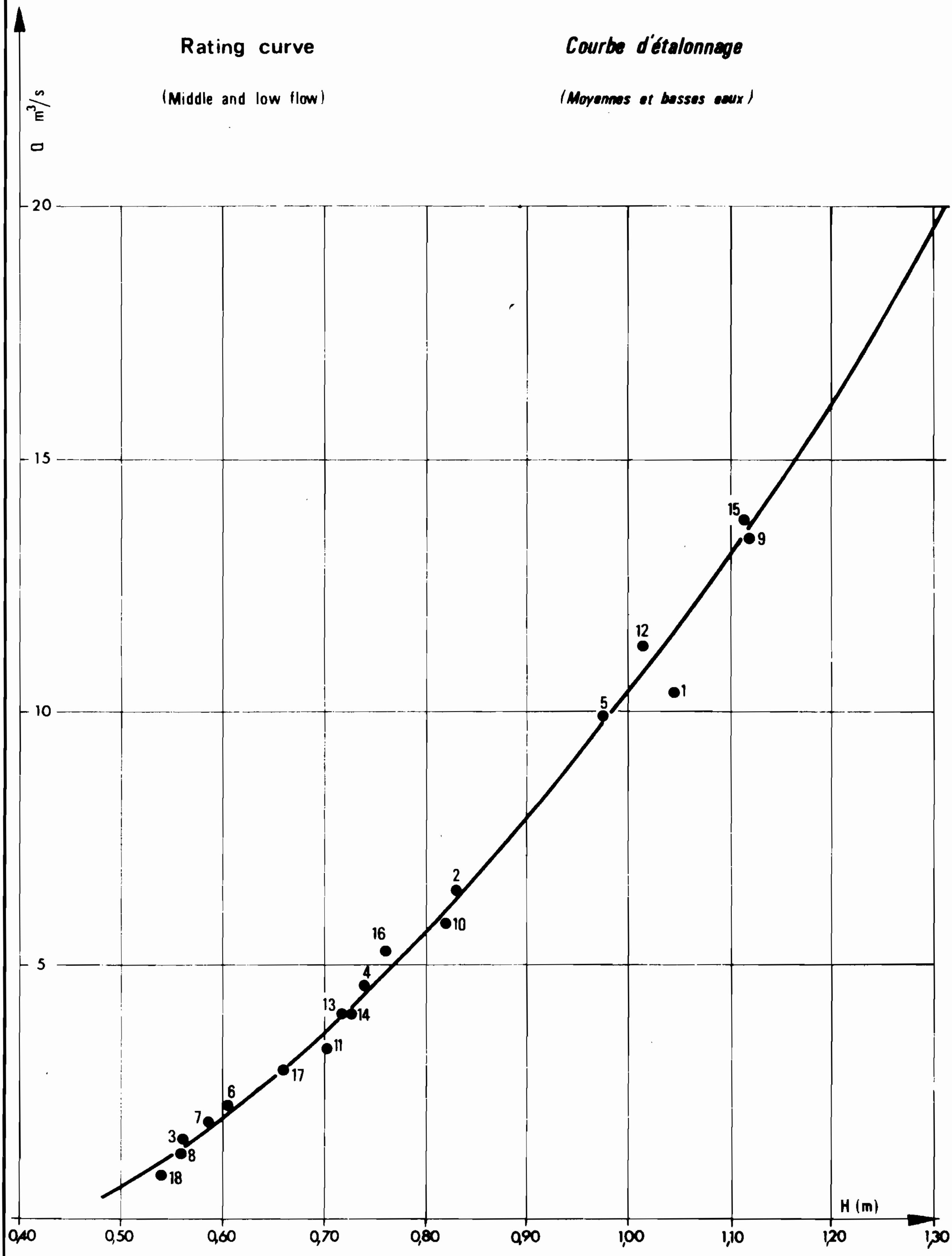
WABI SHEBELLE AU PONT-ROUTE DE DODOLA

Rating curve

(Middle and low flow)

Courbe d'étalonnage

(Moyennes et basses eaux)



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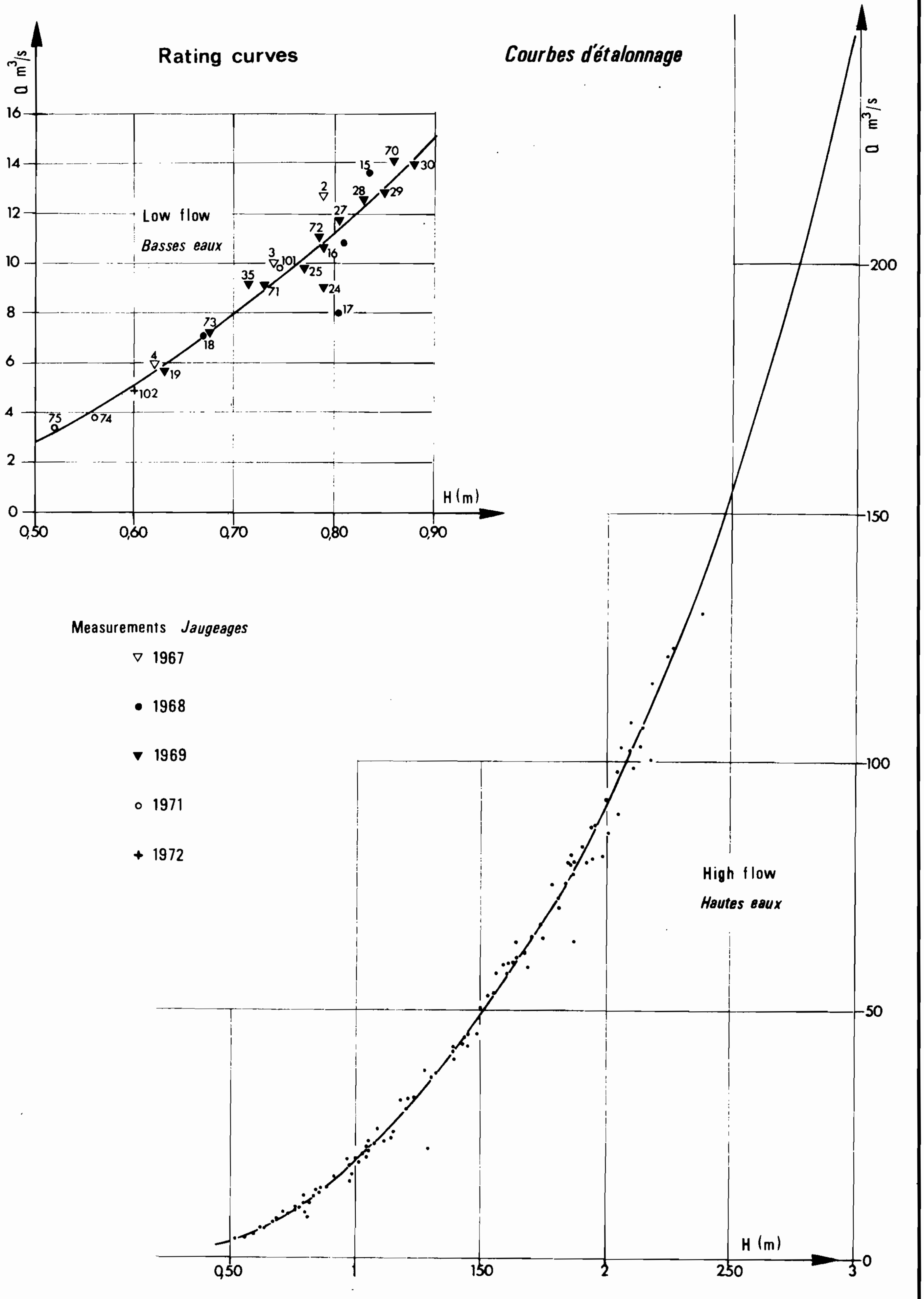
Gr-III-2

WABI SHEBELLE AT MALKA-WAKANA



in by reading the scales. Finally, complete recordings are available for the whole survey-period.

Rating

The station has a rocky base and its position just above the first rapids of Malka-Wakana warrants its stable character.

A fixed cable makes high flow measurements possible.

The univocal rating curve was drawn from 102 gaugings distributed between elevation 0,52 and 2,40 m (graph III 2). The maximal and minimal elevations recorded during the survey-period are respectively 2,89 m and 0,50 m. The necessary extrapolation in order to know the maximum high flow was obtained from the relation height/section of the flow and from the extrapolation of the mean velocity curve.

The discharges of elevations above 2,40 m are known within ± 10 per cent.

The coefficients of rating equations are as follows :

L (m)	C (1,L)	C (2,L)	C (3,L)
0.50	0.2399973 E 02	0.2080003 E 02	0.2799999 E 01
0.60	0.1600006 E 02	0.2719998 E 02	0.5120000 E 01
0.80	0.3499997 E 02	0.3449998 E 02	0.1120000 E 02
1.00	0.2800000 E 02	0.4500000 E 02	0.1950000 E 02
1.50	0.3600000 E 02	0.6700000 E 02	0.4900000 E 02
2.00	0.5200000 E 02	0.1010000 E 03	0.9150000 E 02
2.50	0.8750021 E 02	0.1525001 E 03	0.1550000 E 03
2.90			

Table 3.2

List of measurements of the Wabi Shebelle at Malka Wacana

N°	Date	Height (m)	Discharge (m^3/s)	N°	Date	Height (m)	Discharge (m3/s)
1	6- 7-1967	1.15	25.5	16	18-10-1968	0.81	10.7
2	25-10-1967	0.78	12.7	17	19-11-1968	0.81-0.80	13.4
3	5-11-1967	0.74	10.0	18	4-12-1968	0.67	7.10
4	2- 1-1968	0.61	5.90	19	23- 1-1969	0.63	5.70
5	6- 6-1968	0.92	16.5	20	26- 3-1969	1.76	64.4
6	6- 9-1968	1.29	21.8	21	28- 3-1969	1.62-1.61	59.5
7	25- 9-1968	1.15	25.4	22	30- 3-1969	149	45.2
8	27- 9-1968	1.39	39.9	23	4- 4-1969	0.96-0.95	15.3
9	1-10-1968	1.42	43.0	24	16- 4-1969	0.79	9.00
10	3-10-1968	1.55-1.56	53.6	25	17- 4-1969	0.77	9.70
11	4-10-1968	1.40	42.2	26	19- 4-1969	0.79	10.8
12	7-10-1968	1.53	52.9	27	20- 4-1969	0.81-0.80	1.7
13	9-10-1968	1.28	97.9	28	21- 4-1969	0.83	12.5
14	12-10-1968	0.97-0.96	19.9	29	22- 4-1969	0.85	12.8
15	16-10-1968	0.84-0.83	13.6	30	25- 4-1969	0.88	14.0

Table 3.2.

List of measurements of the flow of the Wabi Shebelle at Malka Wacana

N°	Date	Height (m)	Discharge (m3/s)	N°	Date	Height (m)	Discharge (m3/s)
31	27- 4-1969	0.97	18.7	67	29- 9-1969	1.04-1.04	22.3
32	29- 4-1969	1.03-1.03	20.8	68	29- 9-1969	1.05-1.06	23.7
33	2- 5-1969	1.45-1.46	42.5	69	1-10-1969	1.08	23.2
34	13- 5-1969	1.15-1.14	24.0	70	13-10-1969	0.86	14.1
35	3- 6-1969	0.72	9.25	71	18-10-1969	0.73	9.10
36	9- 7-1969	0.99-0.98	16.8	72	20-10-1969	0.78	11.1
37	15- 7-1969	1.09-1.13	23.3	73	28-10-1969	0.67	7.20
38	27- 7-1969	1.79-1.83	70.4	74	10- 1-1971	0.56	3.80
39	28- 7-1969	2.17-2.19	100	75	8- 3-1971	0.52	3.40
40	29- 7-1969	2.06-2.04	89.6	76	20- 7-1971	2.00	92.8
41	30- 7-1969	1.99-1.98	81.0	77	21- 7-1971	1.73	67.3
42	31- 7-1969	2.11	98.8	78	21- 7-1971	1.67	61.5
43	5- 8-1969	2.01-2.00	85.9	79	22- 7-1971	1.56	57.4
44	6- 8-1969	1.92	79.5	80	22- 7-1971	1.63	63.7
45	12- 8-1969	1.87	63.7	81	26- 7-1971	1.50	50.4
46	13- 8-1969	1.94	80.6	82	28- 7-1971	1.60	57.0
47	15- 8-1969	1.70-1.68	58.6	83	29- 7-1971	1.80	72.6
48	20- 8-1969	1.85-1.82	75.7	84	30- 7-1971	1.85	81.3
49	22- 8-1969	2.24-2.25	121	85	3- 8-1971	1.45	45.3
50	23- 8-1969	2.40-2.35	130	86	5- 8-1971	2.13	103
51	23- 8-1969	2.28-2.25	123	87	7- 8-1971	1.95	87.7
52	27- 8-1969	1.86-1.86	79.8	88	7- 8-1971	2.06	103
53	1- 9-1969	1.78-1.77	75.4	89	8- 8-1971	2.10	108
54	2- 9-1969	1.59	58.9	90	9- 8-1971	1.90	83.2
55	13- 9-1969	1.95-1.94	86.8	91	15- 8-1971	2.18	116
56	14- 9-1969	1.85	79.2	92	17- 8-1971	2.04	98.0
57	15- 9-1969	1.87-1.86	77.4	93	19- 8-1971	2.09	102
58	16- 9-1969	1.63-1.62	59.6	94	22- 8-1971	2.14	107
59	17- 9-1969	1.44-1.43	44.5	95	29- 8-1971	2.22	122
60	20- 9-1969	1.31-1.30	36.8	96	8- 9-1971	1.84	79.8
61	21- 9-1969	1.20-1.21	29.9	97	9- 9-1971	1.70	65.0
62	23- 9-1969	1.18-1.17	31.8	98	15- 9-1971	1.39	41.5
63	24- 9-1969	1.21-1.21	32.0	99	16- 9-1971	1.32	37.4
64	25- 9-1969	1.23-1.22	32.2	100	29-10-1971	1.00	19.8
65	26- 9-1969	1.09	26.1	101	29-11-1971	0.74	9.90
66	28- 9-1969	1.00-0.99	20.2	102	13- 1-1972	0.60	4.46

3.1.3. THE WABI SHEBELLE AT LEGE HIDA (21 500 km^2)

This station is located approximately half way between Malka-Wacana and Hamero-Hedad and has provided information concerning flow conditions and inflows of the big tributaries issued from the most rainy regions of the high plateaus. In fact, between Malka-Wacana and Lege-Hida, the Wabi Shebelle receives the main tributaries : the ULUL, HADIDA, SIYANAN.

The station is located in deep gorges at approximately 15 km from the police camp of Beltu. Between this camp and the station the difference of level measured with an altimeter is 900 meters.

The coordinates of the station are 7°53'N and 40° S 4'E.

The installation of the water-level recorder was started in February 1978 but several different teams successively proceeded to the equipping work which ended in April 1968. The water-level recorder has a 6 months recording capacity and also includes a staff-gauge (6 meters long)

Unfortunately, owing to various reasons such as the defective functionning of the clock-work and the silting up of the head-race, the water-level recorder never operated in a normal way in 1968 and 1969. Besides, the remoteness of the station and the difficulties of access combined with the problem of finding an escort to protect the teams did not make frequent visits possible though the latter would have been necessary for the good running of the station.

In March 1970 in order to ameliorate the functionning of the water-level recorder, the latter was modified in various ways. An operator was trained to palliate the failures of the water-level recorder.

Since March 1970; the recordings present no more gaps.

RATING

The station is located on rocky outcroppings and should be stable. It is equipped with a Neyrpic cable way installed in January 9.1970 for high flow measurements.

One hundred and thirty gaugings, from elevation 0.34 to 3.89 m, allowed plotting a univocal rating curve (graph III.3) The maximal and minimal elevations observed are respectively 4.30 m and 0.28 m.

The rating curve was extrapolated from the relation height/section of the flow and the extrapolation of the mean-velocity curve. The discharge for elevations greater than 3.90 m are known within ± 10 per cent.

The coefficients of the rating equations are as follows , i.e :

L(m)	C (1,L)	C (2,L)	C (3,L)
0.25	0.9629640 E + 02	0.2422221 E + 02	0.4400000 E + 01
0.40	0.1047627 E + 03	0.4695227 E + 02	0.1020000 E + 02
0.55	0.9000066 E + 02	0.6899985 E + 02	0.1960001 E + 02
0.75	0.9866713 E + 02	0.1041332 E + 03	0.3700000 E + 02
1.00	0.7888866 E + 02	0.1123333 E + 03	0.6920000 E + 02
1.60	-0.9536769 E + 02	0.2000021 E + 03	0.1650000 E + 03
1.80	-0.5000940 E + 02	0.2050020 E + 03	0.2050000 E + 03
2.00	-0.8000000 E + 01	0.2020000 E + 03	0.2440000 E + 03
2.50	-0.4000000 E + 01	0.2060000 E + 03	0.3430000 E + 03
3.50	0.2499936 E + 02	0.1950005 E + 03	0.5450000 E + 03
4.30			

Table 3.3

List of measurements of the WABI SHEBELLE AT LEGE-HIDA

N°	Date	Height	Discharge	N°	Date	Height	Discharge
1	15- 1-1969	0.50	15.0	26	18-4-1970	1.73-1.76	192
2	16- 1-1969	0.51	17.5	27	18-4-1970	1.64-1.61	165
3	7- 1-1970	0.35	2.85*	28	19-4-1970	1.51-1.50	148
4	25- 3-1970	0.99-0.98	66.6	29	19-4-1970	1.48-1.47	141
5	27- 3-1970	1.04-1.04	71.1	30	20-4-1970	1.45-1.43	133
6	28- 3-1970	1.13-1.13	83.6	31	20-4-1970	1.40-1.38	122
7	29- 3-1970	1.08-1.08	75.8	32	20-4-1970	1.33-1.32	114
8	30- 3-1970	1.06-1.06	71.6	33	21-4-1970	1.33-1.33	115
9	31- 3-1970	0.95-0.95	59.3	34	21-4-1970	1.30-1.29	110
10	1- 4-1970	0.87-0.87	50.8	35	22-4-1970	1.49-1.41	136
11	3- 4-1970	0.81-0.81	42.2	36	23-4-1970	1.26-1.25	105
12	4- 4-1970	0.75-0.75	35.8	37	23-4-1970	1.26-1.26	105
13	6- 4-1970	0.92-0.93	58.7	38	24-4-1970	1.20-1.19	96.6
14	8- 4-1970	0.85-0.84	47.2	39	24-4-1970	1.15-1.15	83.5
15	10- 4-1970	0.96-0.94	62.2	40	25-4-1970	1.07-1.07	76.8
16	13- 4-1970	1.03-0.99	68.0	41	25-4-1970	1.12-1.11	81.2
17	14- 4-1970	1.27-1.26	104	42	26-4-1970	1.09-1.10	80.6
18	14- 4-1970	1.21-1.22	96.5	43	27-4-1970	1.27-1.28	108
19	15- 4-1970	1.31-1.37	119	44	27-4-1970	1.25-1.24	103
20	15- 4-1970	1.39-1.37	125	45	28-4-1970	1.24-1.23	102
21	15- 4-1970	1.42-1.42	129	46	29-4-1970	1.14-1.14	87.6
22	16- 4-1970	2.16-2.15	269	47	30-4-1970	1.02-1.01	70.3
23	16- 4-1970	2.02-2.04	233	48	30-4-1970	1.00-1.00	69.6
24	17- 4-1970	1.77-1.74	190	49	30-4-1970	0.99-0.99	67.9
25	17- 4-1970	1.80-1.80	195	50	1-5-1970	0.94-0.94	60.8

Float measurement

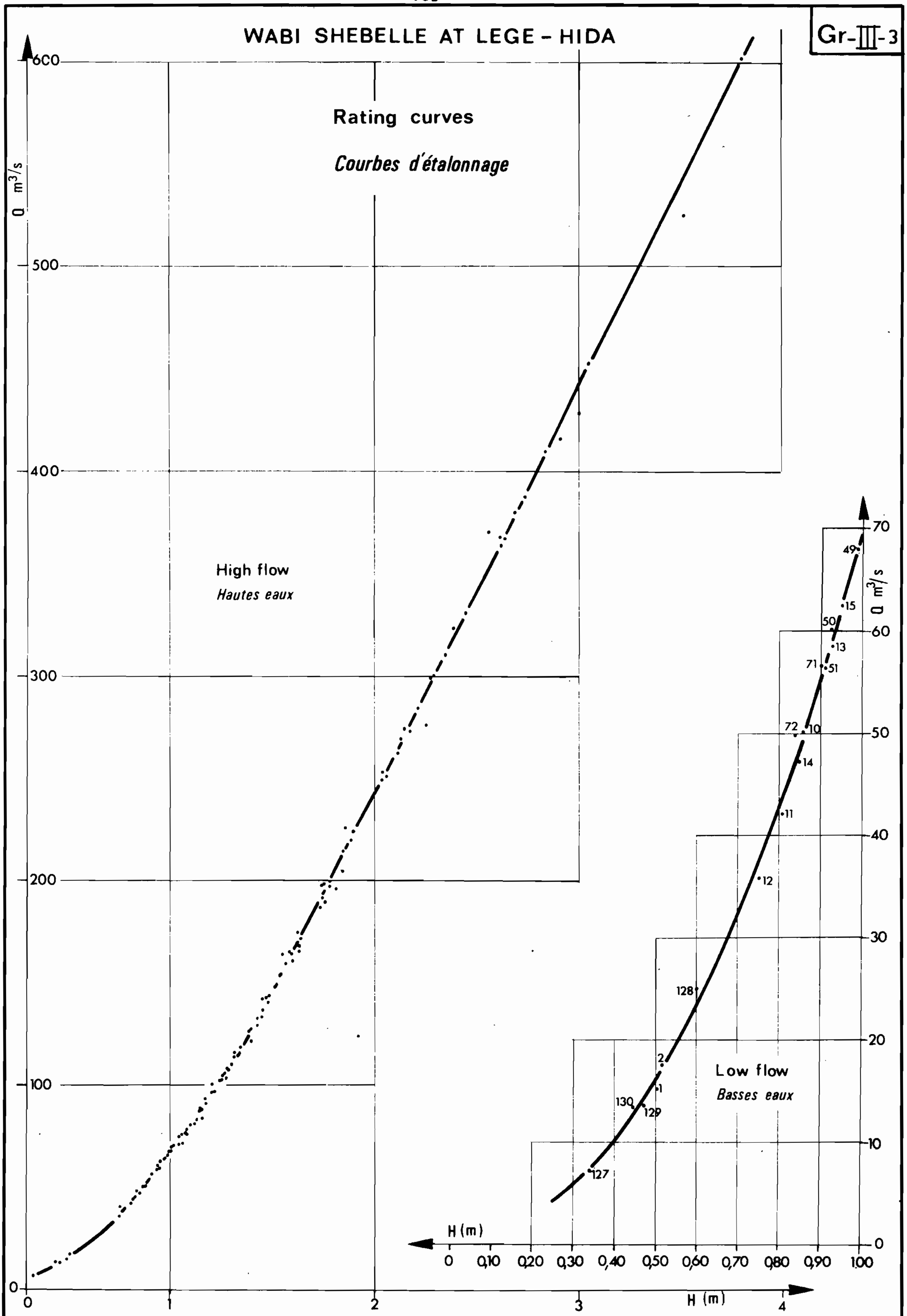


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Table 3.3.

List of measurements of the Wabi Shebelle flow to Lege Hida

N°	Date	Height (m)	Discharge (m3/s)	N°	Date	Height (m)	Discharge (m3/s)
51	1- 5-1970	0.92-0.91	56.5	91	4- 8-1970	1.75	198
52	3- 5-1970	1.08-1.07	78.6	92	5- 8-1970	2.16-2.39	301
53	3- 5-1970	1.16-1.24	101	93	5- 8-1970	2.34-2.14	277
54	4- 5-1970	1.05-1.03	75.0	94	5- 8-1970	2.51-2.59	370
55	4- 5-1970	1.15-1.19	93.5	95	5- 8-1970	2.64-2.71	380
56	4- 5-1970	1.13-1.10	83.9	96	6- 8-1970	2.18-2.14	273
57	5- 5-1970	1.40-1.36	127	97	6- 8-1970	2.08-2.02	251
58	5- 5-1970	1.33-1.29	113	98	7- 8-1970	1.89	224
59	6- 5-1970	1.66-1.62	171	99	7- 8-1970	1.85-1.83	214
60	6- 5-1970	1.61-1.56	164	100	8- 8-1970	2.20-2.21	285
61	6- 5-1970	1.54-1.48	149	101	8- 8-1970	2.03-2.02	249
62	6- 5-1970	1.46-1.46	143	102	9- 8-1970	1.88-1.88	220
63	7- 5-1970	1.46-1.44	136	103	9- 8-1970	1.96-1.93	233
64	8- 5-1970	1.32-1.30	113	104	11- 8-1970	2.10-2.17	275
65	8- 5-1970	1.28-1.28	109	105	11- 8-1970	2.33-2.43	323
66	9- 5-1970	1.18-1.17	91.0	106	11- 8-1970	2.47-2.32	335
67	9- 5-1970	1.15-1.14	88.0	107	13- 8-1970	2.61	363
68	10- 5-1970	1.06-1.05	75.9	108	14- 8-1970	2.83-2.82	410
69	10- 5-1970	1.02-1.00	69.6	109	14- 8-1970	2.75-2.70	388
70	11- 5-1970	0.93-0.93	60.5	110	15- 8-1970	2.65-2.61	367
71	11- 5-1970	0.91-0.90	56.6	111	16- 8-1970	2.12-2.10	269
72	12- 5-1970	0.86-0.86	50.3	112	17- 8-1970	3.83-3.69	601
73	12- 5-1970	0.84-0.84	48.3	113	17- 8-1970	3.55-3.44	525
74	17- 7-1970	1.14	88.3	114	18- 8-1970	3.03-2.94	428
75	19- 7-1970	1.54	153	115	18- 8-1970	2.93-2.87	416
76	19- 7-1970	1.78	197	116	19- 8-1970	2.44	331
77	21- 7-1970	1.42	133	117	22- 8-1970	3.04-3.03	453
78	22- 7-1970	1.25	105	118	23- 8-1970	2.34-2.33	311
79	24- 7-1970	1.31	116	119	24- 8-1970	2.10	263
80	26- 7-1970	1.78	200	120	25- 8-1970	1.75	199
81	26- 7-1970	1.73	187	121	26- 8-1970	1.71-1.76	197
82	27- 7-1970	1.63	168	122	27- 8-1970	1.86-1.85	226
83	27- 7-1970	1.60	162	123	28- 8-1970	2.27-2.25	300
84	28- 7-1970	1.48	144	124	30- 8-1970	2.04-2.02	254
85	29- 7-1970	1.39	127	125	31- 8-1970	1.56-1.54	164
86	30- 7-1970	1.54	154	126	1- 9-1970	1.45-1.43	142
87	31- 7-1970	1.52 -1.65	165	127	16- 1-1971	0.34	7.20
88	31- 7-1970	1.84	206	128	7-11-1971	0.60	25.1
89	1- 8-1970	1.60- 1.65	175	129	2- 1-1972	0.47	13.5
90	3- 8-1970	1.56	160	130	3- 1-1972	0.44	13.4

3.1.4. The WABI SHEBELLI AT HAMERO HEDAD (64 450 km2)

Between Lege Hida and Hamero Hedad, the Wabi Shebelle is joined by four big tributaries, three with a permanent flow on the left bank (UNGWATA, RAMIS, ERRER) and an intermittent tributary on the right bank (LEDAE). This station is essential for the dam-project in the gorges of the Wabi Shebelle (site II b) since it alone controls more than 95 per cent of the water supply of this installation.

The main inflows between Lege Hida and Hamero Hedad come from the high plateaus of CHERCHER and from the HARAR granite group.

The station is located just below the junction of the Wabi Shebelle and of the LEDAE at approximately 20 km from the police station of Hamero Hedad, and the coordinates are 7° 19'N and 42° 11'E. It is equipped with a monthly water-level recorder to which is added a staff-gauge with nine metric units. The zero level corresponds to -8 030 m on the bench-mark.

The first recordings started on the 11th of February 1968 and several small gaps have been compensated for by relation to the downstream station of Imi. The only recordings still lacking concern a relativety longer period, from the 23rd of April to the 12th of June 1971, during high flow.

Rating

One hundred and seventy nine measurements were caried out from 1968 to 1971. Since the 3rd of April 1970, high and middle flows have been measured using the cableway. A chronological study of these data shows the slightly unsteady nature of the sandy channel of the river, but a systematical variation of the channel due to scouring or filling in has not been observed. Accordingly it seemed more adequate to use an average rating curve proving valid for the whole observation period. The maximum deviation of the measurements to the curve never exceeds ± 15 per cent. This curve is shown on graph III.4.

The coefficients of rating equations are given below :

L(m)	C (1,L)	C (2,L)	C (3,L)
0.75	0.7500015 E + 02	0.2749997 E + 02	0.6700000 E + 01
0.95	0.1333391 E + 02	0.5266653 E + 02	0.1520000 E + 02
1.20	0.2666808 E + 02	0.5999956 E + 02	0.2920000 E + 02
1.50	0.2666525 E + 02	0.7333366 E + 02	0.4960001 E + 02
1.80	0.3333406 E + 02	0.8999968 E + 02	0.7400000 E + 02
2.40	0.3333304 E + 02	0.1233334 E + 03	0.1400000 E + 03
3.00	- 0.2500006 E + 02	0.1750002 E + 03	0.2260000 E + 03
3.40	0.2777765 E + 01	0.1783332 E + 03	0.2920000 E + 03
4.60	0.2369283 E + 02	0.2008987 E + 03	0.5100000 E + 03
6.30			

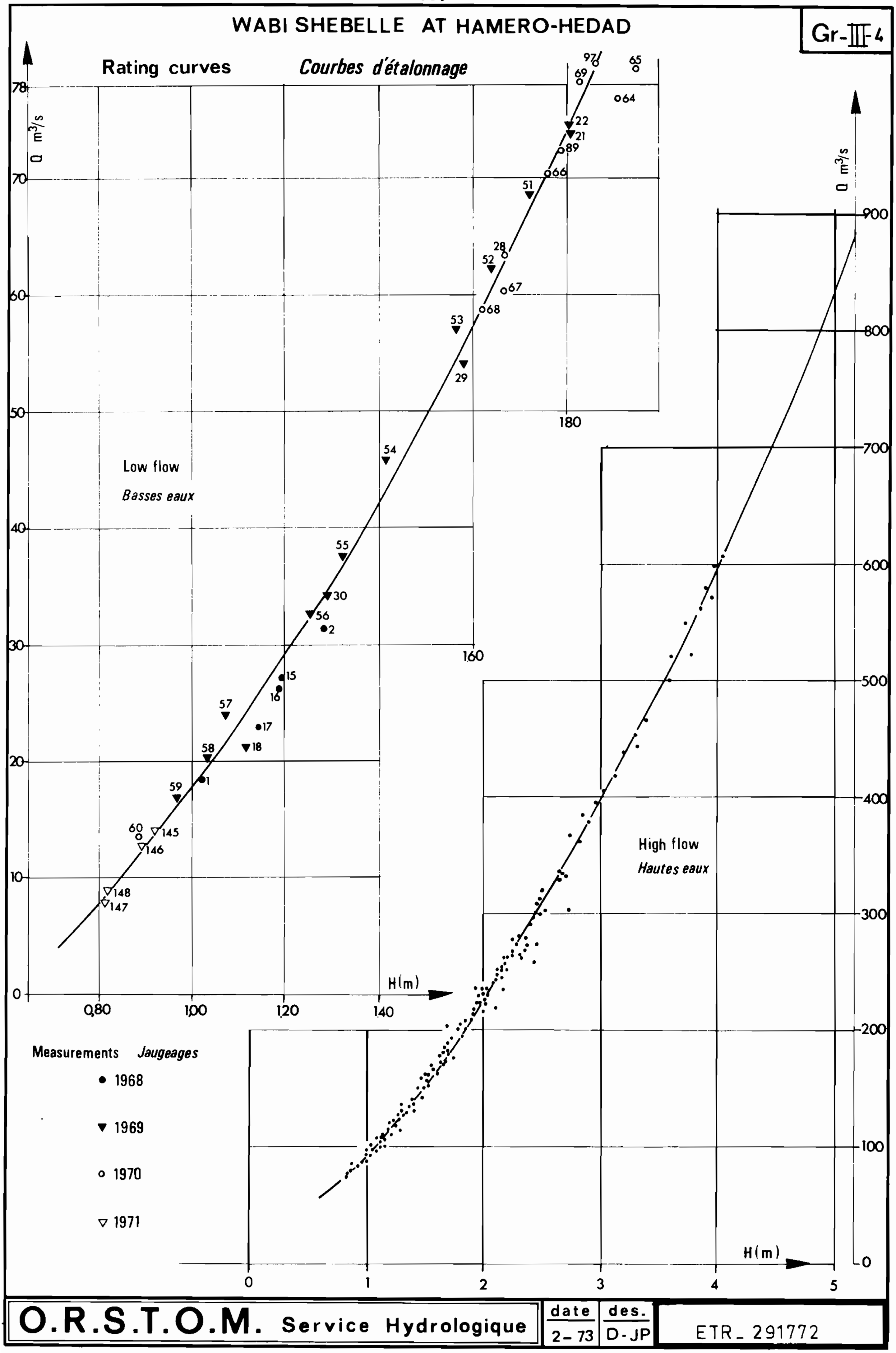

WABI SHEBELLE AT HAMERO-HEDAD
Gr-III-4
Rating curves
Courbes d'étalonnage
Q m³/s
Low flow
Basses eaux
High flow
Hautes eaux
H(m)
Measurements Jaugeages
1968
1969
1970
1971
O.R.S.T.O.M. Service Hydrologique
date
2-73
des.
D-JP
ETR_ 291772

Table 3.4.

List of measurements of the Wabi Schebelle flow at Hamero-Hedad

N°	Date	Height (m)	Discharge (m3/s)	N°	Date	Height (m)	Discharge (m3/s)
1	7- 2-1968	1.02	18.4	46	3- 9-1969	2.71-2.67	179
2	10- 2-1968	1.25-1.31	31.4	47	4- 9-1969	2.48-2.46	148
3	3- 6-1968	2.17-2.12	99.4	48	5- 9-1969	2.33-2.34	130
4	12- 7-1968	2.41-2.42	131	49	23- 9-1969	2.11-2.10	104
5	13- 7-1968	2.41-2.39	130	50	28- 9-1969	1.87-1.86	81.2
6	16- 7-1968	2.20-2.22	111	51	30- 9-1969	1.73-1.72	68.5
7	17- 7-1968	2.28-2.27	112	52	4-10-1969	1.64	662.6
8	13- 7-1968	3.14-3.20	324	53	13-10-1969	1.57-1.56	57.0
9	14- 8-1968	3.45-3.47	273	54	16-10-1969	1.41	45.9
10	14- 8-1968	3.10-3.11	219	55	19-10-1969	1.32	37.6
11	16- 8-1968	3.47-3.39	258	56	25-10-1969	1.25	32.6
12	17- 8-1968	3.31-3.35	262	57	29-11-1969	1.07	24.1
13	19- 8-1968	3.37-3.33	268	58	2-12-1969	1.03	20.3
14	22- 8-1968	3.71-3.72	304	59	9-12-1969	0.96	16.8
15	9-11-1968	1.20-1.19	27.1	60	3- 1-1970	0.88	13.6
16	10-11-1968	1.19-1.18	26.2	61	21- 3-1970	3.00-2.96	236
17	26- 1-1969	1.12-1.12	22.9	62	23- 3-1970	2.49-2.46	142
18	27- 1-1969	1.12-1.11	21.3	63	25- 3-1970	2.11-2.10	99.8
19	Defective measurement			64	27- 3-1970	1.91	76.9
20	4- 4-1969	2.02	94.1	65	28- 3-1970	1.95	79.4
21	6- 4-1969	1.81-1.80	73.9	66	2- 4-1970	1.77-1.76	70.5
22	8- 4-1969	1.80-1.81	74.2	67	3- 4-1970	1.67	60.3
23	9- 4-1969	1.92-1.90	82.5	68	9- 4-1970	1.62	58.7
24	10- 4-1969	3.08-3.01	230	69	11- 4-1970	1.78-1.88	78.4
25	12- 4-1969	2.54-2.50	151	70	15- 4-1970	1.99	93.4
26	14- 4-1969	2.27-2.26	117	71	16- 4-1970	2.93-2.85	209
27	16- 4-1969	2.03-2.02	92.7	72	17- 4-1970	3.84-3.83	384
28	19- 4-1969	1.68-1.66	63.3	73	17- 4-1970	3.75-3.71	366
29	21- 4-1969	1.58	54.1	74	17- 4-1970	3.67-3.65	234
30	20- 6-1969	1.28-1.29	34.2	75	18- 4-1970	3.18-3.15	262
31	28- 7-1969	2.67-2.65	173	76	19- 4-1970	2.94-2.91	236
32	30- 7-1969	3.01-2.97	216	77	20- 4-1970	2.70-2.65	204
33	31- 7-1969	2.81-2.80	194	78	21- 4-1970	2.52-2.49	162
34	3- 8-1969	3.42-3.54	299	79	22- 4-1970	2.38	139
35	3- 8-1969	3.72-3.66	332	80	24- 4-1970	2.31	128
36	4- 8-1969	3.28-3.23	267	81	25- 4-1970	2.26	127
37	5- 8-1969	3.16-3.17	245	82	25- 4-1970	3.82-3.57	406
38	7- 8-1969	3.13-3.09	242	83	29- 4-1970	2.28-2.29	113
39	11- 8-1969	3.52-3.54	303	84	29- 4-1970	2.23	119
40	12- 8-1969	2.58-3.35	272	85	30- 4-1970	2.15-2.14	105
41	16- 8-1969	2.69-2.67	181	86	30- 4-1970	2.09-2.08	97.1
42	17- 8-1969	2.59	162	87	1- 5-1970	1.99-1.98	87.2
43	24- 8-1969	2.91-2.95	217	88	2- 5-1970	1.88-2.04	86.4
44	25- 8-1969	3.34-3.30	264	89	3- 5-1970	1.79	72.4
45	27- 8-1969	3.20-3.18	252	90	5- 5-1970	2.15-2.13	99.6

Table 3.4. (suite)

List of measurements of the Wabi Shebelle flow at Hamero-Hedad

N°	Date	Height (m)	Discharge (m3/s)	N°	Date	Height (m)	Discharge (m3/s)
91	6-5-1970	2.69-2.62	185	136	27- 9-1970	3.02-3.00	223
92	7-5-1970	3.12-3.05	240	137	2-10-1970	2.55-2.54	166
93	8-5-1970	2.65-2.63	171	138	4-10-1970	2.46	159
94	9-5-1970	2.48-2.47	151	139	8-10-1970	2.16-2.17	115
95	10-5-1970	2.24	119	140	13-10-1970	2.50-2.49	148
96	11-5-1970	2.04-2.03	97,4	141	16-10-1970	2.02	101
97	12-5-1970	1.86	79,9	142	21-10-1970	1.98	96.6
98	22-7-1970	2.38	141	143	24-10-1970	1.86	84.7
99	23-7-1970	2.11-2.10	108	144	29-10-1970	2.36-2.34	135
100	24-7-1970	2.12	111	145	1- 1-1971	0.92	13.9
101	26-7-1970	2.28-2.27	130	146	30- 1-1971	0.89	12.3
102	27-7-1970	2.91-2.90	213	147	1- 3-1971	0.81	7.80
103	28-7-1970	2.69-2.67	184	148	22- 3-1971	0.82	8.20
104	6-8-1970	3.59-3.67	337	149	8- 8-1971	3.23	266
105	7-8-1970	3.39-3.34	280	150	9- 8-1971	2.83	209
106	7-8-1970	3.19-3.22	261	151	10- 8-1971	2.68	190
107	8-8-1970	3.04-3.02	233	152	11- 8-1971	2.60	178
108	13-8-1970	3.80-3.82	362	153	14- 8-1971	2.54	171
109	14-8-1970	3.87-3.88	378	154	16- 8-1971	2.72	194
110	15-8-1970	3.99-4.04	406	155	16- 8-1971	2.95	224
111	15-8-1970	4.12-4.13	419	156	20- 8-1971	3.02	236
112	17-8-1970	3.45-3.42	307	157	21- 8-1971	3.12	252
113	18-8-1970	4.52-4.69	521	158	23- 8-1971	3.34-3.50	297
114	18-8-1970	4.69-4.76	549	159	23- 8-1971	3.60-3.68	328
115	18-8-1970	4.80-4.90	562	160	26- 8-1971	2.76	201
116	18-8-1970	4.88-4.93	579	161	28- 8-1971	3.14-3.16	254
117	18-8-1970	4.97-5.00	598	162	28- 8-1971	3.29-3.27	274
118	18-8-1970	5.05-5.04	607	163	2- 9-1971	2.79-2.80	206
119	18-8-1970	4.99-4.94	571	164	5- 9-1971	2.98-3.02	232
120	19-8-1970	4.22-4.19	438	165	6- 9-1971	2.98	230
121	19-8-1970	4.30	454	166	7- 9-1971	3.11	248
122	21-8-1970	4.30-4.32	444	167	9- 9-1971	2.78	204
123	21-8-1970	4.39-4.40	467	168	10- 9-1971	2.90	218
124	22-8-1970	4.78-4.76	522	169	12- 9-1971	2.97	229
125	23-8-1970	4.58-4.57	500	170	13- 9-1971	2.63	182
126	24-8-1970	3.95-3.94	395	171	15- 9-1971	2.50	162
127	25-8-1970	3.51-3.50	320	172	16- 9-1971	2.42	151
128	26-8-1970	3.25-3.24	277	173	18- 9-1971	2.29	136
129	1-9-1970	2.95-2.94	230	174	19- 9-1971	2.20	123
130	4-9-1970	3.49-3.46	312	175	20- 9-1971	2.18	121
131	7-9-1970	2.91-2.92	223	176	21- 9-1971	2.08	108
132	15-9-1970	3.30-3.30	280	177	23- 9-1971	2.04	102
133	20-9-1970	2.71-2.74	176	178	25- 9-1971	2.02	101
134	23-9-1970	2.84-2.83	201	179	28- 9-1971	1.98	94.2
135	25-9-1970	3.02-3.00	223				

3.1.5. The Wabi Shebelle at Imi (91 600 km2)

The Wabi Shebelle, between Hamero Hedad and Imi, is joined by two main tributaries : on the left bank the Daketa which is by far the most important and the Darole on the right bank. The Daketa originates in the granite mountains of Harar and has an intermittent flow.

The station of Imi is located at the entrance of the Wabi Shebelle into the alluvial plain which stretches down to the border. It is placed at approximately 25 km downstream from where it issues out of the gorges near Buliche village (12 km upstream from Imi) and its coordinates are 6° 31' N and 42° 08' E.

A temporary gauge was installed on the 1st of March 1969 during the early floods of the year and only consisted of three metric units for high flow measurements.

In June 1969 a monthly water-level recorder was installed to which a staff-gauge with five metric units (including a negative unit) has been added. The correspondence between the two staff-gauges was established by simultaneous reading of both for all the different heights. All the recordings prior to the 11th of June 1969 were thus correlated to the staff-gauge of the water-level recorder.

The zero level of the staff-gauge corresponds to the elevation point : 0.422 m of the bench mark . The latter is at elevation 405.45 m in the levelling system of the Lower Valley achieved by the Project topographic Division.

Water-level recordings are available since the 28th of March 1969. Some small gaps have been filled in by relation to the recordings of the Hamero Hedad station or by interpolation when floods subside. The recordings for December 1971 and January 1972 are lacking owing to the presence of a sand-layer covering up the staff-gauge unit corresponding to low water level and because of the warping of the lower part of the water level recorder.

Rating

One hundred and fifteen measurements, between elevations - 0.07 and 2.46 m, were carried out in 1969, 1970 and 1971 and may be found in table 3.5

The relation between gauge/height and discharge through these measurements in univocal up to elevation 1.50 m on the staff-gauge (approximately 160 m3/s). Above this elevation, measurements vary considerably, for instance for a gauge measurement of 2.31 m the discharge is 520 m3/s for March 1970, and 302 m3:s for August 1971. The reason of this variation was sought for by analysing the relations between gauge-heights and sections of the flow as well as the mean relation between water-levels and mean velocities obtained through the measurement points.

The area of section of the flow scarcely varies during the observation period, but the mean velocity and consequently, the water surface slope, present considerable variations for a same gauge height.

It was believed at first that the variations of the water surface slope might be related to the various shape of hydrographs linked to the floods from the upper basin or from the tributaries of the middle basin like the DAKETA. The non-univocal character of the station was to be corrected by a method using the limnigraphic gradient

This method proved unsatisfactory.

In fact, it seems that the variable water surface slopes correspond to the filling level of more or less broken up flood plains located upstream and mainly downstream from the station (these floods occur when the water level is above 1.50 m at Imi)

When the plains are full, flooding is cheked and the water surface slope decreases but when they are empty the water surface slope remains high since flooding is not cheked. Two extreme cases exist : either the plains are completely empty and velocity is maximal or the plains are completely full and velocity is minimal. Between these extreme forms velocity varies progressively. In order to know the exact variations of the water slopes, two automatic water level recorders would have been necessary in the reach of Imi.

This method would have allowed making for each height corrections linked to the water surface slope hence, to find the univocal stage discharge relation.

The study of series of measurements and the comparison of the flow volume at the upstream and downstream stations for periods of five days allowed to determine three long periods to which two different mean stage discharge relations correspond.

The two rating curves are plotted on graph III.5 Curve I corresponds to strong water surface slopes and curve II to weak water surface slopes.

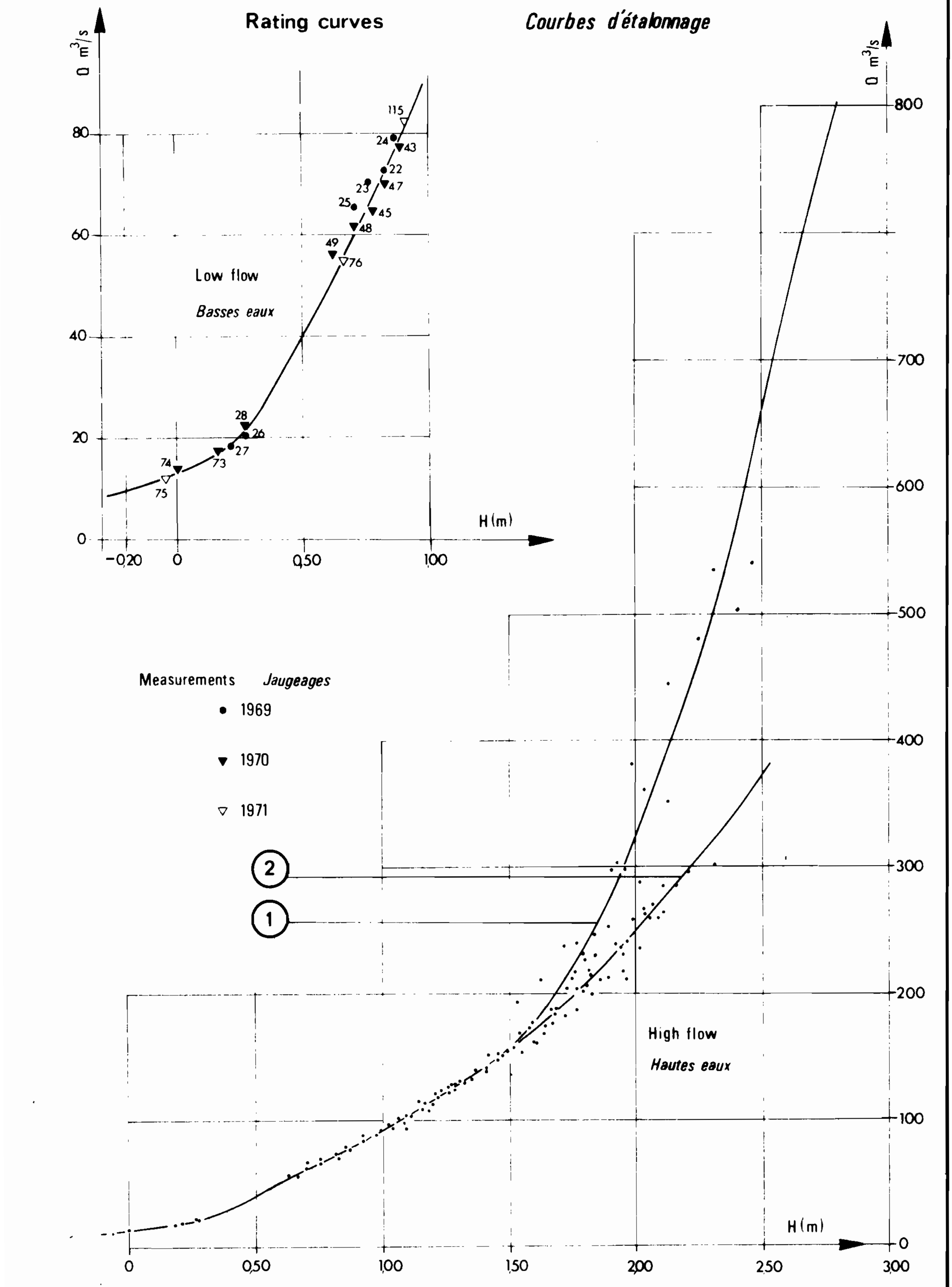
The validity periods of each of these rating curves are as follows :
from February 28 to November 3 1969 = Curve II
from November 4 1969 to May 7 1971 = Curve I
from May 8 1971 to December 31 1972 = Curve II

The rating equations of each curve are :

Rating n° 1

L (m)	C (1,L)	C (2,L)	C (3,L)
-0.20	0.1166656 E + 02	0.1416669 E + 02	0.9700000 E + 01
0.10	0.1000000 E + 03	0.2500002 E + 02	0.1500000 E + 02
0.40	0.3125006 E + 02	0.8624995 E + 02	0.3150000 E + 02
0.80	0.2777867 E + 02	0.1016662 E + 03	0.7100000 E + 02
1.40	0.3999968 E + 03	0.9999965 E + 02	0.1420000 E + 03
1.60	0.3000012 E + 03	0.2399999 E + 03	0.1780000 E + 03
2.00	0.4160000 E + 03	0.4680000 E + 03	0.3220000 E + 03
2.50	0.4442674 E + 02	0.7933379 E + 03	0.6600000 E + 03
2.80			

WABI SHEBELLE AT IMI



Rating n° 2

L (m)	C (1,L)	C (2,L)	C (3,L)
-0.20	0.1166656 E + 02	0.1416669 E + 02	0.9700000 E + 01
0.10	0.1000000 E + 03	0.2500002 E + 02	0.1500000 E + 02
0.40	0.3125006 E + 02	0.8624995 E + 02	0.3150000 E + 02
0.80	0.2777867 E + 02	0.1016662 E + 03	0.7100000 E + 02
1.40	0.4999962 E + 02	0.1349995 E + 03	0.1420000 E + 03
1.60	0.7500018 E + 02	0.1650002 E + 03	0.1710000 E + 03
2.00	0.6400000 E + 02	0.2160000 E + 03	0.2490000 E + 03
2.50			

An accuracy of ± 20 per cent may be expected for discharges greater than 160 m3/s

Table 3.5

List of measurements of the Wabi Shebelle flow at Imi

N°	Date	Height	Discharge	N°	Date	Height	Discharge
1	23- 8-1969	1.70-1.67	189	26	29-11-1969	0.27	20.6
2	23- 8-1969	1.60-1.58	177	27	4-12-1969	0.21	18.4
3	24- 8-1969	1.48-1.47	151	28	6- 2-1970	0.26	22.0
4	25- 8-1969	1.82	215	29	15- 3-1970	1.15-1.22	108
5	25- 8-1969	1.91-1.93	239	30	16- 3-1970	1.65-1.72	184
6	26- 8-1969	2.04	263	31	17- 3-1970	2.26-2.24	480
7	28- 8-1969	2.10-2.12	285	32	17- 3-1970	2.16-2.13	445
8	2- 9-1969	1.77-1.76	217	33	19- 3-1970	2.46	540
9	4- 9-1969	1.56-1.55	166	34	20- 3-1970	2.31	520
10	5- 9-1969	1.41-1.40	141	35	21- 3-1970	1.97-1.96	298
11	6- 9-1969	1.29-1.30	130	36	22- 3-1970	1.81-1.80	227
12	7- 9-1969	1.23	124	37	23- 3-1970	1.59-1.58	173
13	10- 9-1969	1.73-1.74	204	38	24- 3-1970	1.40-1.39	138
14	13- 9-1969	1.97-2.01	258	39	24- 3-1970	1.32-1.31	129
15	16- 9-1969	1.85-1.92	231	40	25- 3-1970	1.21-1.20	112
16	16- 9-1969	2.06-2.08	270	41	26- 3-1970	1.07-1.06	98.5
17	21- 9-1969	1.36-1.35	140	42	27- 3-1970	0.99	92.2
18	23- 9-1969	1.16-1.16	114	43	28- 3-1970	0.87	77.4
19	24- 9-1969	1.09	104	44	30- 3-1970	1.10-1.11	103
20	26- 9-1969	1.02	97.0	45	3- 4-1970	0.76-0.75	65.0
21	27- 9-1969	0.92	88.1	46	4- 4-1970	1.49-1.41	147
22	30- 9-1969	0.81	73.0	47	6- 4-1970	0.81-0.80	70.2
23	1-10-1969	0.75	70.4	48	7- 4-1970	0.71-0.69	61.7
24	2-10-1969	0.85-0.84	79.1	49	8- 4-1970	0.60-0.62	56.0
25	3-10-1969	0.70	65.6	50	13- 4-1970	0.93-0.92	84.2

Table 3.5.

List of measurements of the Wabi Shebelle flow at IMI

N°	Date	Height (m)	Discharge (m3/s)	N°	Date	Height (m)	Discharge (m3/s)
51	15- 4-1970	1.26-1.26	123	84	19- 8-1971	1.93-1.97	217
52	16- 4-1970	1.51-1.53	193	85	20- 8-1971	2.10-2.12	264
53	17- 4-1970	1.73-1.72	238	86	21- 8-1971	2.19-2.23	296
54	18- 4-1970	2.06-2.03	361	87	22- 8-1971	2.04-2.08	261
55	18- 4-1970	1.94-1.93	304	88	22- 8-1971	2.16	285
56	19- 4-1970	1.88-1.91	255	89	24- 8-1971	2.30	302
57	19- 4-1970	1.85-1.84	247	90	26- 8-1971	1.80	207
58	21- 4-1970	2.48-2.33	504	91	27- 8-1971	1.72	182
59	23- 4-1970	1.45-1.44	153	92	29- 8-1971	2.09	259
60	25- 4-1970	1.28-1.27	124	93	30- 8-1971	1.96-1.93	234
61	26- 4-1970	2.03-2.02	288	94	1- 9-1971	1.84-1.89	214
62	26- 4-1970	1.82-1.76	231	95	4- 9-1971	1.61-1.60	161
63	27- 4-1970	1.65-1.61	211	96	5- 9-1971	1.75-1.78	204
64	1- 5-1970	1.15	108	97	6- 9-1971	1.93-1.94	234
65	5- 5-1970	1.90-1.93	299	98	8- 9-1971	1.97-1.96	240
66	5- 5-1970	1.79-1.75	240	99	10- 9-1971	1.78-1.80	202
67	6- 5-1970	1.76-1.74	211	100	11- 9-1971	1.89	212
68	7- 5-1970	2.03-1.95	381	101	11- 9-1971	2.02	236
69	8- 5-1970	1.86-1.83	230	102	13- 9-1971	1.85	211
70	8- 5-1970	1.67-1.66	188	103	14- 9-1971	1.64	174
71	9- 5-1970	2.18-2.08	352	104	15- 9-1971	1.51	157
72	10- 5-1970	1.47-1.46	143	105	17- 9-1971	1.41	144
73	25- 6-1970	0.18-0.17	17.8	106	18- 9-1971	1.34	133
74	20-12-1970	0.00	13.8	107	19- 9-1971	1.28	129
75	2- 2-1971	-0.07	11.7	108	20- 9-1971	1.21	119
76	3- 6-1971	0.66	55.4	109	21- 9-1971	1.26	125
77	12- 8-1971	1.67	176	110	22- 9-1971	1.14	115
78	13- 8-1971	1.59	162	111	23- 9-1971	1.06	99.4
79	15- 8-1971	1.55	153	112	27- 9-1971	1.04	93.8
80	16- 8-1971	1.64	169	113	28- 9-1971	1.09	93.7
81	17- 8-1971	1.82	199	114	29- 9-1971	0.97	88.1
82	17- 8-1971	1.95-1.98	211	115	30- 9-1971	0.91	82.4
83	18- 8-1971	1.77	187				

3.1.6. The WABI SHEBELLE at GODE (127 300 km)

Between Imi and Gode the Wabi Shebelle is only joined by not very large tributaries presenting a torrential flow of arid type. The most important is the Madiso which originates from the limestone plateaux of the Duhun Region. The total area of the drainage basin controlled by this station must not include the inactive parts where endhoreic flow is collected in closed drainage basins such as the Danan basin. These areas are not easily evaluated but represent approximately 7 500 km^2. The station is located in the middle of the large alluvial plain of Gode. There the Wabi Shebelle is well embanked in its alluvial deposits. The banks are 8 to 9 meters high. The coordinates of the station are 5° 51' N and 43° 33' E.

As soon as August 1967, a temporary staff-gauge with four metric units was installed. Observations started on the 4th of October 1967.

This staff gauge was remplaced on the 24th of June 1968 with a weekly water level recorder and a 7 meters staff gauge located upstream from the temporary staff-gauge. The gauge datum (zero) is at - 6.41 m of the bench mark and at elevation 293 78 m in the general levelling system of the Lower Valley.

The correspondence between the temporary staff gauge and the water level recorder was determined by simultaneous reading of the elevations on both staff gauges. All the recordings prior to the 24 th of June 1968 are copied down in the water level recording system.

Complete recordings are available since the 5th of October 1967 and only a gap of 16 days may be noted for March-April 1968.

Rating

One hundred and thirteen flow measurements were made for elevations between -0.49 and 3.83m on the staff gauge (table 3.6). The maximal and minimal recorded heights are respectively 3.93 and 0.49 m. The five measurements from n° 53 to 57 carried out with a defective current meter are excluded. Measurements from n°22 to 24 and from 32 to 35 are float measurements.

A slight variation for low flow measurements may be observed but it is insignificant and the station may be considered as stable and univocal. The relative difference between measurements with a current meter and the average curve is never greater than ± 10 per cent.

The rating curve (graph III.6) is broken at elevation 2.00m, the discharge gradient being smaller above 2.00 m than it was below. This anomaly of the site linked to decreasing velocities might be due to the back water effect on the rocky layer downstream from the water level recorder or to a narrowing of the section of the flow at Gode bridge.

The equations of the rating curve are, as follows :

L (m)	C (1,L)	C (2,L)	C (3,L)
-0.50	0.3888901 E 02	0.2583328 E 02	0.3750000 E 01
-0.20	0.7500031 E 02	0.4749994 E 02	0.1500000 E 02
0.00	0.5374980 E 02	0.7175006 E 02	0.2750000 E 02
0.40	0.5018495 E 02	0.1023706 E 03	0.6479999 E 02
0.87	0.9050063 E 01	0.1522977 E 03	0.1240000 E 03
0.160	-0.1632576 E 02	0.1828566 E 03	0.2400000 E 03
2.30	0.4186216 E-03	0.1555551 E 03	0.3600000 E 03
3.20	-0.3576276 E-03	0.1500002 E 03	0.5000000 E 03
4.00			

Table 3.6

List of measurements of the Wabi Shebelle flow at Gode

N°	Date	Height (m)	Discharge (m3/s)	N°	Date	Height (m)	Discharge (m3/s)
1	6- 9-1968	0.73	105	36	11- 5-1969	1.35	194
2	8- 9-1968	0.64-0.63	93.3	37	25- 8-1969	1.23-1.22	183
3	10- 9-1968	0.77-0.78	109	38	28- 8-1969	1.63	253
4	13- 9-1968	0.91-0.92	131	39	1- 9-1969	1.62	255
5	14- 9-1968	1.03	151	40	4- 9-1969	1.36	205
6	19- 9-1968	1.28-1.29	183	41	4- 9-1969	1.36-1.35	204
7	21- 9-1968	1.17-1.16	163	42	7- 9-1969	1.01	147
8	28- 9-1968	0.81	115	43	9- 9-1969	0.92	134
9	18-10-1968	0.49	79.9	44	12- 9-1969	1.29	193
10	20-10-1968	0.40-0.39	67.5	45	15- 9-1969	1.59	247
11	23-10-1968	0.30-0.34	54.9	46	16- 9-1969	1.40	210
12	4-11-1968	0.19-0.18	43.8	47	18- 9-1969	1.49	228
13	6-11-1968	0.10	37.6	48	25- 9-1969	0.81	116
14	11-11-1968	0.00	28.8	49	27- 9-1969	0.69	101
15	27-12-1968	-0.10	22.3	50	29- 9-1969	0.64	94.0
16	15- 1-1969	-0.05	24.6	51	1-10-1969	0.55	83.0
17	22- 1-1969	-0.15	20.5	52	3-10-1969	0.49	74.6
18	17- 2-1969	-0.22	15.5	58	23-11-1969	-0.15	18.8
19	21- 2-1969	-0.27	13.8	59	11-12-1969	-0.20	15.5
20	22- 2-1969	1.67-1.68	268	60	18-12-1969	-0.25	12.7
21	23- 2-1969	1.43	218	61	2- 1-1970	-0.32	9.60
22	2- 3-1969	2.04	325	62	21- 1-1970	-0.37	7.80
23	2- 3-1969	2.16-2.18	379	63	18- 3-1970	1.94-2.02	307
24	2- 3-1969	2.21-2.22	400	64	19- 3-1970	2.84-2.86	440
25	6- 3-1969	1.46-1.44	198	65	20- 3-1970	3.15-3.16	496
26	9- 3-1969	0.90	137	66	22- 3-1970	3.26-3.25	510
27	12- 3-1969	1.61-1.62	247	67	22- 3-1970	3.16-3.14	492
28	13- 3-1969	1.83	276	68	22- 3-1970	2.98-2.96	475
29	15- 3-1969	1.79-1.83	288	69	23- 3-1970	2.32-2.31	362
30	15- 3-1969	1.92-1.94	320	70	23- 3-1970	2.16-2.15	338
31	17- 3-1969	1.26	194	71	23- 3-1970	2.05-2.03	319
32	6- 5-1969	2.82-2.80	440	72	23- 3-1970	1.99-1.98	308
33	6- 5-1969	2.65-2.63	407	73	24- 3-1970	1.65-1.64	243
34	6- 5-1969	2.45-2.43	382	74	24- 3-1970	1.51	223
35	6- 5-1969	2.32-2.30	360	75	25- 3-1970	1.31	185
35a	7- 5-1969	1.96	304	76	26- 3-1970	1.10	156
35b	7- 5-1969	1.87	294	77	27- 3-1970	0.93	132
35c	8- 5-1969	1.66-1.65	279	78	16- 4-1970	0.92	127
35d	10- 5-1969	1.60-1.59	270	79	18- 4-1970	2.03	318
35e	11- 5-1969	1.35-1.34	213	80	19- 4-1970	1.98-2.00	313

WABI SHEBELLE AT GODE

Gr-III-6

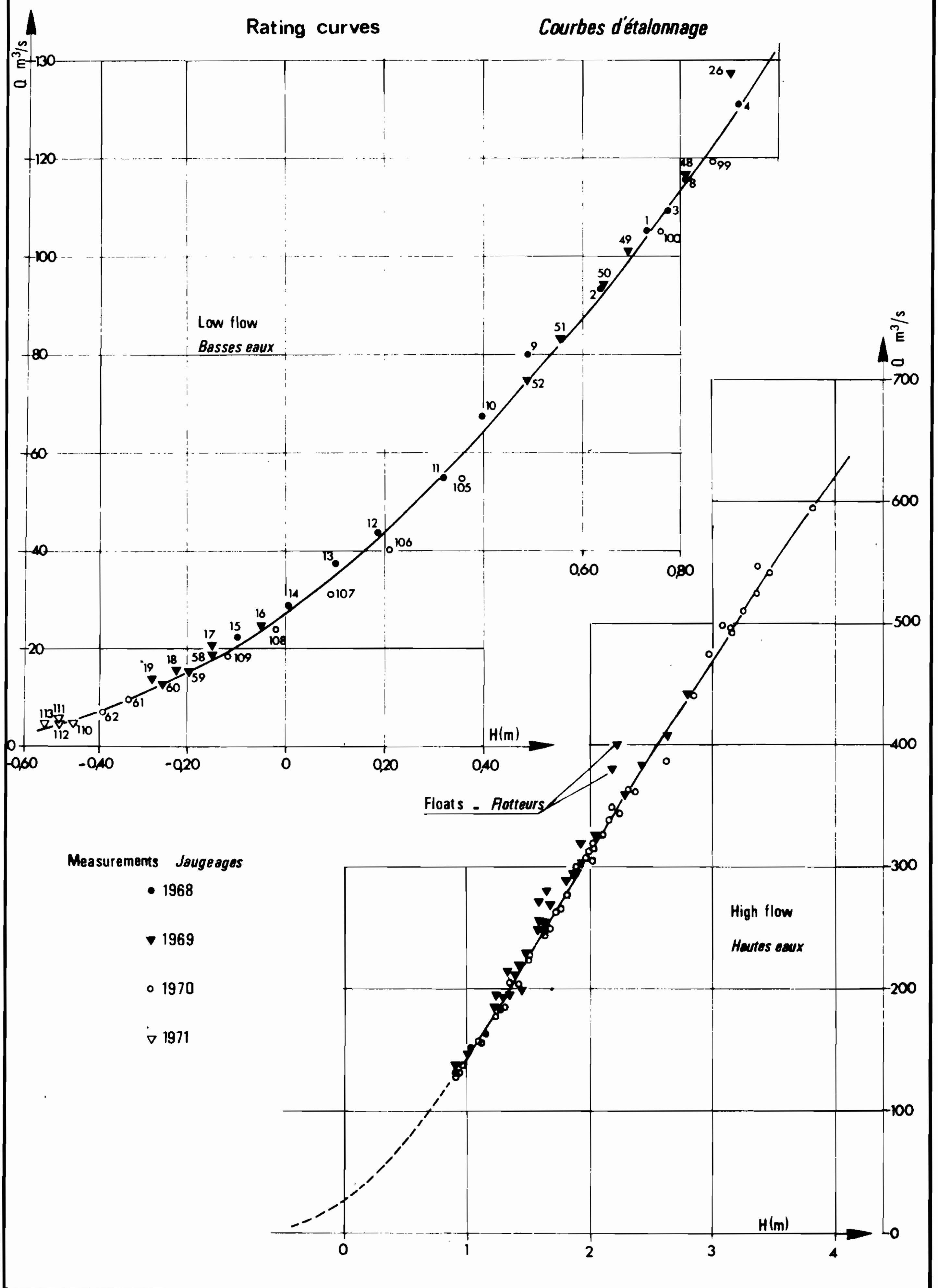


Table 3.6

Measurements of the Wabi Shebelle flow at Gode

N°	Date	Height (m)	Discharge (m3/s)	N°	Date	Height (m)	Discharge (m3/s)
81	19-4-1970	2.18	348	98	1-5-1970	0.97	137
82	20-4-1970	1.89	300	99	3-5-1970	0.86	119
83	21-4-1970	1.81	277	100	4-5-1970	0.76	105
84	22-4-1970	3.83	594	101	7-5-1970	1.68	249
85	23-4-1970	3.48	541	102	8-5-1970	1.23-1.24	177
86	24-4-1970	2.66-2.60	386	103	9-5-1970	1.77-1.76	265
87	24-4-1970	2.40-2.36	361	104	10-5-1970	1.52-1.51	227
88	24-4-1970	2.12-2.11	326	105	28-5-1970	0.36-0.35	54.7
89	24-4-1970	2.05-2.03	314	106	31-5-1970	0.21	40.3
90	25-4-1970	3.37-3.39	546	107	6-6-1970	0.09	31.3
91	25-4-1970	3.40-3.35	524	108	11-6-1970	-0.02	24.0
92	25-4-1970	3.04-3.12	498	109	15-6-1970	-0.12	18.4
93	26-4-1970	2.26-2.24	343	110	3-3-1971	-0.42	5.40
94	27-4-1970	1.42-1.41	204	111	13-3-1971	-0.46	5.20
95	28-4-1970	2.03-2.01	304	112	14-3-1971	-0.46	4.70
96	29-4-1970	1.74-1.73	263	113	24-3-1971	-0.49	4.18
97	30-4-1970	1.12	157				

3.1.7. The Wabi Shebelle at Kelafo (139 100 km^2)

Between Kelafo and Gode the Wabi Shebelle is only supplied by small local tributaries. Moste of them do not directly meet the river but flow into the alluvial plain. This water seeps into the ground and partly supplies the alluvial ground-water table or evaporates.

The active area of the intermediate basin located between Gode and Kelafo is small and probably only covers 5 000 km^2.

The Kelafo station presents the following coordinates : 5° 35' and 44° 13' E. Il is located just below the alluvial basin of ILO-UEN which is approximately 35 km long.

In this basin, the banks of the Wabi Shebelle become progressively lower and are approximately 5 meters high at the station. When strong floods occur, the Wabi Shebelle overflows in this basin. Overflowing is even created artificially by a system of deep irrigation canals cutting the banks of the river during a very high flow period, part of the flow is not controlled by the station and it joins a secondary arm in the Northen part of the alluvial plain.

Downstream from Kelafo, the height of the banks still decreases and the river divides into several channels in the middle of a vast flood plain (Shebelle plain).

Owing to its very particular location, this station only provides an incomplete knowledge of high flow.

An old Italian staff-gauge fixed on a pier of the bridge used to exist at Kelafo and consisted of four metric units (2 to 6 m). The Yugoslav report : Electroproject mentions weekly measurements carried out on this staff gauge in 1957, 1958 and 1959 but despite inquiries made at the Water Resources Department and at the Sudanese Interior Mission which was at that time in charge of the recordings, none of these observations were found.

Observations started again on this staff-gauge in December 1967, they proceded until the 11th of March 1968 and were then interrupted owing to the departure of the observer.

In January 1969, the Wabi Shebelle Project installed another staff-gauge with five metric units at 150 m downstream from the bridge. The two lower units having been swept away by the flood of April 1969, observations were continued later on the Italian staff-gauge of the bridge which was made two meters longer. The zero level of this staff-gauge is at elevation 263.15 m in the levelling system for the lower Valley. A correspondence between both staff-gauges was made and all recordings are related to the Italian system.

The available recordings only correspond to sixty days from December 1967, to March 1968. Since the 8th of January 1969 the recordings made twice a day are complete until the end of the observation period.

Rating

Fifty nine measurements between elevations 2.91 and 7.82 m were carried out in 1969, 1970 and 1971 (table 3.7).The maximum and minimum elevations observed are respectively 7,89 and 2,86 m. These measurements show that the discharge-rating curve is not univocal.

The study of the relations gauge-heights/sections of the flow and gauge-heights/Mean velocities reveals that the non-univocal character is related to two causes : the instability of the channel and the variation of water surface slopes for a same height due to flooding conditions. We noticed on the one hand that during all the observation period a permanent silting-up of the section could be observed (this silting-up particulary affects the rating of low flow) and on the other hand, that the water surface slopes for heights above 5.80 m vary with the level downstream in the flood plains.

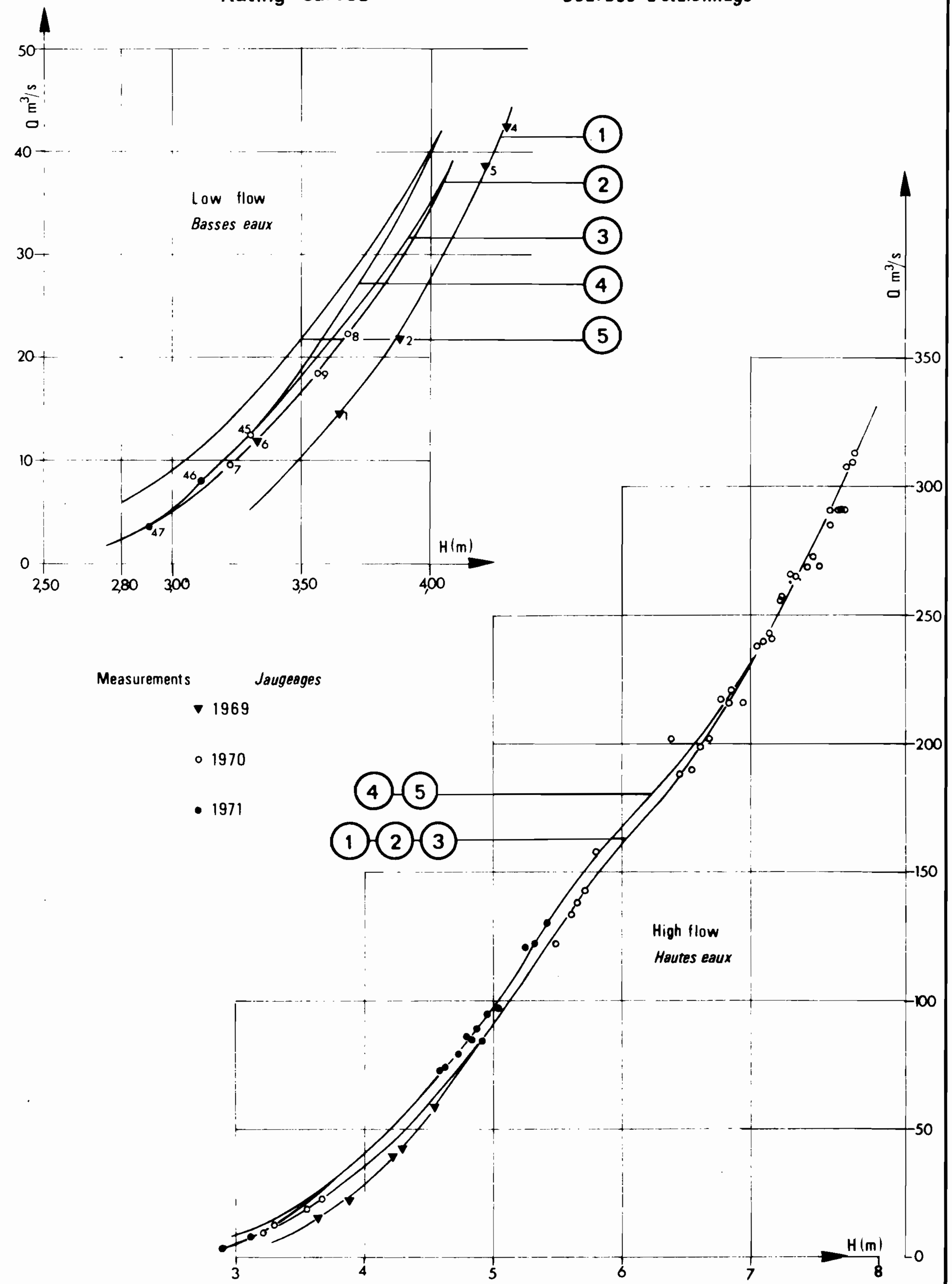
Taking into account the measurements and flood period several mean rating curves were plotted : five curves for low water and two for high water (graph III.7) A greater accuracy than ± 15 per cent cannot be expected for the discharges obtained through these curves. The valid periods applied for each of these curves are as follows :

Rating n° 1 : period before the 1st of August 1969
Rating n° 2 : from the 1st of August 1969 to the 11th of November 1970
Rating n° 3 : from the 18 th of November to the 27th of March 1971
Rating n° 4 : from 28th of March 1971 to the 10th of June 1971
Rating n° 5 : from 11th of June 1971 to the 31st of January 1972

WABI SHEBELLE AT KELAFO

Gr-III-7

Rating curves — *Courbes d'étalonnage*



The equations of the rating curves are given below :

Rating n° 1

L (m)	C (1,L)	C (2,L)	C (3,L)
3.40	0.1833325 E + 02	0.2249998 E + 02	0.7600000 E + 01
4.00	0.1299986 E + 02	0.4930014 E + 02	0.2700000 E + 02
5.00	-0.2980228 E - 03	0.7500011 E + 02	0.9000000 E + 02
5.60	-0.1666669 E + 02	0.7333339 E + 02	0.1350000 E + 03
6.20	0.2187512 E + 02	0.5374988 E + 02	0.1730000 E + 03
7.00	0.1166655 E + 02	0.9283349 E + 02	0.2300000 E + 03
7.90			

Rating n° 2

L (m)	C (1,L)	C (2,L)	C (3,L)
2.80	0.1500004 E + 02	0.1100001 E + 02	0.2200000 E + 01
3.20	0.9999914 E + 01	0.2300003 E + 02	0.9000000 E + 01
3.70	0.2500064 E + 02	0.3249977 E + 02	0.2300000 E + 02
4.00	0.1666644 E + 02	0.4166675 E + 02	0.3500000 E + 02
4.60	0.2500006 E + 02	0.5500005 E + 02	0.6600000 E + 02
5.00	0.1666637 E + 02	0.6166678 E + 02	0.9200000 E + 02
	Beyond 5.60 m, identical rating to N°1		

Rating n° 3

L(m)	C (1,L)	C (2,L)	C (3,L)
2.80	0.1444459 E 02	0.1266660 E + 02	0.2200000 E + 01
3.40	0.6547569 E 01	0.2970236 E + 02	0.1500000 E + 02
4.10			

Rating n° 4

L (m)	C (1,L)	C (2,L)	C (3,L)
2.80	0.1875002 E + 02	0.1125002 E + 02	0.2200000 E + 01
3.20	0.1533315 E + 02	0.2593340 E + 02	0.9700000 E + 01
3.70	0.1500093 E + 02	0 .4049968 E + 02	0.2650000 E + 02
4.00	0.6249779 E + 01	0.4875008 E + 02	0.4000000 E + 02
4.60	0.1250003 E + 02	0 .6000005 E + 02	0.7150000 E + 02
5.00	0.9333019 E + 01	0.7083347 E + 02	0.9750000 E + 02
5.60	-0.1666669 E + 02	0 .6833337 E + 02	0.1430000 E + 03
6.20	0.1562523 E + 02	0.5624977 E + 02	0.1780000 E + 03
7.00	0.1999989 E + 02	0.8200014 E + 02	0.2330000 E + 03
7.90			

Rating n° 5

L (m)	C (1,L)	C (2,L)	C (3,L)
2.80	0.1499998 E + 02	0.1200003 E + 02	0.6000000 E + 01
3.20	0.1033329 E + 02	0.2543333 E + 02	0.1320000 E + 02
3.70	0.1666730 E + 02	0.3333310 E + 02	0.2850000 E + 02
Beyond 4.00 m, identical rating to n° 4			

Table 3.7

List of measurements of the WABI SHEBELLE flow at KELAFO

N°	Date	Height (m)	Discharge (m3/s)	N°	Date	Height (m)	Discharge (m3/s)
1	4- 2-1969	3.65	14.7	11	3- 8-1970	5.50	122
2	9- 2-1969	3.88	21.9	12	4- 8-1970	5.72	143
3	25- 4-1969	4.54	58.7	13	5- 8-1970	5.81	158
4	6- 6-1969	4.29	42.6	14	8- 8-1970	5.67-5.66	138
5	8- 6-1969	4.21	38.9	15	9- 8-1970	6.32-6.47	202
6	20-12-1969	3.32	12.0	16	9- 8-1970	6.64-6.73	229
7	1- 1-1970	3.22	9.60	17	9- 8-1970	6.96-7.03	253
8	9- 2-1970	3.68	22.2	18	10- 8-1970	7.24-7.22	256
9	29- 6-1970	3.56	18.5	19	10- 8-1970	7.11-7.09	240
10	2- 8-1970	5.63-5.62	133	20	11- 8-1970	6.84-6.83	217

Table 3.7

List of measurements of WABI SHEBELLE flow at KELAFO

N°	Date	Height (m)	Discharge (m3/s)	N°	Date	Height (m)	Discharge (m3/s)
21	12-8- 1970	6.75-6.79	217	41	11- 9-1970	6.62-6.60	199
22	14-8- 1970	7.04-7.06	238	42	12- 9-1970	6.47-6.46	188
23	15-8- 1970	7.31-7.32	266	43	13- 9-1970	6.84-6.85	221
24	15-8- 1970	7.44-7.46	269	44	17- 9-1970	7.22-7.26	257
25	16-8- 1970	7.62-7.64	291	45	24-12-1970	3.30	12.4
26	17-8- 1970	7.63	285	46	5- 2-1971	3.11	8.00
27	18-8- 1970	7.73	292	47	16- 3-1971	2.91	3.60
28	19-8- 1970	7.69	291	48	17- 5-1971	5.26	121
29	21-8- 1970	7.83-7.81	313	49	18- 5-1971	5.04	97.5
30	24-8- 1970	7.74-7.75	308	50	19- 5-1971	4.88	89.0
31	25-8- 1970	7.80-7.79	309	51	19- 5-1971	4.84	84.8
32	27-8- 1970	7.70-7.69	291	52	20- 5-1971	4.92	84.7
33	28-8- 1970	7.55-7.54	269	53	21- 5-1971	5.42	130
34	30-8- 1970	7.15-7.14	243	54	21- 5-1971	5.32	122
35	31-8- 1970	7.35-7.37	265	55	22- 5-1971	4.96	95.1
36	1-9- 1970	7.50-7.51	273	56	24- 5-1971	4.80	85.6
37	4-9- 1970	6.95-6.93	216	57	24- 5-1971	4.74	79.1
38	6-9- 1970	7.16-7.18	241	58	25- 5-1971	4.60	72.8
39	9-9- 1970	6.70-6.67	202	59	26- 5-1971	4.64	73.8
40	10-9- 1970	6.55-6.56	190				

3.1.8. The Wabi Shebelle at BURKUR (144 000 km2)

After Kelafo, the Wabi Shebelle supplies the vast spreading basin of Shebelle which stretches down to MUSTAHIL. Beyond Mustahil it sinks once again in its alluvial deposits and flows in a single very distinct channel. From Kelafo to Burkur it supplies but negligible quantities of water.

Burkur station is located at approximately 10 km ± to the North of Burkur village and its coordinates are 5° 11' N and 44° 48' E.

A first water level recorder was installed on the 6th of January 1969. The basis of the water level recorder having given way the latter was replaced with a provisary staff-gauge on the 13th of June 1969. The zero level of the staff-gauge corresponds to -7.84 m under the bench march and to 225.33 m in the general levelling system for the Lower Valley.

All the recordings of gauge heights have been related to the system of the new water-level recorder. They are complete since the 6th January 1969. The short gaps in the recordings have been compensated for through interpolation.

Rating

The rating of the station consits of eighty eight measurements made from elevations -0.19 and 5.88 m (table 3.8). The maximum and the minimum observed during this period are respectively 5.89 and 0.49 m.

As velocities are considerably reduced in the flood zone stretching from Kelafo to Mustahil, the station presents a relatively stable character and calibration is practically univocal. The dispersion of measurement points around the average curve is very small and never more than ± 7 percent (graph III.8). Between elevations 3.20 and 4.00 m the rating curve no longer presents a parabola aspect and its lower part is incurvated since the velocity gradient decreases while the elevations increase. This anomaly is probaly due to the effect of the flood plain of Burkur located 15 km downstream from the station and which controls the flow in the downstream part by reducing the water surface slope.

Above 4.00 m the downstream plain being full, the curve once more presents a parabolic shape.

One may note that the measurements made on the first annuals floods (measurements of March-April 1970) coming into an empty plain present a higher velocity gradient and are consequently above the curve.

For a greater precision, for elevations from 3.20 to 4.00 m,two curves should have been plotted : a first curve before flooding and a second and lower curve after flooding. This would have required knowing the state of flooding day after day in the donwstream part. As this was impossible,a single average curve was plotted. The distance of the farthest measurement points from this curve never exceeds ± 7 per cent.

The equations of the rating curve are given below :

L (m)	C (1,L)	C (2,L)	C (3,L)
-0.50	0.1000001 E 02	0.1000000 E 02	0.2599999 E 01
0.00	0.6399994 E 01	0.1959999 E 02	0.1060000 E 02
0.50	0.8000000 E 01	0.2300000 E 02	0.2200000 E 02
1.50	0.4000000 E 01	0.3600000 E 02	0.5300000 E 02
2.50	0.3333188 E 01	0.4433340 E 02	0.9300000 E 02
3.00	-0.5555805 E 01	0.4833350 E 02	0.1160000 E 03
3.60	-0.3750043 E 02	0.5750012 E 02	0.1430000 E 03
4.00	0.1250003 E 02	0.3000002 E 02	0.1730000 E 03
4.40	0.1111110 E 02	0.3999995 E 02	0.1890000 E 03
4.80	0.2777774 E 02	0.4166664 E 02	0.2170000 E 03
5.40			
6.00			

O.R.S.T.O.M. Service Hydrologique

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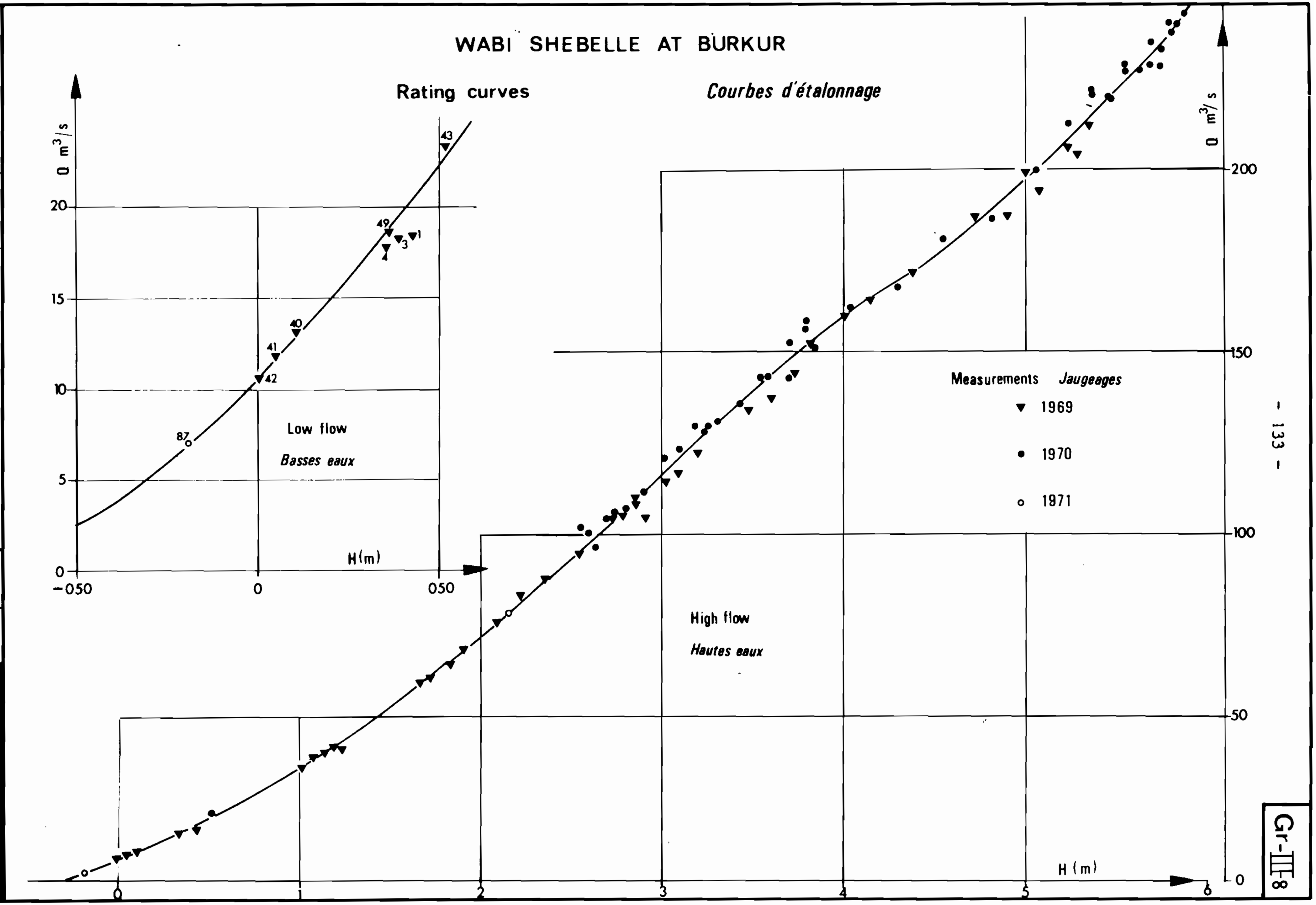


Table 3.8.

List of the measurements of the Wabi Shebelle flow at BURKUR

N°	Date	Height (m)	Discharge (m3/s)	N°	Date	Height (m)	Discharge (m3/s)
1	4- 1-1969	0.43	18.4	45	31- 3-1970	3.79-3.80	156
2	6- 1-1969	0.39	18.3	46	1- 4-1970	3.79	158
3	5- 2-1969	0.39	18.2	47	2- 4-1970	3.59-3.58	143
4	7- 2-1969	0.34	17.8	48	3- 4-1970	3.24-3.22	128
5	7- 4-1969	3.60	137	49	1- 7-1970	0.36	18.6
6	9- 4-1969	3.91	152	50	4- 8-1970	2.55	102
7	10- 4-1969	4.01	159	51	5- 8-1970	2.60	100
8	14- 4-1969	3.09	116	52	6- 8-1970	2.63-2.64	96.0
9	15- 4-1969	2.86	109	53	7- 8-1970	2.68-2.69	104
10	16- 4-1969	2.79	105	54	8- 8-1970	2.74	106
11	21- 4-1969	2.91	(104)	55	9- 8-1970	2.79-2.80	107
12	28- 4-1969	1.83	64.0	56	11- 8-1970	2.89-2.90	112
13	29- 4-1969	1.72	61.0	57	13- 8-1970	3.01-3.02	121
14	30- 4-1969	1.67	58.9	58	14- 8-1970	3.09-3.10	123
15	2- 5-1969	1.90	68.5	59	15- 8-1970	3.18	130
16	3- 5-1969	2.08	75.6	60	16- 8-1970	3.25-3.26	130
17	3- 5-1969	2.21	82.8	61	17- 8-1970	3.31	131
18	3- 5-1969	2.36	87.2	62	18- 8-1970	3.43	136
19	6- 5-1969	2.55	94.5	63	19- 8-1970	3.55-3.56	143
20	8- 5-1969	2.71	104	64	20- 8-1970	3.70	143
21	9- 5-1969	2.86	109	65	21- 8-1970	3.85	151
22	10- 5-1969	3.01	114	66	22- 8-1970	4.04	162
23	11- 5-1969	3.20	122	67	23- 8-1970	4.29-4.30	168
24	12- 5-1969	3.47	134	68	24- 8-1970	4.55	181
25	13- 5-1969	3.74	144	69	25- 8-1970	4.82-4.83	186
26	14- 5-1969	4.14	164	70	26- 8-1970	5.05-5.06	199
27	15- 5-1969	4.38	172	71	28- 8-1970	5.24-5.25	213
28	16- 5-1969	4.72	187	72	29- 8-1970	5.38-5.38	222
29	17- 5-1969	5.00	199	73	30- 8-1970	5.47-5.48	219
30	18- 5-1969	5.23	206	74	31- 8-1970	5.55	227
31	19- 5-1969	5.35	212	75	2- 9-1970	5.69	235
32	22- 5-1969	5.28	204	76	3- 9-1970	5.74-5.75	233
33	26- 5-1969	5.07	194	77	4- 9-1970	5.80	238
34	27- 5-1969	4.89	187	78	5- 9-1970	5.83	240
35	10- 6-1969	1.23	41.1	79	8- 9-1970	5.87-5.88	243
36	11- 6-1969	1.20	41.6	80	13- 9-1970	5.79	241
37	13- 6-1969	1.14	40.1	81	14- 9-1970	5.74	228
38	16- 6-1969	1.08	38.4	82	15- 9-1970	5.69	229
39	19- 6-1969	1.01	35.6	83	16- 9-1970	5.63	228
40	22-12-1969	0.11	13.0	84	17- 9-1970	5.55	229
41	25-12-1969	0.05	11.8	85	18- 9-1970	5.46	220
42	30-12-1969	0.00	10.7	86	19- 9-1970	5.37	221
43	11- 2-1970	0.52	23.2	87	6- 2-1971	-0.19	7.00
44	30- 3-1970	3.70	152	88	28- 5-1971	2.17-215	78.4

3.1.9. The MARIBO at the Bridge road of DODOLA (260 km2-)

The Maribo is a permanent tributary of the right bank and it is located at the upstream end of the basin of the Wabi Shebelle. It springs from the Arena Mountains and its torrential conditions of flow are due to the very pronouced relief of the basin.

The station is located at 10 km from Adaba at the bridge of the Shashemane-Adaba road and its coordinates are 7° 00' N and 39° 22' E. It consists of three staff-gauge metric units which have not been modified during the survey period. The observations made twice a day are complete from the 24th of January 1967 until the end of the period.

Rating

The gauging section is rocky and stable. Twenty seven measurements were carried out between elevations 0.52 and 1.35 m (Table 3.9) enabling the plotting of a univocal rating curve (graph III.9). The extrapolation of this curve up to 2.25m (the maximum height observed) was made using the relation gauge- height/Section of the flow and the extrapolation of the mean velocity curve. The discharge for high flow may be known with an accuracy corresponding to ± 20 per cent.

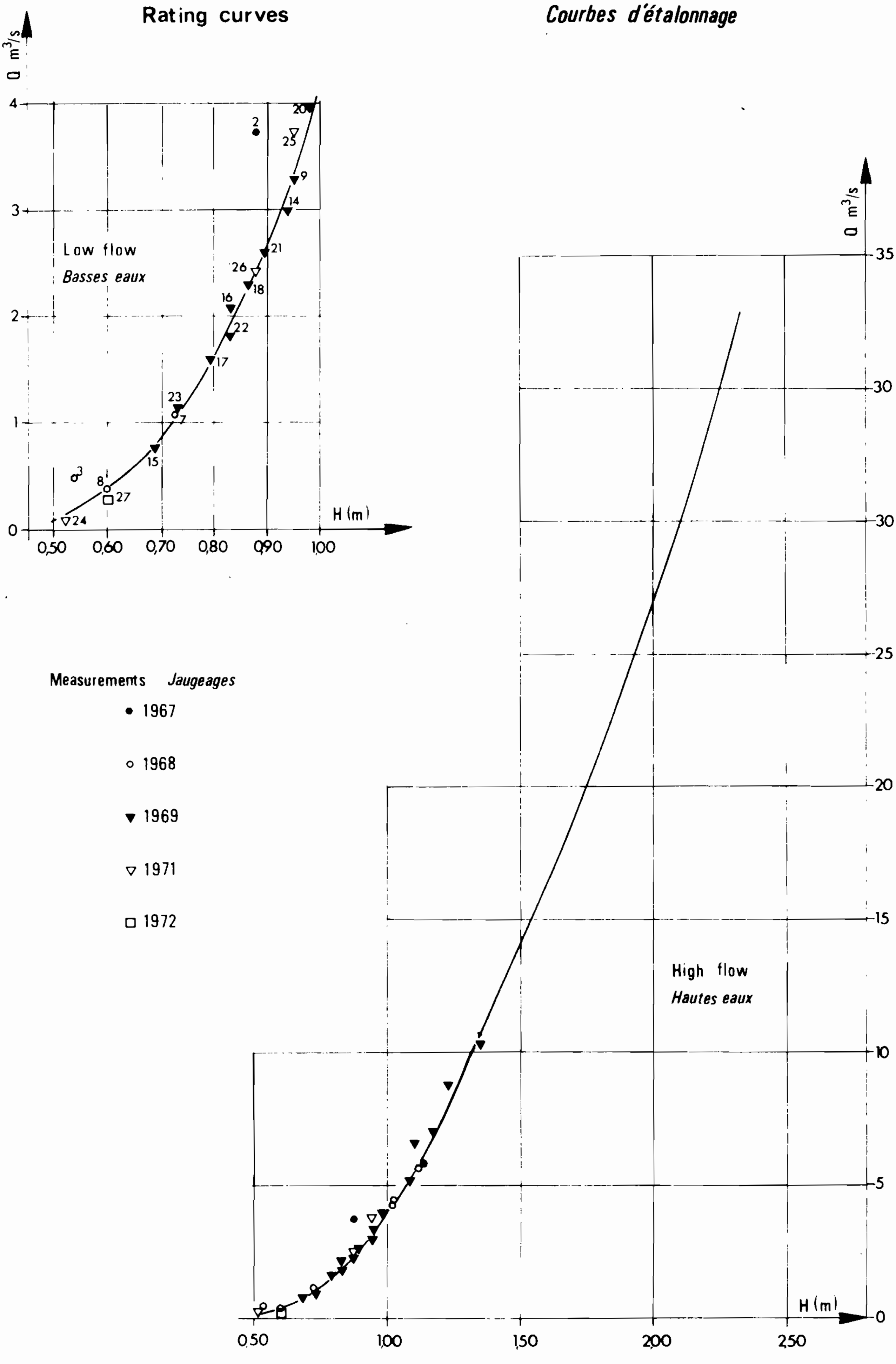
The rating equations are as follows:

L (m)	C (1,L)	C (2,L)	C (3,L)
0.50	0.9999973 E 01	0.1950006 E 01	0.7999998 E-01
0.70	0.1400005 E 02	0.5899993 E 01	0.8699999 E 00
0.80	0.0	0.9999997 E 01	0.1599999 E 01
0.90	0.1500053 E 02	0.1149994 E 02	0.2599999 E 01
1.10	0.1500101 E 02	0.1749980 E 02	0.5500000 E 01
1.30	0.9999936 E 01	0.1999991 E 02	0.9599999 E 01
1.50	0.5000370 E 01	0.2299986 E 02	0.1400000 E 02
1.90	0.1250003 E 02	0.2750002 E 02	0.2400000 E 02
2.30			

MARIBO AT BRIDGE-ROAD OF DODOLA

Gr-III-9

Rating curves   *Courbes d'étalonnage*



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MARIBO NEAR OF CONFLUENCE

Rating curves *Courbes d'étalonnage*

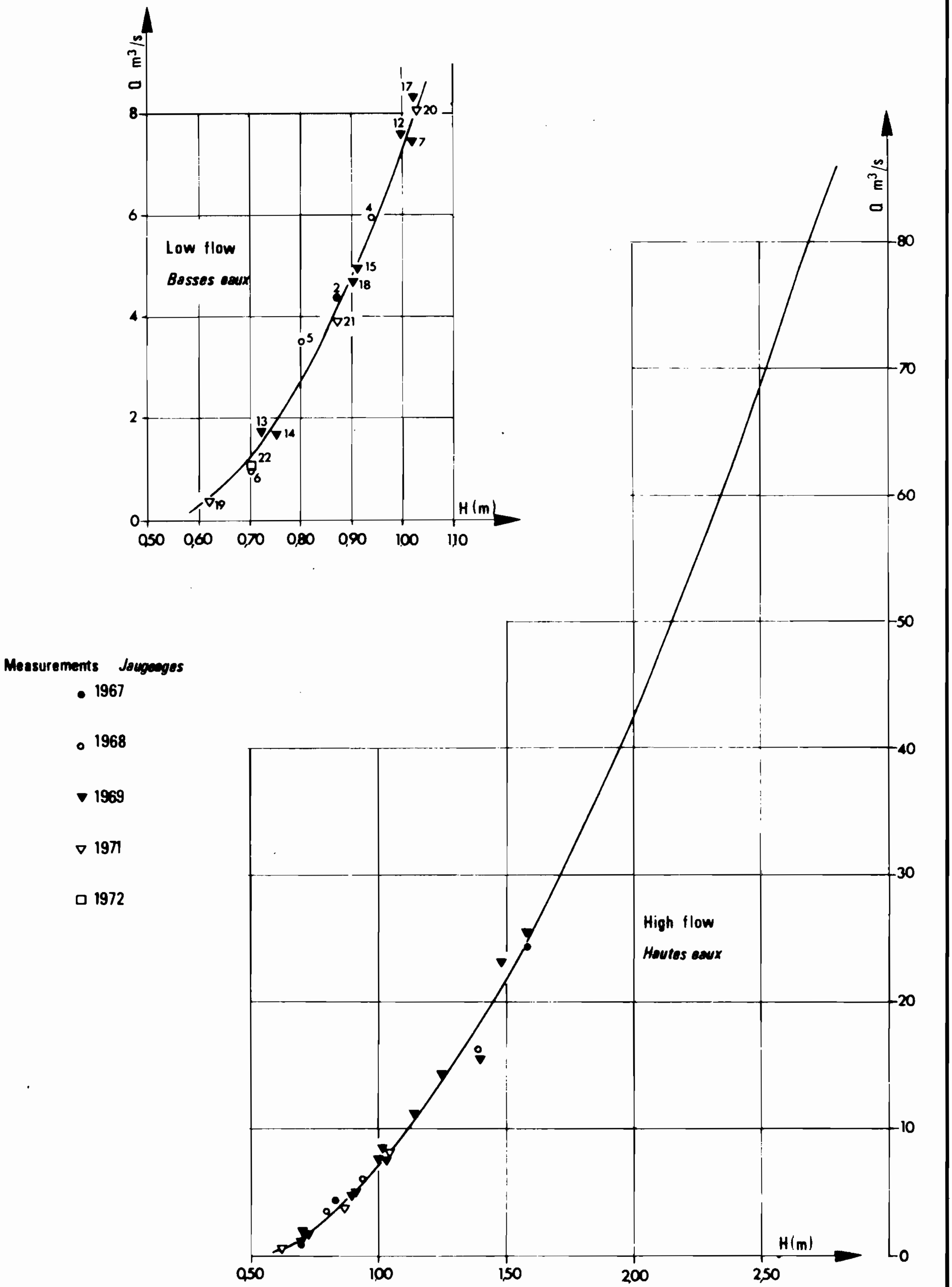


Table 3.9

List of the measurements of the Maribo at the Bridge Road of DODOLA

N°	Date	Height	Discharge	N°	Date	Height	Discharge
1	7- 7-1967	1.13	5.78	15	4- 6-1969	0.68-0.68	0.75
2	26-10-1967	0.88	3.73	16	3- 7-1969	0.83	2.08
3	31- 1-1968	0.54	0.48	17	13- 7-1969	0.79	1.60
4	26- 5-1968	1.02	4.40	18	19- 7-1969	0.86	2.27
5	26- 6-1968	1.02	4.25	19	8-10-1969	1.08	5.13
6	20-11-1968	1.12-1.11	5.65	20	10-10-1969	0.98	3.94
7	2-12-1968	0.72	1.07	21	15-10-1969	0.89	2.60
8	23-12-1968	0.60	0.37	22	17-10-1969	0.83	1.81
9	18- 2-1969	0.95-0.94	3.28	23	28-10-1969	0.73	1.11
10	25- 2-1969	1.35-1.34	10.3	24	7- 3-1971	0.52	0.10
11	6- 4-1969	1.17-1.16	6.99	25	30-10-1971	0.95	3.73
12	5- 5-1969	1.10	6.61	26	14-11-1971	0.88	2.42
13	7- 5-1969	1.23-1.22	8.80	27	12- 1-1972	0.60	0.33
14	14- 5-1969	0.94-0.93	2.99				

3.1.10 The Maribo at the junction with the Wabi Shebelle (1.220 km)

This station is located at approximately 20 km downstream from the preceding station in the GUEDEB plain, just before the junction of the Maribo with the Wabi Shebelle, and it controls all the Maribo basin. Between the two stations, the Maribo is joined by other tributaries all flowing from the Arena mountains. The flow conditions, since they are moderated by the comparatively flat zones of the Guedeb, present a less torrential character than at the preceding station. The inflows from the Maribo represent approximately 40 per cent of the flow at Malka Wacana.

The station presents the following coordinates 7° 06' N and 39° 19' E. It consists of four staff units and has not been modified during the observation period. Apart from October and November 1971 during which no recordings were made and except for some small gaps, the recordings are complete since the 1st of January 1968.

Rating

Twenty two measurements between elevation 0.62 and 1.58 m (table 3.10) allow plotting a univocal curve for low and medium flow. The maximum and minimum heights observed are 2.76 and 0.62 m. The extrapolation of the rating curve for high flow was made using the relation gauge height/Section of the flow and mean velocities (graph III.10) The relative error concerning discharge greater than 25m3/s is approximately ± 20 per cent.

The equations of the rating curve are given in the following table :

L (m)	C (1.L)	C (2.L)	C (3.L)
0.60	0.2333330 E 02	0.7333328 E 01	0.2750000 E 00
0.75	0.1999977 E 02	0.1600002 E 02	0.1900000 E 01
0.85	0.3999998 E 02	0.1899998 E 02	0.3700000 E 01
0.95	0.1333279 E 02	0.2200014 E 02	0.6000000 E 01
1.25	0.1749992 E 02	0.2750003 E 02	0.1380000 E 02
1.65	0.9999907 E 01	0.4000008 E 02	0.2759999 E 02
2.05	0.8190566 E 01	0.4799039 E 02	0.4520000 E 02
2.80			

Table 3.10

List of measurements of the Maribo at the junction with the Wabi Shebelle

N°	Date	Height (m)	Discharge (m3/s)	N°	Date	Height (m)	Discharge (m3/s)
1	11- 7-1967	1.58	24.3	12	15- 5-1969	1.00	7.60
2	8-11-1967	0.87	4.38	13	4- 6-1969	0.72	1.76
3	29- 6-1968	1.38 - 1.40	16.2	14	6- 6-1969	0.75	1.69
4	25-11-1968	0.94 - 0.93	5.96	15	10- 7-1969	0.91	4.95
5	3-12-1968	0.80	3.50	16	31- 8-1969	1.48	23.1
6	26-12-1968	0.70	0.97	17	10-10-1969	1.02	8.33
7	26- 4-1969	1.01 - 1.02	7.47	18	22-10-1969	0.90	4.68
8	28- 4-1969	1.14 - 1.13	11.2	19	8- 3-1971	0.62	0.38
9	1- 5-1969	1.59 - 1.57	25.3	20	30-10-1971	1.03	8.04
10	7- 5-1969	1.40 - 1.39	15.5	21	29-11-1971	0.87	3.90
11	12- 5-1969	1.25	14.2	22	13- 1-1972	0.70	1.03

3.1.11 The ERRER at HAMERO-HEDAD (14 200 km2)

The Errer is the last permanent tributary of the Wabi Shebelle. It originates in the granite mountains of Harar and then cuts through the limestone plateau in gorges sometimes more than 100 m deep. It is joined by two main tributaries, the Gobele and the Majo. Its torrential conditions of flow are due to the very strong slope of the river bed.

The station is located at approximately 15 km upstream from the junction Errer- Wabi Shebelle. Its coordinates are 7° 43' N and 42° 03' E.

A first monthly water level recorder was installed on the 23rd of May 1968 and equipped with six staff units. This water level recorder did not operate regularly owing to a periodical silting-up, and was moved on the 11th of May 1972 to a more suitable place approximately 30 m upstream from the former site.

The gauge datum of the second water level recorder corresponds to -0.85 m on the old water-level recorder.

The recordings for 1968 and 1969 present important gaps but from the 13th of December 1969 to the end of the observation period recordings are complete.

Rating

The station has been equipped with a cableway (1st of May 1969) for the gauging of high flow. The gauging section consists of a sandy bed between rocky banks.

The rating of the station consists of one hundred and two measurements distributed between elevations -0.60 and 3.16 m (table 3.11) (system of the first water level recorder). The maximum and the minimum observed are respectively 3.27 m and -0.06 m. Consequently, the rating of the station may be considered as satisfactory.

The non-univocal character of the station is relatively pronouced in the case of low flow and is due to a permanent altering of the sandy channel. By studying the measurements, one may know the periods of successive changes of calibration curves since they are due to strong floods reaching 1.50 to 2.00 m (and higher) on the staff-gauge.

For the observation time, seven periods stand out each corresponding to different ratings. The flow discharge curves plotted on graphs 3.11 all converge at elevation 0.70 m and form a common high discharge curve.

The observation periods corresponding to these calibrations are as flollows, i.e :

Rating curve	Validity period	Measurements
n° 1	24- 5-1968 to 10- 3- 1969	2 to 14
n° 2	11- 3-1969 to 1-11- 1969	15 to 18
n° 3	2-11-1969 to 24- 4- 1970	19 to 56
n° 4	25- 4-1970 to 4- 5- 1970	57 to 72
n° 5	5- 5-1970 to 9- 5- 1970	73 to 82
n° 6	10- 5-1970 to 3- 5- 1971	83 to 96
n° 7	4- 5-1971 to 31- 1- 1972	97 to 102

It may be noted that calibrations 3.5 and 7 are identical and that curves 4 and 6 remain very close to curve 3 which is the basic curve.

The set of curves meet in the lower part for a permanent base flow of approximately 1.50 m3/s.

It may also be noted that the considerable changes in the rating of low flow always occur during the first floods of the year (March to May). Then the rating curve presents less tangible and more progressive fluctuations.

The equations of the rating curves plotted according to the system of the old water level recorder are given below. In order to apply these equations to the system of the new water level recorder, 85 cm must be added to the limit heights.

Rating n°1

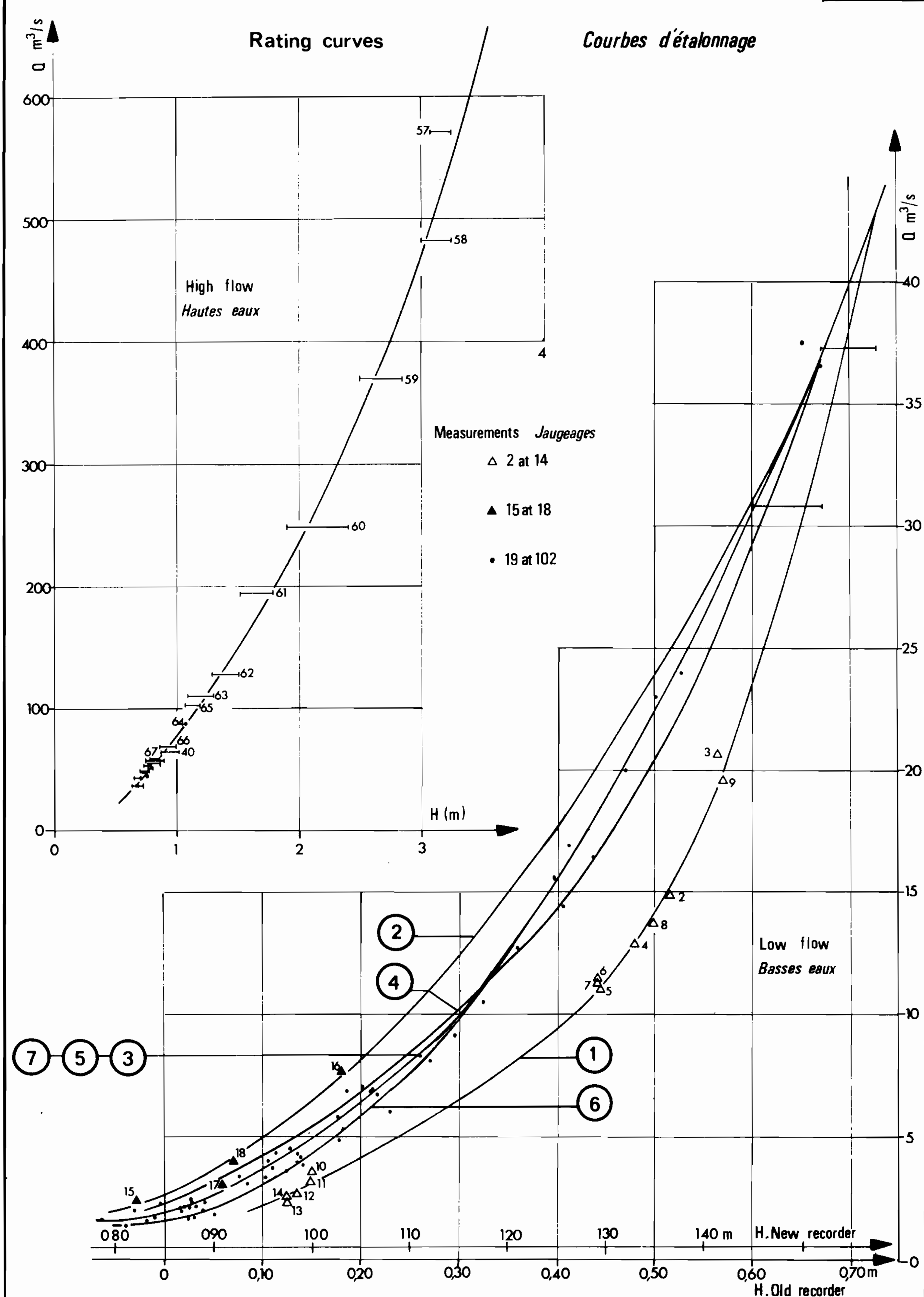
L (m)	C (1.L)	C (2.L)	C (3.L)
0.10	0.2050006 E 02	0.1764998 E 02	0.2150000 E 01
0.30	0.6000021 E 02	0.2299995 E 02	0.6500000 E 01
0.40	0.1761904 E 03	0.3090479 E 02	0.9400000 E 01
0.55	0.2533343 E 03	0.9533315 E 02	0.1800000 E 02
0.70	0.1785736 E 02	0.1246428 E 03	0.3800000 E 02
1.40	0.2999968 E 02	0.1530003 E 03	0.1340000 E 03
2.40	0.6749957 E 02	0.2155004 E 03	0.3170000 E 03
3.40			

Rating n°2

L (m)	C (1.L)	C (2.L)	C (3.L)
-0.05	0.7142877 E 02	0.9285690 E 01	0.2000000 E 01
0.10	0.4000017 E 02	0.2899995 E 02	0.5000000 E 01
0.30	0.4000136 E 02	0.4999971 E 02	0.1240000 E 02
0.50	0.7000067 E 02	0.6399982 E 02	0.2400000 E 02
0.70	0.2547641 E 02	0.1170238 E 03	0.3959999 E 02
Beyond 1.40 m, identical rating to n°1			

ERRER AT HAMERO-HEDAD

Gr-III-11



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Rating n°3-5-7

L (m)	C (1.L)	C (2.L)	C (3.L)
- 0.06	0.5555525 E 02	0.1666688 E 01	0.1599999 E 01
0.00	0.6000027 E 02	0.1199998 E 02	0.1900000 E 01
0.10	0.4500011 E 02	0.2249997 E 02	0.3700000 E 01
0.30	0.7500024 E 02	0.4749992 E 02	0.1000000 E 02
0.50	0.6500008 E 02	0.7249994 E 02	0.2250000 E 02
0.70	0.2547641 E 02	0.1170238 E 03	0.3959999 E 02
	Beyond 0.70, identical to rating n° 2		

Rating n° 4

L (m)	C (1.L)	C (2.L)	C (3.L)
- 0.02	0.2083357 E 02	0.1583330 E 02	0.2000000 E 01
0,10	0.4000017 E 02	0.2199995 E 02	0.4200000 E 01
0.30	0.9499974 E 02	0.3250005 E 02	0.1020000 E 02
0.50	0.1049991 E 03	0.7450014 E 02	0.2050000 E 02
0.70	0.2547641 E 02	0.1170238 E 03	0.3959999 E 02
	Beyond 0.70m, identical to rating n° 2		

Rating n° 6

L (m)	C (1.L)	C (2.L)	C (3.L)
- 0.05	0.6000009 E 02	0.9999857 E 00	0.1400000 E 01
0.05	0.4666823 E 02	0.1766656 E 02	0.2099999 E 01
0.20	0.9499924 E 02	0.2949991 E 02	0.5799999 E 01
0.40	0.5833507 E 02	0.6283302 E 02	0.1550000 E 02
0.70	0.2547592 E 02	0.1170238 E 03	0.3959999 E 02
	Beyond 0.70 m identical to rating n° 2		

Table 3.11

List of the measurements of the ERRER flow at HAMERO-HEDAD

N°	Date	Height (m)	Discharge (m3/s)	N°	Date	Height (m)	Discharge (m3/s)
1	11-12-1967		4.38	42	16-4-1970	0.73-0.67	37,3
2	22- 5-1968	0.52-0,51	14.8	43	16-4-1970	0.67-0.67	36.6
3	23- 5-1968	0.57	20.8	44	16-4-1970	0.77-0.70	49.2
4	28- 7-1968	0.48	12.9	45	16-4-1970	0.67-0.60	30.8
5	29- 7-1968	0.44	11.0	46	16-4-1970	0.60-0.55	29.8
6	30- 7-1968	0.44-0.44	11.4	47	16-4-1970	0.55-0.50	24,0
7	31- 7-1968	0.44-0.44	11.2	48	16-4-1970	0.48-0.46	20,1
8	3- 8-1968	0.50-0.50	13.8	49	16-4-1970	0.42-0.41	16,7
9	28- 8-1968	0.57-0.56	19.6	50	17-4-1970	0.39-0.40	15.6
10	6-11-1968	0.15	3.53	51	18-4-1970	0.22-0.22	7,50
11	3-12-1968	0.15	3.18	52	20-4-1970	0.17-0.17	5,80
12	1- 1-1969	0.13	2.72	53	21-4-1970	0.10-0.10	4.00
13	30- 1-1969	0.12	2.42	54	22-4-1970	0.21-0.20	7.00
14	30- 1-1969	0.12	2.53	55	23-4-1970	0.07-0.07	3.20
15	27- 4-1969	-0.03	2.36	56	24-4-1970	0.13-0.12	4.50
16	27- 5-1969	0.18	7.65	57	25-4-1970	3.08-3.25	571
17	23- 6-1969	0.06	3.06	58	25-4-1970	3.25-3.00	482
18	23- 7-1969	0,07	3.97	59	25-4-1970	2.85-2.50	369
19	2- 1-1970	0.00	2.00	60	25-4-1970	2.40-1.90	248
20	13- 2-1970	-0.06	1.54	61	25-4-1970	1.80-1.52	194
20bi	21- 3-1970	0.10-0.10	3.77	62	25-4-1970	1.52-1.29	128
21	23- 3-1970	0.02-0.02	2.53	63	25-4-1970	1.29-1.09	110
22	25- 3-1970	0.01-0.01	2.16	64	25-4-1970	1.09-1.07	88.0
23	27- 3-1970	0.22-0.21	7.10	65	25-4-1970	1.07-1.19	102
24	28- 3-1970	0.12-0.12	4.19	66	25-4-1970	1.00-0.86	68.8
25	29- 3-1970	0.05-0.05	2.68	67	25-4-1970	0.86-0.79	58.0
26	30- 3-1970	0.03-0.03	2.47	68	26-4-1970	0.41-0.40	14.4
27	31- 3-1970	0.02-0.02	2.15	69	27-4-1970	0.19-0.18	6.90
28	1- 4-1970	0.02-0.02	2.14	70	29-4-1970	0.12-0.11	4.43
29	2- 4-1970	0.02-0.02	2.19	71	1-5-1970	0.00-0.00	2.27
30	4- 4-1970	0.14-0.13	4.27	72	2-5-1970	0.45-0.42	16.4
31	4- 4-1970	0.08-0.08	3.30	73	4-5-1970	0.90-0.75	57.9
32	7- 4-1970	0.09-0.08	3.29	74	4-5-1970	0.75-0.71	48.4
33	9- 4-1970	0.02-0.02	2.17	75	4-5-1970	0.70-0.66	43.2
34	11- 4-1970	0.33-0.32	10.5	76	4-5-1970	0.66-0.64	37.6
35	11- 4-1970	0.30-0.29	9.16	77	4-5-1970	0.87-0.76	55.3
36	11- 4-1970	0.26-0.26	8.60	78	6-5-1970	0.81-0.76	50.6
37	12- 4-1970	0.18-0.18	5.30	79	6-5-1970	0.76-0.76	45.4
38	13- 4-1970	0.28-0.26	8.30	80	7-5-1970	0.50-0.50	23.1
39	15- 4-1970	0.12-0.12	3.55	81	8-5-1970	0.21-0.21	6.81
40	16- 4-1970	1.02-0.87	64.1	82	9-5-1970	0.14-0.14	4.44
41	16- 4-1970	0.80-0.73	53.2	83	10-5-1970	0.10-0.10	3.33

Table 3.11 (flow)

List of the measurements of the ERRER flow at HAMERO-HEDAD

N°	Date	Height (m)	Discharge m3/s	N°	Date	Height (m)	Discharge m3/s
84	8.06.1970	0.05	1.80	94	2.03.1971	0.00	1.46
85	17.07.1970	0.04	1.96	95	23.03.1971	-0.02	1.50
86	2.09.1970	0.23	6.00	96	22.04.1971	-0.04	1.56
87	16.09.1970	0.36	12.7	97	15.05.1971	0.21	6.96
88	30.09.1970	0.28	8.17	98	14.06.1971	0.00	1.86
89	14.10.1970	0.17	4.96	99	15.07.1971	0.14 - 0.13	3.95
90	28.10.1970	0.27 - 0.25	8.50	100	5.08.1971	0.03	2.31
91	3.12.1970	0.03	2.10	101	1.10.1971	0.08	3.20
92	2.01.1971	0.00	1.74	102	31.10.1971	-0.01	1.72
93	31.01.1971	0.02	1.68				

Note : All the heights are included in the system of the first water level recorder.

3.1.12. The DAKETA at HAMERO-HEDAD (14 200 km2)

The Daketa is the biggest intermittent tributary of the Wabi Shebelle. It springs in the granite mountains of Harar and then cuts across the limestone plateau. Its gorges are wider and not so deep as those of the Errer. In these gorges the main channel develops and consists of alluvial sediments sometimes as wide as 500 meters.

The station is located at approximately 5 km from the junction Daketa Wabi Shebelle and its coordinates are 7° 22' N and 42° 17' E. This station presents a considerable interest for the dam project at site II b since it controls all the inflows downstream from the station of the Wabi Shebelle to Hamero-Hedad. For this dam-project, the intermediate basin which is not controlled by these two stations only represents 2 600 km2.

Operating in this station presented many difficulties owing to the very mobile nature of its section and particularly, to the modification of the flow channel after each important flood.

A first monthly water level recorder including a staff gauge with four metric units was installed on the 5th of February 1968. The gauge datum was at elevation -0.897 m of the bench mark. The cessation of flow occured at approximately 0.39 m. As the recordings were often incomplete owing to frequent modifications of the low flow channel, the water level recorder was moved approximately 200 m further upstream on the 19th of July 1970. The gauge datum is at elevation -2.310 m of a bench mark plugged in the rock, the cessation of flow corresponds to approximately 0.16 m in the new system.

The correspondence between the two system results from a simultaneous reading on both staff-gauges in 1970 and 1971. The result is satisfactory for levels higher than 1.50 m on the new staff-gauge; it is not so accurate below this elevation.

Until June 1970 many gaps are noted in the recordings of the first water level recorder. After June 1970, the recordings are complete until the end of the observation period.

Rating

Eighty measurements were made between elevations 0.20 and 3.08 m (present staff gauge) and correspond to the rating of the station (Table 3.12) Apart from the first four measurements, all the gaugings took place during the second rainy season of 1970 and during the first rainy season of 1971.

All the gaugings higher than 2.20m on the staff-gauge result from the measurements of surface velocities (floats or current meters).

Change of the calibration curve due to the modifications of the channel were revealed by examining the measurements series. These changes of the curve always occur after strong floods reading 2.70m or more on the staff-gauge. During the measuring period(from 25.9.1970 to 19.5.1971) four different rating curves (graph III.12) were measured in this way. The changes of calibration curve always occur in the same direction, the discharge decreasing for the same elevations, this showing a silting-up of the section after the flood .

It is difficult, owing to the instability of the bed , to convert heights into discharges for observations made before or after the measuring period.

For data prior to 25.9.1970, the four measurements of low flow made in 1968 and 1969 were used (old gauge system). These measurements seem to correspond well with the first measurements of low flow of 1970.

Hence, it is believed that the section has scarcely been modified during this period and the first rating curve (curve n°1 of graph III.12) is applied to the heights observed.

For data subsequent to 9.5.1971, the observation of records shows that floods were very weak hence, considerable changes of the calibration curve were improbable. Consequently, the last rating curve has been applied (curve N°4 of graph 111.12)

For the periods during which no gaugings were made a considerable lack of precision as regards discharge may be expected though it cannot be easily estimated.

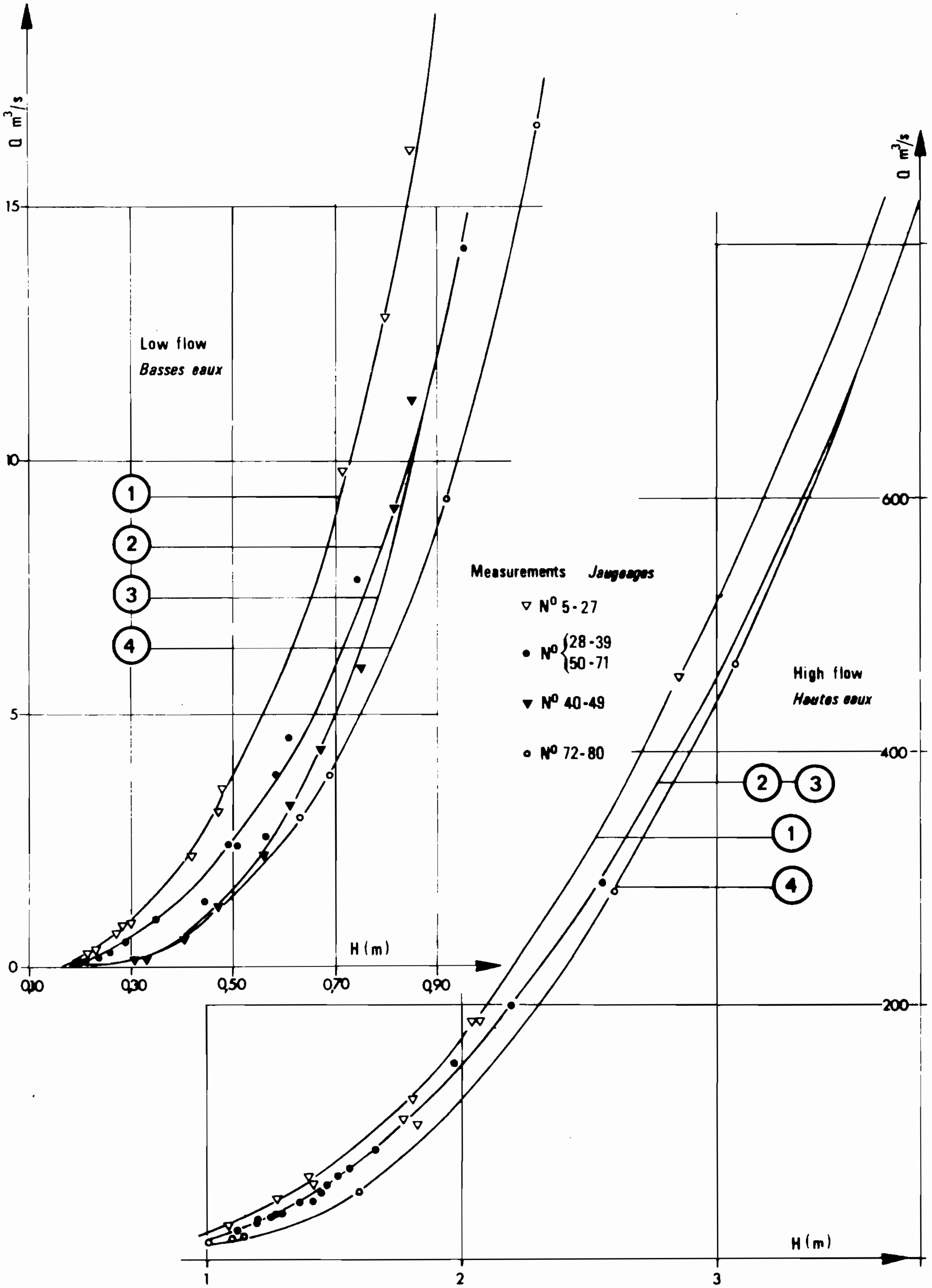
Finally, the validity periods for the four rating curves are as follows :

Rating	Validity Period	Measurements
1	6 - 2 - 1968 to 21 - 10 - 1970	1 to 27
2	22 - 10 - 1970 to 24 - 3 - 1971 5 - 4 - 1971 to 5 - 5 - 1971	28 to 39 50 to 71
3	25 - 3 - 1971 to 4 - 4 - 1971	40 to 49
4	6 - 5 - 1971 to 31 - 1 - 1972	72 to 80

DAKETA AT HAMERO-HEDAD

Gr-III-12

Rating curves — *Courbes d'étalonnage*



The coefficients of rating curves are :

Rating n° 1

L (m)	C (1,L)	C (2,L)	C (3,L)
0·00	0.0	0.0	0.0
0·16	0.2684526 E + 02	0.2098808 E + 01	0.0
0·40	0.3458330 E + 02	0.1404167 E + 02	0.2050000 E + 01
0·80	0.6619044 E + 02	0.4052382 E + 02	0.1320000 E + 02
1·50	0.8600000 E + 02	0.1590000 E + 03	0.7400000 E + 02
2·50	0.9727243 E + 02	0.3393635 E + 03	0.3190000 E + 03
3.60			

Rating n° 2

L (m)	C (1,L)	C (2,L)	C (3,L)
0·00	0.0	0.0	0.0
0·16	0.1422620 E + 02	0.1794046 E + 01	0.0
0·40	0.2875000 E + 02	0.9124984 E + 01	0.1250000 E + 01
0·80	0.7976166 E + 02	0.2059541 E + 02	0.9500000 E + 01
1·50	0.8200000 E + 02	0.1370000 E + 03	0.6300000 E + 02
2·50	0.8087128 E + 02	0.3115642 E + 03	0.2820000 E + 03
3·85			

Rating n° 3

L (m)	C (1,L)	C (2,L)	C (3,L)
0.00	0.0	0.0	0.0
0.16	0.1020410 E + 01	0.5714286 E + 00	0.0
0.30	0.3928574 E + 02	0.3214293 E + 00	0.1000000 E + 00
0.40	0.3045833 E + 02	0.6704150 E + 01	0.5250000 E + 00
0.80	0.7569034 E + 02	0.2617390 E + 02	0.8080000 E + 01
	Beyond 1,50 m identical to rating n° 2		

Rating N° 4

L (m)	C (1,L)	C (2,L)	C (3,L)
0.00	0.0	0.0	0.0
0.16	0.1020410 E + 01	0,5714286 E + 00	0.0
0.30	0.2857146 E + 02	0.6428556 E + 00	0.1000000 E + 00
0.40	0.2141666 E + 02	0.5858335 E + 01	0.4500000 E + 00
0.80	0.8769031 E + 02	0.6873932 E + 01	0.6220000 E + 01
1.50	0.7400000 E + 02	0.1250000 E + 03	0.5400000 E + 02
2.50	0.9437889 E + 02	0.3148103 E + 03	0.2530000 E + 03
3.85			

Table 3.12

List of the measurements of the DAKETA flow at HAMERO-HEDAD

N°	Date	Height (m)	Discharge (m3/s)	N°	Date	Height (m)	Discharge (m3/s)
1	27- 5-1968	0.51	1.36	28	22-10-1970	1.21-1.18	30.4
2	31- 5-1968	0.43	0.23	29	23-10-1970	0.59-0.58	3.80
3	4-12-1968	0.42	0.16	30	26-10-1970	0.45-0.44	1.33
4	14. 5-1969	0.49-0.48	1.04	31	27-10-1970	1.06-1.03	24.0
5	25- 9-1970	2.86	459	32	29-10-1970	0.61	4.56
6	25- 9-1970	2.05	187	33	30-10-1970	0.50-0.48	2.40
7	26- 9-1970	0.96-0.93	20.6	34	31-10-1970	0.35	0.95
8	26- 9-1970	0.87-0.83	16.1	35	1-11-1970	0.29	0.50
9	26- 9-1970	0.73-0.70	9.80	36	2-11-1970	0.26	0.32
10	27- 9-1970	0.48-0.46	3.12	37	3-11-1970	0.23	0.23
11	28- 9-1970	0.42-0.41	2.23	38	4-11-1970	0.21	0.15
12	28- 9-1970	0.31-0.30	0.85	39	25- 3-1971	1.50-1.62	73.4
13	28- 9-1970	0.27	0.67	40	26- 3-1971	0.82-0.81	9.10
14	29- 9-1970	0.23	0.32	41	26- 3-1971	0.77-0.73	5.90
15	11-10-1970	0.50-0.46	3.53	42	27- 3-1971	0.56	2.22
16	14-10-1970	0.28	0.82	43	28- 3-1971	0.40	0.50
17	15-10-1970	0.21	0.27	44	29- 3-1971	0.33	0.14
18	17-10-1970	0.96-0.92	20.7	45	31- 3-1971	0.31	0.12
19	17-10-1970	0.84-0.77	12.8	46	3- 4-1971	0.47	1.22
20	17-10-1970	1.86-1.80	106	47	4- 4-1971	0.90-0.80	11.2
21	17-10-1970	1.81-1.76	111	48	4- 4-1971	0.68-0.66	4.30
22	18-10-1970	1.31-1.50	63,9	49	4- 4-1971	0.61	3.18
23	19-10-1970	1.44-1.39	59.5	50	6- 4-1971	0.96-0.95	14.9
24	19-10-1970	1.30-1.27	48.3	51	7- 4-1971	0.76-0.73	7.68
25	19-10-1970	1.10-1.08	26.1	52	7- 4-1971	2.60-2.50	296
26	20-10-1970	2.12-2.03	188	53	7- 4-1971	2.30-2.10	201
27	20-10-1970	1.87-1.76	128	54	8- 4-1971	0.57-0.56	2.56

Table 3.12

List of the measurements of the DAKETA flow at HAMERO-HEDAD

N°	Date	Height (m)	Discharge (m3/s)	N°	Date	Height (m)	Discharge (m3/s)
55	10- 4-1971	1.00-0.92	17.1	68	3- 5-1971	1.08	24.5
56	11- 4-1971	1.75-1.60	87.0	69	3- 5-1971	2.02-1.92	156
57	11- 4-1971	1.55-1.50	67.8	70	4- 5-1971	1.47-1.48	59.0
58	11- 4-1971	1.47-1.37	47.5	71	5- 5-1971	1.32-1.20	35.4
59	11- 4-1971	1.30-1.25	36.8	72	6- 5-1971	3.10-3.06	470
60	11- 4-1971	1.23-1.17	32.6	73	7- 5-1971	2.70-2.50	290
61	13- 4-1971	1.47-1.43	54.8	74	7- 5-1971	1.17-1.13	19.4
62	13- 4-1971	1.40-1.34	46.6	75	8- 5-1971	0.69	3.80
63	15- 4-1971	0.51	2.38	76	9- 5-1971	1.04-0.98	13.9
64	23- 4-1971	0.21	0.10	77	9- 5-1971	0.91-0.93	9.30
65	25- 4-1971	0.20	0.05	78	11- 5-1971	1.61-1.59	53.6
66	29- 4-1971	0.17	0.02	79	12- 5-1971	1.11-1.09	16.6
67	3- 5-1971	.40-1.17	37.2	80	13- 5-1971	0.63	2.98

3.2. THE BASIN OF THE FAFEN

The hydrometric system consists of two stations: the first on one of the main branches of the Fafen : The Jerer, and the second on the Fafen before it flows into the flood plains.

3.2.1 The Jerer at Degahbour (6 470 km2)

The Jerer is the only important tributary of the Fafen. It originates in the North of Jijiga and presents an intermittent flow limited to rainy periods only.

The station is located at Degahbour village and its coordinates are 8° 13' N and 43° 33' E It is equipped with a monthly water-level recorder installed on the 9th of October 1967 and with three staff metric units. The gauge datum is at elevation -1.609 m under the bench mark. An observer measured the height of flow during floods and these observations enabled correcting as regards heights the often inaccurate water level recordings.

Apart from a gap of nine days in October 1971 observations are complete from 9.1.1967 to 31.12.1972.

Rating

The rating of the station consists of seventy two measurements from elevation 0,11 to 1,45 m (table 3.13).

Three measurements were made in 1967, twenty one during the second rainy season in 1970, and fourty eight during the first rainy season of 1971.

An apron built in June 1970, approximately 100 m downstream, considerably disturbed the hydrological conditions of the station since it caused an accumulation of transported sediments and a higher bottom of the channel. A series of eight cross-sections carried out from the 21st of October 1970 to the 16^{th} of may 1971 at the water-level recorder revealed the influence of the apron (graph III.13). During this period the river bed was 50 cm higher. The cessation of the flow corresponding before to 0.00 m on the staff gauge was then 0.45 m. Hence successive changes of the calibration curve may be noted after each flood.

The rating curves (graph III.14) were plotted after a very complete study of each series of measurements.

The three measurements of low-flow made in 1967 were used for the plotting of the rating curve before the apron was constructed (curve n°1) this presupposing that the station was stable at that time.

For curves n° 2 and 6, the measurements of 1970 and 1971 were used. Curve n° 7, corresponding to a period before measurements were carried out, is derived from curve n° 6 through relation to the cessation of flow at elevation 0.57 m

To summarize, the validity periods of these curves are :

Rating	Validity period	Height of cessation of flow (m.)	Measurements
n° 1	9-10-1967 to 25- 9-1970	0.00	1 to 3
2	26- 9-1970 to 14-10-1970	0.04	4 to 11
3	15-10-1970 to 22-10-1970	0.04	12 to 17
4	23-10-1970 to 10- 4-1971	0.20	18 to 36
5	11- 4-1971 to 6- 5-1971	0.37	37 to 59
6	7- 5-1971 to 31- 5-1971	0.45	60 to 72
7	After 31-5-1971	0.57	

The equations of the rating curves are given below :

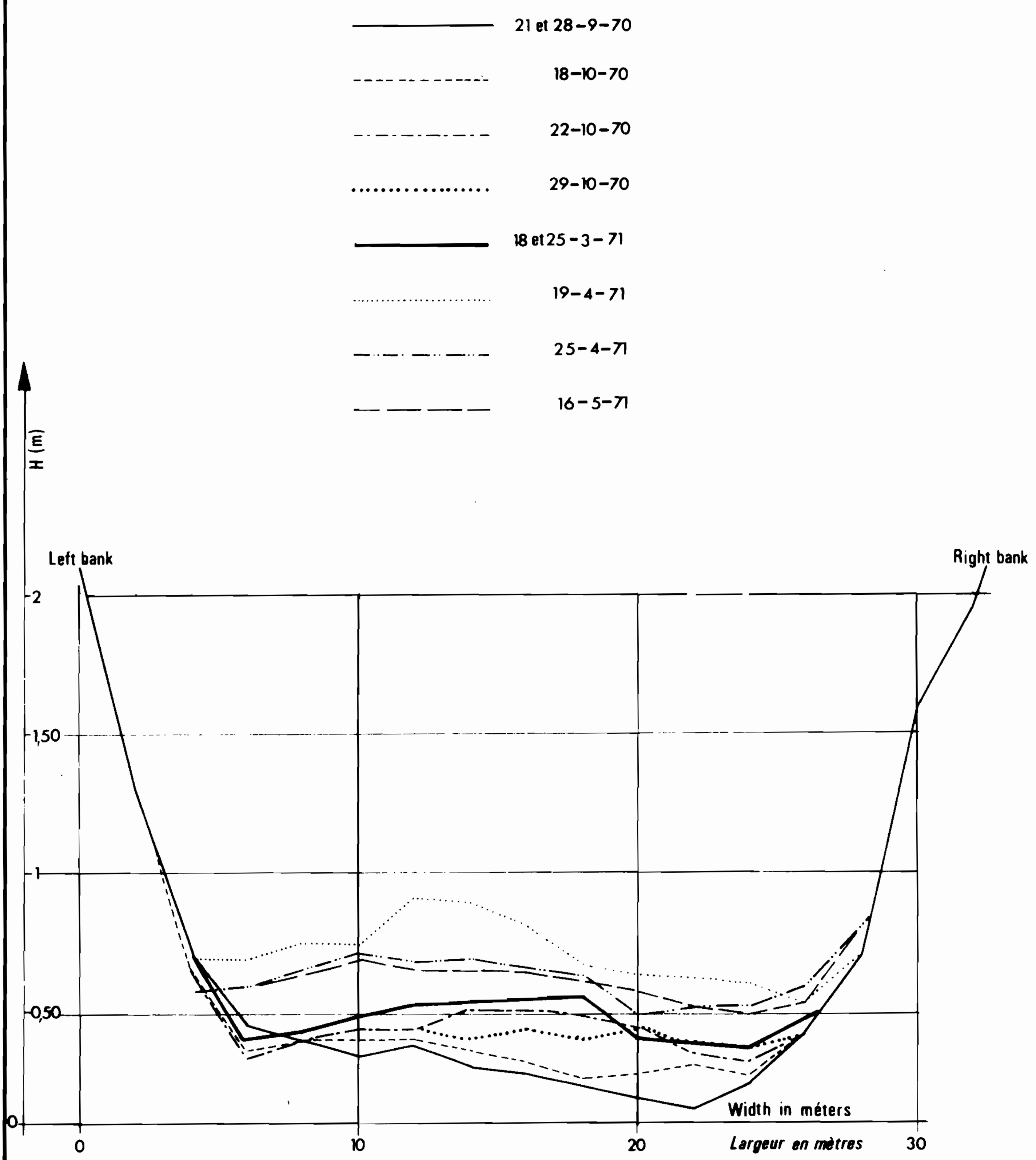
JERER AT DEGAHBOUR

Modifications of the cross-section

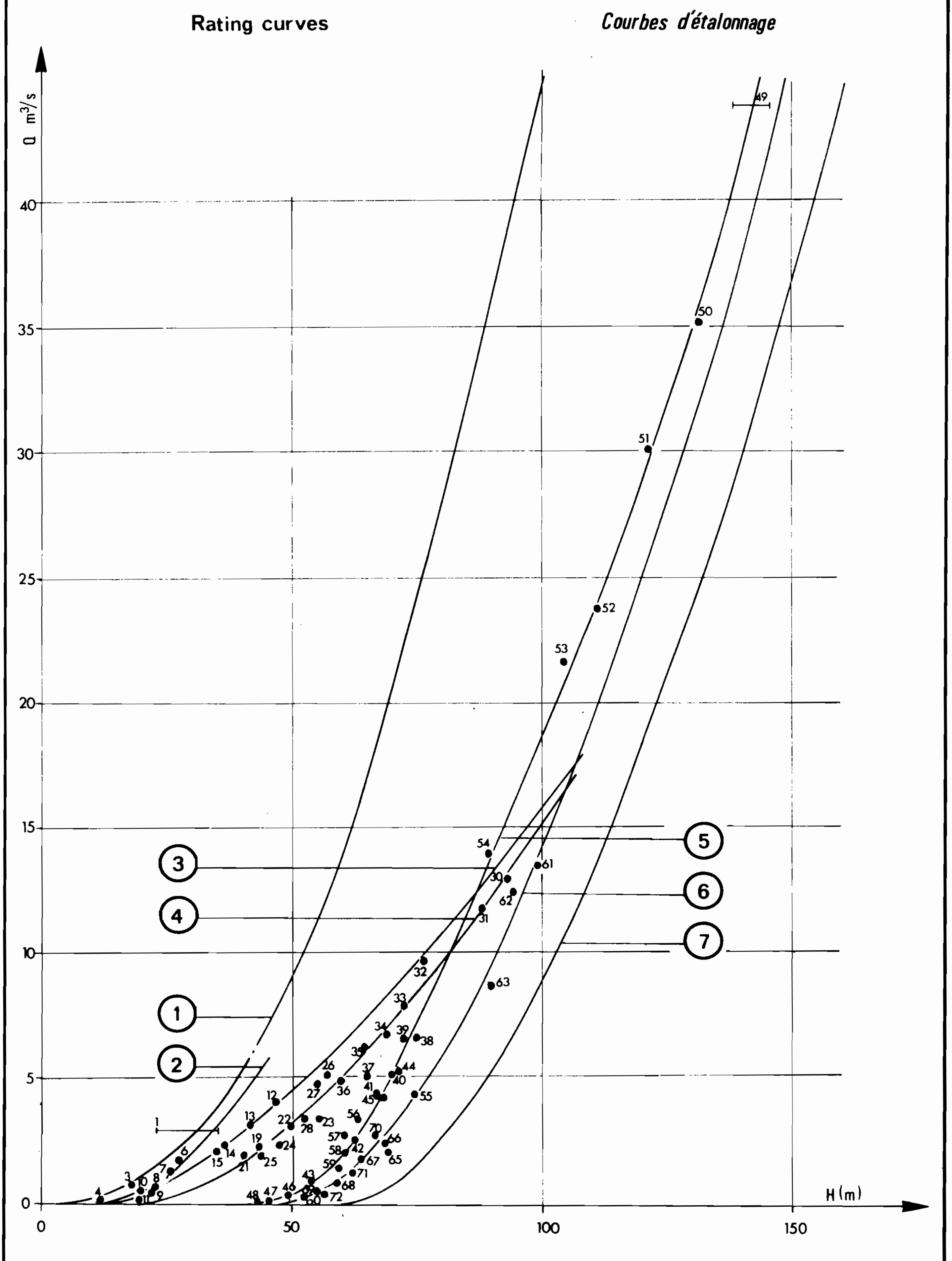
(from 21-9-70 to 16-5-71)

Modifications de la section mouillée

(du 21-9-70 au 16-5-71)



JERER AT DEGAHBOUR



Rating n°1

L (m)	C (1.L)	C (2.L)	C (3.L)
-0.20	0.0	0.0	0.0
0.00	0.2000002 E + 02	0.9999981 E + 00	0.0
0.20	0.4600008 E + 02	0.1279997 E + 02	0.1000000 E + 01
0.40	0.6624998 E + 02	0.3074998 E + 02	0.5400000 E + 01
0.80	0.5041692 E + 02	0.7341660 E + 02	0.2830000 E + 02
1.40	0.5277780 E + 02	0.1324999 E + 03	0.9050000 E + 02
2.00			

Rating n° 2

L (m)	C (1.L)	C (2.L)	C (3.L)
0.00	0.0	0.0	0.0
0.04	0.1344170 E + 02	0.5208292 E + 00	0.0
0.20	0.4999974 E + 02	0.1010001 E + 02	0.4300000 E + 00
0.30	0.1200009 E + 02	0.2459998 E + 02	0.1940000 E + 01
0.45			

Rating n° 3

L (m)	C (1.L)	C (2.L)	C (3.L)
0.00	0.0	0.0	0.0
0.04	0.1354170 E + 02	0.5208292 E + 00	0.0
0.20	0.2199988 E + 02	0.7900002 E + 01	0.4300000 E + 00
0.30	0.1200000 E + 02	0.1340000 E + 02	0.1440000 E + 01
0.50	0.1000003 E + 02	0.1799997 E + 02	0.4600000 E + 01
0.80	0.6666315 E + 01	0.2433337 E + 02	0.1090000 E + 02

Rating n° 4

L (m)	C (1,L)	C (2,L)	C (3,L)
0.00	0.0	0.0	0.0
0.20	0.5000005 E + 02	0.4999924 E + 00	0.0
0.30	0.2099994 E + 02	0.8400010 E + 01	0.5500000 E + 01
0.50	0.8166704 E + 01	0.1998331 E + 02	0.3070000 E + 01
0.80	0.1199978 E + 02	0.2580002 E + 02	0.9800000 E + 01
1.05			

Rating n° 5

L (m)	C (1,L)	C (2,L)	C (3,L)
0.00	0.0	0.0	0.0
0.37	0.3038461 E + 02	-0.1180768 E + 01	0.0
0.50	0.8133336 E + 02	0.7933334 E + 01	0.3600000 E + 00
0.70	0.1500003 E + 02	0.4149997 E + 02	0.5200000 E + 01
1.00	0.4250005 E + 02	0.4300005 E + 02	0.1900000 E + 02
1.40	0.5625117 E + 02	0.8624934 E + 02	0.4300000 E + 02
I.80			

Rating n° 6

L (m)	C (1,L)	C (2,L)	C (3,L)
0.00	0.0	0.0	0.0
0.45	0.4400005 E + 02	0.3999929 E + 00	0.0
0.55	0.4600002 E + 02	0.1149999 E + 02	0.4800000 E + 00
0.70	0.5200001 E + 02	0.2239998 E + 02	0.3240000 E + 01
0.90	0.2500055 E + 02	0.4449974 E + 02	0.9800000 E + 01
1.30			

Rating n° 7

L (m)	C (1.L)	C (2 L.)	C (3.L)
0.00	0.0	0.0	0.0
0.57	0.3833345 E + 02	-0.3166752 E + 00	0.0
0.65	0.6400003 E + 02	0.7599976 E + 01	0.2200000 E + 00
0.80	0.4000021 E + 02	0.2349995 E + 02	0.2800000 E + 01
1.20	0.4000099 E + 02	0.5066628 E + 02	0.1860001 E + 02
1.50			

Table 3.13

List of the measufements of the JERER flow at DEGAHBOUR

N°	Date	Height (m)	Discharge (m3/s)	N°	Date	Height (m)	Discharge (m3/s)
1	5-10-1967	0.35 -0.23	2.95	21	24-10-1970	0.41 - 0.40	1.99
2	5-10-1967	0.44 -0.40	6.07	22*	26-10-1970	0.80 - 0.60	Unin-Meas.
3	7-10-1967	0.18 -0.17	0.76	23	26-10-1970	0.60 - 0.50	3.40
4	5-10-1970	0.11	0.09	24	26-10-1970	0.50 - 0.44	2.36
5	12-10-1970	0.28 -0.26	1.73	25	4- 4-1971	0.47 - 0.40	2.00
6	12-10-1970	0.26 -0.25	1.18	26	5- 4-1971	0.57 - 0.57	5.16
7	12-10-1970	0.25 -0.25	1.07	27	5- 4-1971	0.55	4.78
8	12-10-1970	0.24 -0.24	0.86	28	6- 4-1971	0.53 - 0.52	3.42
9	12-10-1970	0.22 -0.21	0.51	29	6- 4-1971	0.50 - 0.49	3.08
10	12-10-1970	0.21 -0.20	0.43	30	7- 4-1971	0.95 - 0.91	13.0
11	12-10-1970	0.20 -0.20	0.43	31	7- 4-1971	0.88 - 0.87	11.9
12	17-10-1970	0.50 -0.44	3.99	32	7- 4-1971	0.78 - 0.75	9.72
13	17-10-1970	0.44 -0.38	3.16	33	7- 4-1971	0.73 - 0.72	7.95
14	17-10-1970	0.38 -0.35	3.32	34	7- 4-1971	0.70 - 0.68	6.77
15	17-10-1970	0.35 -0.34	2.21	35	7- 4-1971	0.65 - 0.64	6.30
16*	20-10-1970	0.85 -0.46	Uninterrup.	36	7- 4-1971	0.60 - 0.59	4.90
17*	20-10-1970	0.46 -0.33	measurement	37	10- 4-1971	0.65	5.11
18	24-10-1970	0.47 -0.42	2.52	38	12- 4-1971	0.75	6.64
19	24-10-1970	0.42 -0.41	2.61	39	12- 4-1971	0.73 - 0.72	6.62
20	24-10-1970	0.44 -0.43	2.29	40	12- 4-1971	0.70	5.13

* Uninterrupted measurements n° 16 - 17

	H	Q
	0.80 m	8.20 m3/s
	0.70	7.00
	0.60	5.70
	0.50	4.30

* Uninterrupted measurements n° 22

	H	Q
	0.80 m	10.0 m3/s
	0.70	7.10
	0.60	4.70

Table 3.13

List of the measurements of the JERER flow at Degahbour

N°	Date	Height (m)	Discharge (m3/s)	N°	Date	Height (m)	Discharge (m3/s)
41	12-4-1971	0,67	4.40	57	5-5-1971	0.60 -0.61	2.69
42	13-4-1971	0.62	2.58	58	6-5-1971	0.61 -0.60	1.96
43	14-4-1971	0.54	0.82	59	6-5-1971	0.59 -0.59	1.47
44	15-4-1971	0.72 -0.71	5.32	60	7-5-1971	0.53 -0.52	0.25
45	15-4-1971	0.67	4.34	61	8-5-1971	1.00 -0.98	13.6
46	20-4-1971	0.49	0.30	62	8-5-1971	0.95 -0.93	12.5
47	20-4-1971	0.46	0.11	63	8-5-1971	0.90 -0.89	8.81
48	3-5-1971	0.43	0.08	64	9-5-1971	0.75 -0.74	4.38
49	4-5-1971	1.45 -1.37	43.9	65	9-5-1971	0.69 -0.69	2.08
50	4-5-1971	1.31 -1.30	35.2	66	10-5-1971	0.69 -0.68	2.58
51	4-5-1971	1.22 -1.20	31.5	67	10-5-1971	0.64 -0.63	1.71
52	4-5-1971	1.11 -1.10	23.8	68	11-5-1971	0.59 -0.58	0.92
53	4-5-1971	1.05 -1.03	21.7	69	12-5-1971	0.55 -0.55	0.51
54	4-5-1971	0.90 -0.88	14.0	70	13-5-1971	0.68 -0.66	2.77
55	5-5-1971	0.69 -0.68	4.20	71	13-5-1971	0.62 -0.61	1.29
56	5-5-1971	0.64 -0.63	3.36	72	14-5-1971	0.56 -0.56	0.41

3.2.2. The Fafen at Kebri Dahar (25 600 km2)

The station controls the discharge of the Fafen before it flows into large water spreading basins where it finally dissapears through infiltration and evaporation.

Four staff-units have been installed on the Kebri Dahar bridge on the 28th of June 1968. The coordinates of the station are 6° 45' N and 44° 17' E The measurements of water levels made twice a day are complete for all the observation period.

Rating

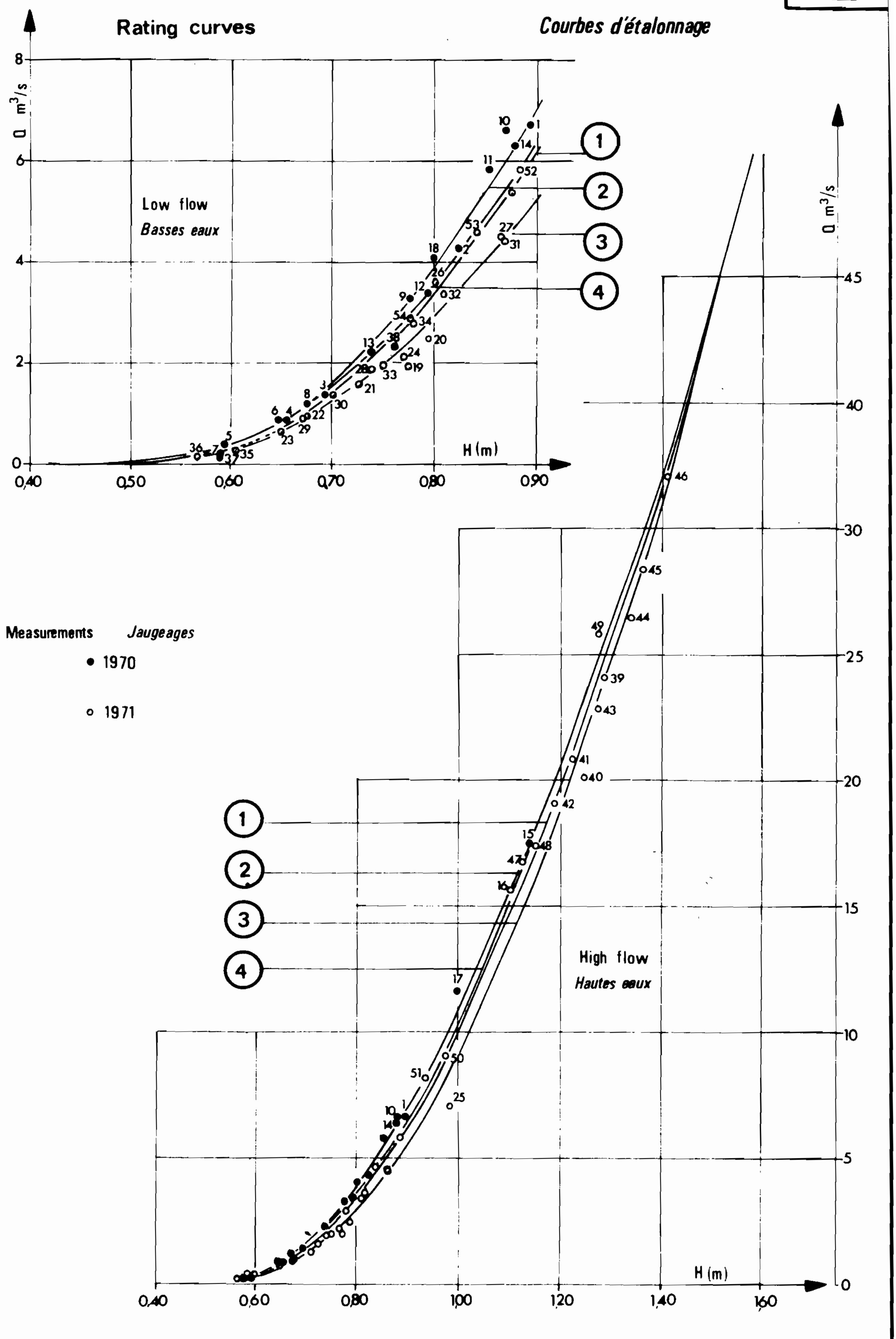
The rating of the station consists of fifty four measurements made between elevations 0.56 and 1.40 m (table 3.14).

The maximum observed is 1.80 m and the cessation of the flow occurs at approximately 0.42 m.

A slight instability of the station appears when examining the series of measurements for elevations below 1.30 m.

FAFEN AT KEBRI-DAHAR

Gr-III-15



Four rating curves are plotted (graph III.15) :

a)curve 1 is a mean curve plotted in the middle of the measurement points and is used for periods for which no measurements of discharge are available.

b) curves 2, 3 and 4 characterize the rating periods. The maximal relative deviation between the extreme curve is approximately 20 per cent for elevation 1.00 m on the staff gauge. Above elevation 1.30 m the curves meet and form a single curve. The extrapolation of the curve for high flow was made from the sections of the flow and from the extrapolation of the velocity curve.

The validity periods for each of these curves are as follows :

curve 1 : before 25.9.1970
after 8.7.1971

Curve 2 : from 26.9.1870 to 5.4.1971
curve 3 : from 6.4.1971 to 7.5.1971
curve 4 : from 8.5.1971 to 8.7.1971

The equations of the rating curves are given below :

Rating n°1

L (m)	C (1,L)	C (2,L)	c (3,L)
0.00	0.0	0.0	0.0
0.42	0.8333331 E 01	0.1666670 E 00	0.0
0.60	0.4250006 E 02	0.6749985 E 01	0.3000000 E 00
0.80	0.3999998 E 02	0.2399998 E 02	0.3349999 E 01
0.90	0.3250140 E 02	0.3524983 E 02	0.6150000 E 01
1.10	0.2444580 E 02	0.4899951 E 02	0.1450000 E 02
1.40	0.7500336 E 02	0.6349939 E 02	0.3139999 E 02
1.60	-0.9995490 E 01	0.8899921 E 02	0.4709999 E 02
1.80			

Rating n° 2

L (m)	C (1,L)	C (2,L)	C (3,L)
0.00	0.0	0.0	0.0
0.42	0.1157407 E 02	-0.2777863 E-01	0.0
0.60	0.5350012 E 02	0.6949970 E 01	0.3699999 E 00
0.80	0.1999998 E 02	0.2899998 E 02	0.3900000 E 01
0.90	0.3500151 E 02	0.3549982 E 02	0.7000000 E 01
1.10	0.1777885 E 02	0.4866629 E 02	0.1550000 E 02
1.40	0.9000328 E 02	0.5899940 E 02	0.3170000 E 02
1.60	-0.9995490 E 01	0.8899921 E 02	0.4709999 E 02
1.80			

Rating n° 3

L (m)	C (1,L)	C (2,L)	C (3,L)
0.00	0.0	0.0	0.0
0.42	0.6018520 E 01	0.3055553 E 00	0.0
0.60	0.3550008 E 02	0.6139983 E 01	0.2500000 E 00
0.80	0.2999998 E 02	0.2049998 E 02	0.2900000 E 01
0.90	0.2750145 E 02	0.3574983 E 02	0.5250000 E 01
1.10	0.2666808 E 02	0.4999951 E 02	0.1350000 E 02
1.40	0.5000319 E 02	0.7099942 E 02	0.3089999 E 02
1.60	-0.9995490 E 01	0.8899921 E 02	0.4709999 E 02
1.80			

Rating n° 4

L (m)	C (1,L)	C (2,L)	C (3,L)
0.00	0.0	0.0	0.0
0.42	0.1157407 E 02	-0.2777863 E -01	0.0
0.60	0.4400012 E 02	0.7099969 E 01	0.3699999 E 00
0.80	0.3999998 E 02	0.2399998 E 02	0.3549999 E 01
0.90	0.4750163 E 02	0.3474982 E 02	0.6349999 E 01
1.10	0.1111205 E 02	0.5166629 E 02	0.1520000 E 02
1.40	0.9000328 E 02	0.5899940 E 02	0.3170000 E 02
1.60	-0.9995490 E 01	0.8899921 E 02	0.4709999 E 02
1.80			

Table 3.14

List of the measurements of the FAFEN flow at KEBRI-DAHAR

N°	Date	Height (m)	Discharge (m3/s)	N°	Date	Height (m)	Discharge (m3/s)
1	27- 9-1970	0,90-0,89	6,68	6	13-10-1970	0,64-0,65	0,85
2	27- 9-1970	0,83-0,82	4,30	7	14-10-1970	0,58-0,58	0,27
3	28- 9-1970	0,70-0,69	1,38	8	15-10-1970	0,68-0,67	1,20
4	28- 9-1970	0,65-0,65	0,86	9	15-10-1970	0,77-0,78	3,23
5	29- 9-1970	0,59-0,58	0,40	10	19-10-1970	0,88-0,88	6,60

Table 3.14

List of the measurements of the FAFEN flow at KEBRI-DAHAR

N°	Date	Height (m)	Discharge (m3/s)	N°	Date	Height (m)	Discharge (m3/s)
11	19-10-1970	0.86-0.85	5.81	33	16- 4-1971	0.75-0.74	1.95
12	19-10-1970	0.80-0.79	3.37	34	16- 4-1971	0.78-0.78	2.79
13	22-10-1970	0.74-0.74	2.20	35	18- 4-1971	0.60-0.60	0.29
14	26-10-1970	0.89-0.87	6.35	36	20- 4-1971	0.56	0.12
15	28-10-1970	1.14-1.14	17.5	37	21- 4-1971	0.59	0.25
16	28-10-1970	1.11-1.10	15.7	38	27- 4-1971	0.76-0.75	2.35
17	28-10-1970	1.00-1.00	11.6	39	6- 5-1971	1.29-1.28	24.1
18	29-10-1970	0.80-0.80	4.05	40	6- 5-1971	1.25-1.24	20.1
19	7- 4-1971	0.78-0.77	1.93	41	6- 5-1971	1.23-1.22	20.8
20	7- 4-1971	0.79	2.42	42	7- 5-1971	1.18-1.20	19.1
21	8- 4-1971	0.73-0.72	1.56	43	7- 5-1971	1.27-1.29	22.8
22	8- 4-1971	0.68-0.67	0.96	44	7- 5-1971	1.33-1.34	26.4
23	8- 4-1971	0.65-0.64	0.62	45	7- 5-1971	1.36-1.37	28.4
24	9- 4-1971	0.77	2.12	46	8- 5-1971	1.41	32.0
25	9- 4-1971	0.97-1.00	7.07	47	8- 5-1971	1.14-1.11	16.8
26	10- 4.1971	0.80	3.61	48	10- 5-1971	1.14-1.16	17.4
27	11- 4.1971	0.88-0.85	4.48	49	10- 5-1971	1.27-1.29	25.8
28	11- 4.1971	0.74	1.88	50	11- 5-1971	0.97-0.96	9.0
29	12- 4.1971	0.67	0.90	51	11- 5-1971	0.93-0.93	8.10
30	13- 4.1971	0.70	1.36	52	11- 5-1971	0.88-0.88	5.80
31	14- 4.1971	0.87-0.86	4.39	53	12- 5-1971	0.84-0.84	4.58
32	14- 4.1971	0.81	3.37	54	12- 5-1971	0.78-0.77	2.90

3.3 Global results of hydrometric observations and of measurements of discharge

These results are given in tables 3.15 and 3.16 and call forth the following remarks ;

a) Apart from three stations in the Lower Valley (Imi, Gode and Burkur) installed at the beginning of 1969,hydrometric observations started in all the stations in 1967 and 1968. Complete records for three to five water-years are thus available at each station.

b) Intensive measurements of discharge were carried out in 1969 1970 and 1971. Correct rating based on the annual amplitude observed at most of the stations was thus possible. The necessary extrapolations in order to convert the highest flows into discharge data are usually small except for the three small stations of the upper basin (Wabi Shebelle and Maribo).

TABLE 3.15

Hydrometric equipment of the basin of the WABI SHEBELLE

N°	River	Station	Basin area (km^2)	coordinates		Date of operating		Characteristics of the staff-gauge			water level recorder	cable-way
				latitude N	longitude E	1st scale	2nd scale	Units (m)	Gauge datum * (m)	observer		
1	WABI SHEBELLE	bridge road of DODOLA	1 260	6°59'	39°03'	30- 1-1967		4		yes		
2	WABI SHEBELLE	MALKA-WAKANA	5 290	7°13'	39°24'	22- 7-1967	6- 1-1968	4	-4.217	yes	yes	
3	WABI SHEBELLE	LEGE-HIDA	21 500	7°53'	40°54'	4- 4-1968		6	-4.00	yes	yes	yes
4	WABI SHEBELLE	HAMERO-HEDAD	64 450	7°19'	42°11'	11- 2-1968		9	-8.030		yes	yes
5	WABI SHEBELLE	IMI	91 600	6°31'	42°08'	1- 3-1969	11- 6-1969	5	-3.422	yes	yes	
6	WABI SHEBELLE	GODE	127 300	5°51'	43°33'	4-10-1967	24- 6-1968	7	-6.410	yes	yes	
7	WABI SHEBELLE	KELAFO	139 100	5°35'	44°13'	8- 1-1969	4-1969	8		yes		
8	WABI SHEBELLE	BURKUR	144 000	5°11'	44°48'	6- 1-1969	25- 7-1969	8	-7.484	yes	yes	
9	MARIBO	Bridge road of DODOLA	260	7°00'	39°22'	24- 1-1967		3		yes		
10	MARIBO	Confluence	1 220	7°06'	39°19'	1- 1-1968		4		yes		
11	ERRER	HAMERO-HEDAD	14 200	7°43'	42°03'	23- 5-1968	11- 5-1970	6			yes	yes
12	DAKETA	HAMERO-HEDAD	14 200	7°22'	42°17'	5- 2-1968	19- 7-1970	4	-2.310		yes	
13	JERER	DEGAHBOUR	6 470	8°13'	43°33'	9-10-1967		3	-1.609	yes	yes	
14	FAFEN	KEBRI-DAHAR	25 600	6°45'	44°17'	28- 6-1968		4		yes		

* Compared to the nearest bench mark

TABLE 3.16

Global results of rating at the stream gauging stations

N°	River	Station	Number of annual measurements						Minimum elevation observed (m)	Minimum Height of measurement (m)	minimal discharge measured (m^3/s)	maximal elevation observed (m)	maximal height of measurement (m)	maximal discharge measured (m^3/s)
			1967	1968	1969	1970	1971	1972						
1	WABI SHEBELLE	bridge road of DODOLA	2	6	9		1		0.54	0.54	0.84	2.80	1.12	13.8
2	WABI SHEBELLE	MALKA-WAKANA	3	15	55		28	1	0.50	0.52	3.40	2.89	2.40	130
3	WABI SHEBELLE	LEGE-HIDA			2	124	2	2	0.28	0.34	7.20	4.30	3.89	630
4	WABI SHEBELLE	HAMERO-HEDAD		16	43	85	35		0.78	0.81	7.80	6,20	5.05	607
5	WABI SHEBELLE	IMI			27	47	41		-0.09	-0.07	11.7	2.78	2.46	540
6	WABI SHEBELLE	GODE		15	45	49	4		-0.49	-0.49	4.20	3.93	3.83	594
7	WABI SHEBELLE	KELAFO			6	39	14		2.86	2.91	3.60	7.89	7.82	313
8	WABI SHEBELLE	BURKUR			42	44	2		-0.48	-0.19	7.00	5.89	5.88	243
9	MARIBO	bridge road of DODOLA	2	6	15		3	1	0.50	0.52	0.10	2.25	1.35	10.3
10	MARIBO	confluence	2	4	12		3	1	0.62	0.62	0.38	2.76	1.58	25.3
11	ERRER	HAMERO-HEDAD	1	10	7	73	12		-0.06	-0.06	1.46	3.27	3.16	571
12	DAKETA	HAMERO-HEDAD		3	1	34	42		0.16 *	0.20	0.06	3.82	3.08	450
13	JERER	DEGAHBOUR	3			21	48		de 0 à 0.57 *	0.11	0.09	2.00	1.45	44.0
14	FEFEN	KEBRI-DAHAR				18	36		0.42 *	0.58	0.27	1.80	1.41	32.0

* Cessation of the flow (temporary river)

CHAPTER IV

Discharge records

Mean daily discharges have been calculated from the observations and hydrometric measurements presented in chapter III and are collected in a special annexe to the present report.

These mean daily discharges are computed from the records made twice a day at the stations equipped with an ordinary staff-gauge, or from the water-level recordings of stations equipped with a permanent automatic water-level recorder.

In the case of water level recordings, the elaborating process varies according to the station :

a) For the Wabi Shebelle stations, a constant interval was taken into consideration (six points a day for high flow and two points a day for low flow). For flash flood periods the chosen interval being too short, a variable interval was used for the elaboration of data.

b) For the Errer, Daketa and Jerer stations a variable time interval was used for the interpretation of all the observations.

Gauge-heights were automatically computed into discharge data using the conversion program in use at the Hydrological Service of ORSTOM : PØ H 301 for the records with a fixed time-interval, PØ H 327 for records with either fixed or variable time-intervals ; PØ H 310 for the integral water level recordings (variable intervals).

All these unprocessed discharges are presented as they are in the annexe.

The basic data presented for each station in this chapter are derived from the collection of unprocessed data.

When observations are incomplete for certain years and when the gaps correspond to short periods, the lacking discharge data are calculated from daily or monthly relations between stations or from interpolation of daily discharges during the recession period. In these cases the discharge data, either completed or computed,are given within brackets.

For each station, the basic data are presented in two tables for each water-year (from the 1st of February to the 31st of January) i.e :

a) a table giving the mean monthly and annual discharges and the long -term average discharges for the observation period.

b) a table of characteristic discharges, the list and signification of which is given below :

- Minimum low flow : mean daily minimum discharge of the water-year. Even if this flow occurs after the 31st of January it is included in preceding water-year to which it is in fact related.

- DCE : mean daily discharges exceeded during 255 days in the year. It is calculated from the minimum flow and consequently it may appear after the 31st of January which is the last day of the water-year.

- DC9, DC6,DC3 : mean daily discharges exceeded during respectively 9,6 and 3 months of the year.

- DCC : mean daily discharge exceeded during 10 days in the year.

- Flood : maximum instantaneous discharge of the water-year.

For the main stations presenting different flow conditions, graphs show the daily variations of discharge for 1971-1972 which is on the whole the weakest water-year of the whole observation period, but which, as revealed by the study of annual flow (chapter V), is the most approximated to the average year.

The same graphs are applied to both the Wabi Shebelle stations for 1968-1969 which is an important water-year.

4.1. WABI SHEBELLE STATIONS

4.1.1. The Wabi Shebelle at the bridge-road of Dodola (1 260 km2)

- Mean monthly and annual discharges for five complete years

- Long-term average discharge for the period : 8.20 m3/s i.e a specific discharge of 6.20 L/s km2

- Minimum low water discharge observed : 1.10 m3/s or 0.87 L/s km2

- Maximum high flow discharge : 106 m3/s or 84.0 L/s km2

- Great regularity of the mean annual discharge owing to a base flow which remains high.

Year	Mean monthly discharge in m3/s												Mean annual Discharge
	F	M	A	M	J	J	A	S	O	N	D	J	
1967-1968	1.34	1.23	1.91	2.46	1.91	10.2	18.4	24.6	21.0	16.1	2.34	1.39	8.60
1969-1970	2.65	3.49	18.1	9.36	8.59	7.85	11.8	17.3	7.17	1.92	1.64	3.34	7.75
1969-1970	4.39	6.75	3.43	4.75	4.06	14.3	29.7	16.4	3.56	1.92	1.50	2.47	7.81
1970-1971	1.84	7.21	7.87	5.70	2.73	7.65	26.1	22.4	8.34	2.24	1.43	1.64	7.97
1971-1972	1.37	1.71	3.13	7.44	9.08	20.3	29.5	14.7	11.4	3.52	2.52	2.10	8.97
Average	2.32	4.08	6.89	5.94	5.27	12.1	23.1	19.1	10.3	5.14	1.89	2.19	8.20

Year	Characteristic discharge in m3/s								
	Minimum low flow		Characteristic discharge					Maximum high flow	
	Q	Date	DCE	DC9	DC6	DC3	DCC	Q	Date
1966-1967	1.10	26- 3-67							
1967-1968	1.24	29- 1-68	1.10	1.38	2.34	10.3	38.2	106	7-10-67
1968-1969	1.38	27-12-68	1.38	2.11	4.28	10.1	29.0	59.7	20- 4-68
1969-1970	1.24	17- 2-70	1.38	1.96	3.81	9.50	37.2	71.9	21- 8-69
1970-1971	1.10	10- 3-71	1.38	1.81	4.77	10.1	34.9	90.9	28- 8-71
1971-1972			(1.10)	1.88	4.77	12.8	35.1	67.5	7- 8-71

4.1.2. <u>The Wabi Shebelle at Malka Wacana</u> (5 290 km2)

The observations correspond to a period of six years. The monthly discharges from February to August 1967 were obtained by relating a monthly scale to the station of the Dodola bridge-road.

- Long-term average discharge for the period 28.9 m3/s or 5.50 L/s km2
- Minimum low flow discharge observed : 301 m3/s or 0.57 L/s km2
- Maximum high flow discharge observed : 228 m3/s or 43.1 L/s km2
- As in the case of the preceding station the mean annual discharge is very regular owing to a high basic flow.

Year	Mean monthly discharge in m3/s												Mean annual dischar-ge m3/s
	F	M	A	M	J	J	A	S	O	N	D	J	
1967-1968	(4.6)	(4.4)	(6.4)	(8,8)	(6,4)	(35.0)	(78.7)	72.8	68.4	43. 0	8.77	4.22	(28:5)
1968-1969	15.6	21.1	68.5	32.8	20.3	43.9	74.3	43.0	23.2	9.64	5.89	9.49	30.7
1969-1970	17.7	40.5	19.2	22.3	9.39	43.2	89.3	50.2	14.0	6.62	4.97	8.50	27.3
1970-1971	5.16	29.3	31.0	16.4	6.63	28.7	99.8	74.2	34.5	10. 8	4.61	4.65	29.0
1971-1972	4.05	4.55	12.9	22.7	25. 9	57.5	90.2	52.3	47.3	12. 4	7.27	5.48	28.8
1972-1973	13.3	14.8	43.7	18.9	8.98	39.2	55.5	42.9	9.27	7.77	4.76	4.35	22.0
Average	10.1	19.1	30.3	20.3	12.9	41.3	81.3	55.9	32.8	15.0	6.05	6.12	27.7

Year	Characteristic discharge in m3/s								
	Minimum low flow		Characteristic discharge					Maximum high flow	
	Q	Date	DCE	DC9	DC6	DC3	DCC	Q	Date
1967-1968	3.90	31- 1-68					(112)	228	7-10-67
1968-1969	4.62	27.12.68	5.12	9.67	19.2	45.1	91.1	133	21- 4-68
1969-1970	3.90	21- 2-70	4.62	7.30	15.1	38.2	101	147	24- 8-69
1970-1971	3.01	6- 3-71	4.13	5.90	16.3	39.4	123	180	29- 8-70
1971-1972	4.37	1- 2-72	4.62	5.95	15.6	42.7	103	143	6-10-71
1972-1973	(3.67)	31- 1-73	(4.37)	6.52	10.7	37.4	72.6	106	14- 4-72

Graph IV.1 shows the daily distribution of discharges for two years : 1968-1969 and 1971-1972.

Exceptionally, for this station, the discharges of 1972-1973 are given because they correspond to a very weak water-year and are very useful for the dam-project at MALKA-WACANA.

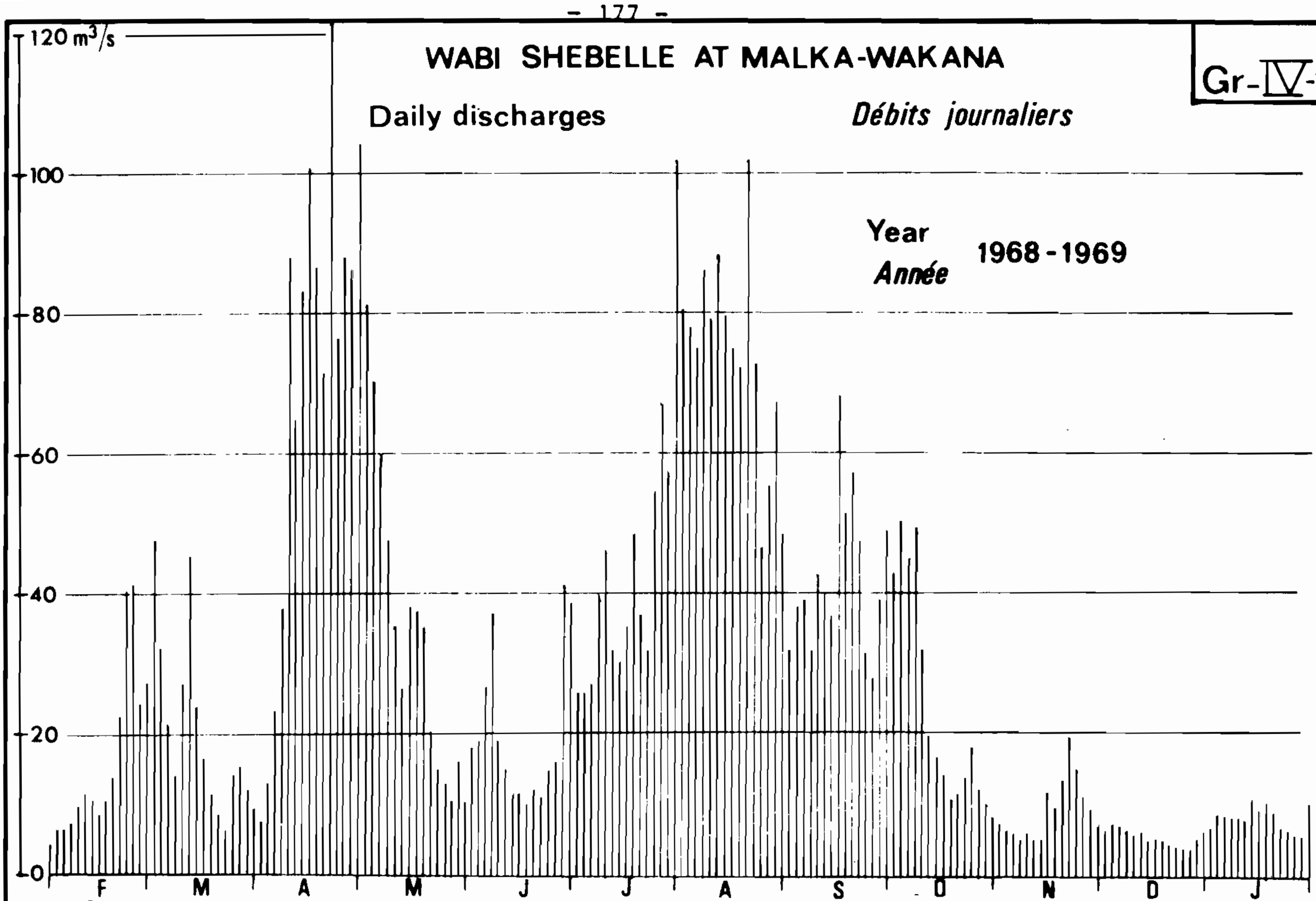
4.1.3. The Wabi Shebelle at Lege Hida (21 500 km2)

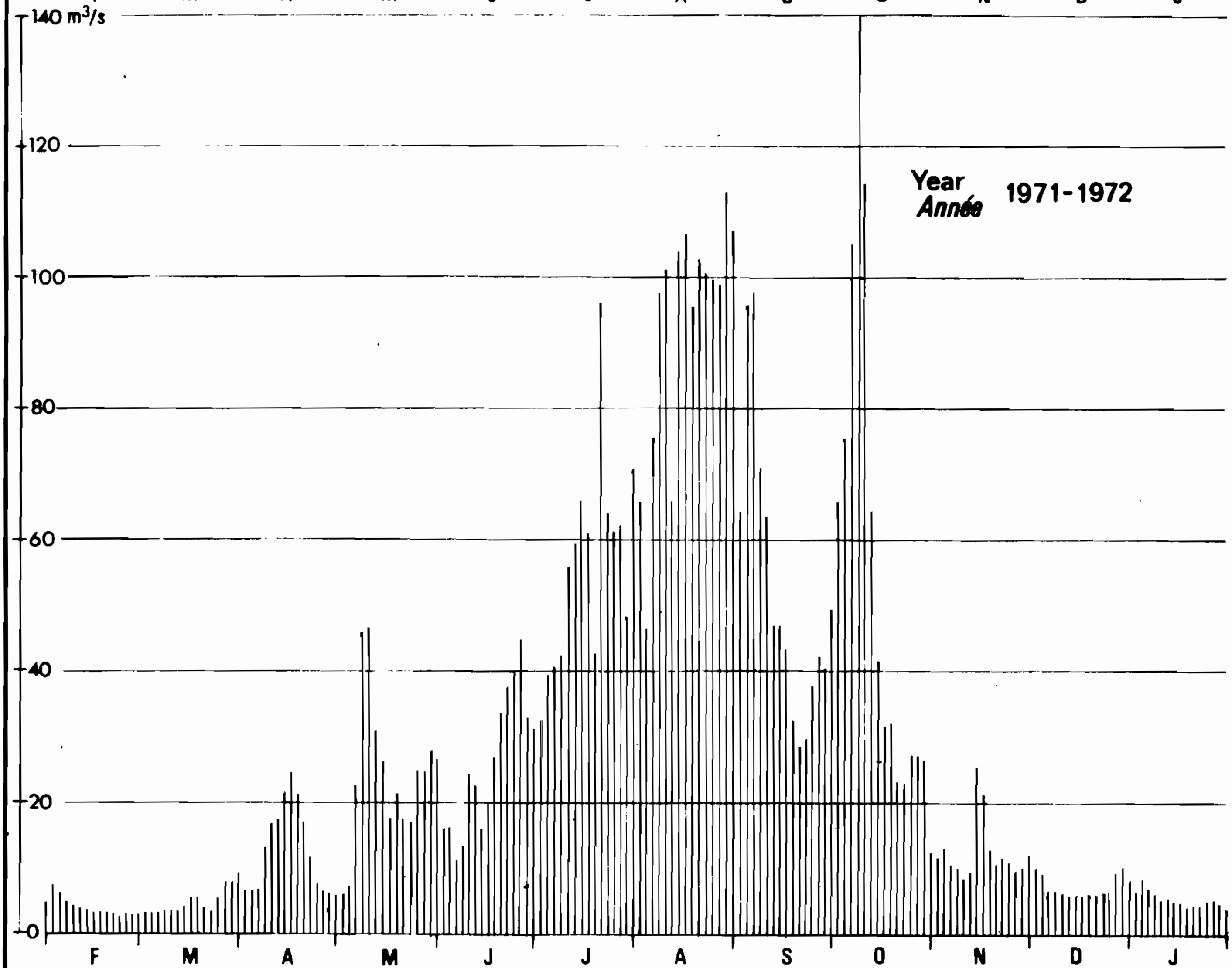
Only discharges for two years are available. The data for February and March 1970 have been reconstructed from the upstream and downstream stations.

Gr-IV-1

WABI SHEBELLE AT MALKA-WAKANA

Daily discharges — *Débits journaliers*





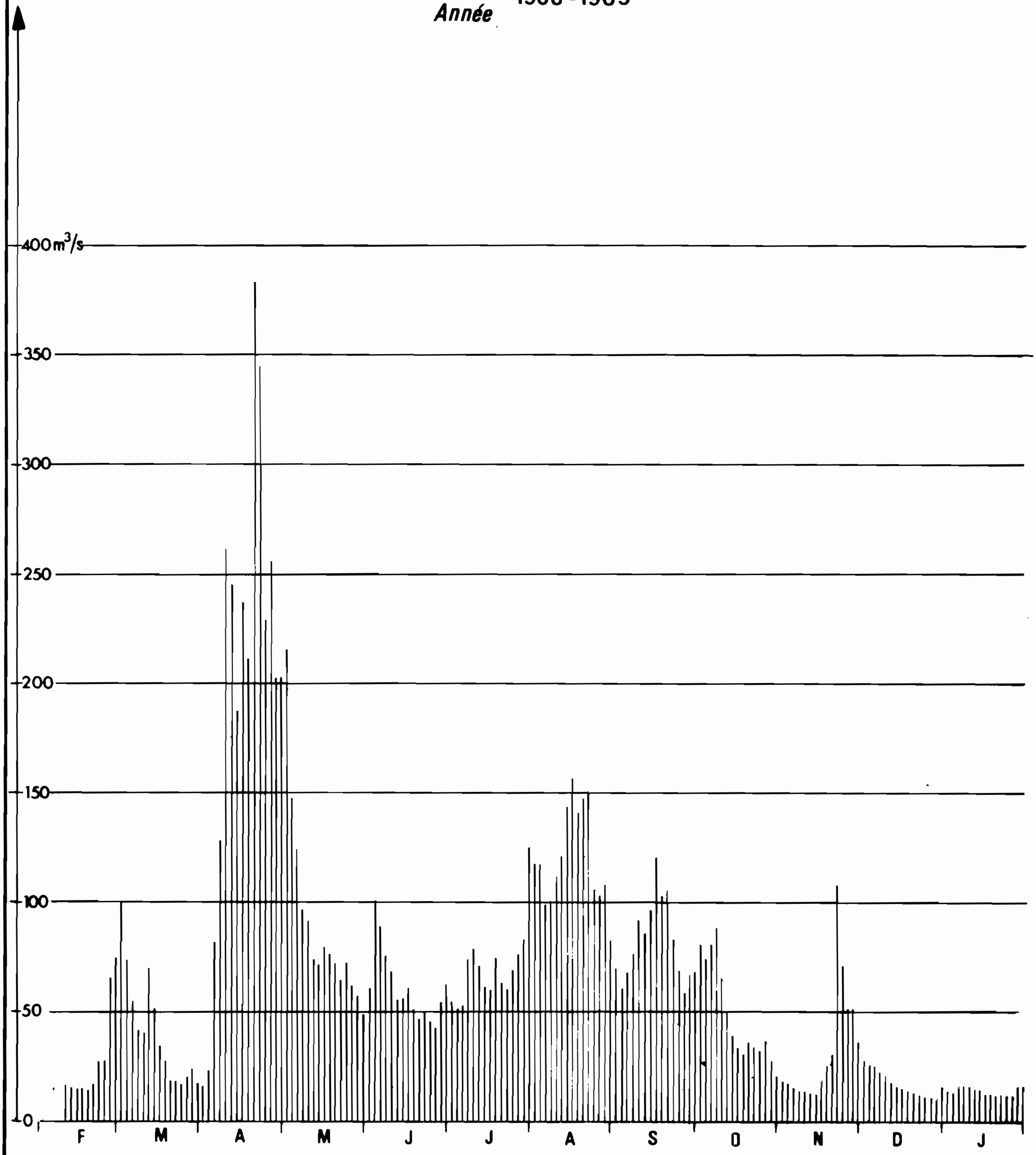
O.R.S.T.O.M. Service Hydrologique	date	des.	
	2-73	D- JP	ETR_291784

Gr-IV-2

WABI SHEBELLE AT HAMERO-HEDAD

Daily discharges — *Débits journaliers*

Year / *Année* 1968-1969



Year	Mean monthly discharge in m3/s												Mean annual discharge m3/s
	F	M	A	M	J	J	A	S	O	N	D	J	
1970-1971	(12,0)	(148)	93,0	54,5	16,1	82,9	287	168	89,5	28,1	9,20	8,00	(83.0)
1971-1972	6.92	12.4	47.8	56.1	58.5	114	160	97.8	82.8	53.5	14.2	8.90	59.4

Year	Characteristic discharge in m3/s								
	Minimum low flow		Characteristic discharge					Maximum high flow	
	Q	Date	DCE	DC9	DC6	DC3	DCC	Q	Date
1970-1971	5,21	15. 3.71	7,36	(15,0)	64.7	156	372	717	17. 3.70
1971-1972			5.21	(12.5)	42.0	95.6	195	327	16.11.71

4.1.4. The Wabi Shebelle at Hamero Hedad (64 450 km2)

Observations are available for four years. The mean discharges in May and June have been reconstituted by correlation of the monthly scale with the Lege Hida and Imi stations. The gaps for 1968 and 9170 correspond to only a few days during low flow and were compensated for by interpreting the recession curves.

- Long-term average discharge computed for a period of four years :106 m3/s or 1'65 L/s km2
- Minimum low flow : 7,59 m3/s or 0,12 L/s.km2
- Maximum high flow: 8.94 m3/s or 13.8 L/s.km2
- The irregularity of mean annual discharge is more pronounced than in the upper basin.

Graph n° IV.2 showingthe daily distribution of discharges for 1968-1969 (an abundant water-year) since 1971-1972 presents some gaps.

Year	Mean monthly discharge in m3/s												Mean annual dis-charge m3/s
	F	M	A	M	J	J	A	S	O	N	D	J	
1968-1969	(47.1)	86.2	371	193	119	136	242	164	100	66.1	37.5	29.1	(133)
1969-1970	102	187	108	160	46.3	119	240	160	47.4	32.6	14.5	25.9	104
1970-1971	18.6	178	120	(81.3)	(22.6)	78.7	317	228	132	48.8	17.3	12.9	(105)
1971-1972	10.8	16.3	70.1	(110)	(79.0)	118	202	155	98.5	74.2	24.8	19.9	(81.6)
Average	44.6	117	167	136	66.7	113	250	177	94.5	55.4	21.0	21.9	106

Year	Characteristic discharges in m3/s								
	Minimum low flow		Characteristic discharges					Maximum high flow	
	Q	Date	DCE	DC9	DC6	DC3	DCC	Q	Date
1967-1968	(29.3)	18. 2.68							
1968-1969	19.5	15. 2.69	24.8	35.3	112	169	494	894	21. 4.68
1969-1970	11.1	13. 1.70	11.5	30.7	70.3	166	286	616	3. 5.69
1970-1971	7.59	17. 3.71	7.92	20.4	62.7	151	396	750	17.3 .70
1971-1972				22.8	(75.0)	(130)	(250)	(384)	23. 8.71

4.1.5. The Wabi Shebelle at Imi (91 600 km2)

Observations for three years are available. The data for February 1969 were reconstituted by relating the monthly scale and the stations of Hamero-Hedad and Gode. The lacking discharge data for December 1971 and January 1972 were reconstituted using the recession curves.

- Long-term average discharge for three years : 98,5 m3/s or 1,08 L/s km2
- Minimum low water discharge 9,84 m3/s or 0,11 L/s km2
- Maximum high water discharge 877 m3/s or 9,60 L/s km2

The absence of the abundant water-year 1968-1969 explains why the mean annual discharge is comparatively lower than at Hamero-Hedad and Gode.

Year	Mean monthly discharges in m3/s												Mean annual discharge m3/s
	F	M	A	M	J	J	A	S	O	N	D	J	
1969-1970	(75.0)	180	106	147	36.2	108	222	152	50.2	31.6	15.6	25.2	(95.9)
1970-1971	17.0	175	148	107	19.9	73.7	330	249	154	46.8	13.6	12.2	113
1971-1972	11.3	18.9	84.1	114	77.8	130	205	159	123	79.3	(26.6)	(18.0)	(87.3)
Average	34.4	125	113	123	44.6	104	252	187	109	52.6	18.6	18.5	98.5

Year	Characteristic discharges in m3/s								
	Minimum low flow		characteristic discharges					Maximum high flow	
	Q	DATE	DCE	DC9	DC6	DC3	DCC	Q	DATE
1969-1970	12.3	25- 2-70	12.6	(22.0)	(72,3)	(165)	(255)	408	3 - 5-69
1970-1971	9.84	19- 3-71	9.99	16.0	71.4	170	407	732	18 - 3-70
1971-1972				(16.0)	74.4	132	249	877	6 - 5-71

4.1.6. The Wabi Shebelle at Gode (127 300 km2)

The discharges for a period of four complete water years are available A gap corresponding to 17 days in March-April 1968 was filled in through relations with the discharges of Hamero-Hedad.

- Long term average discharge for four years : 108 m3/s or 0.85 L/s.km2
- Minimum low water discharge : 4.01 m3/s or 0.03 L/s.km2
- Maximum high water discharge 608 m3/s or 4.80 L/s.km2
- One must note the marked long term irregularity of mean annual discharges and the decrease of low water discharges compared to those of Imi Station.

Graph n° IV.3 shows the daily distribution of discharges for the water-years 1968-1969 and 1971-1972.

Year	Mean Monthly discharges in m3/s												Mean annual dis charges
	F	M	A	M	J	J	A	S	O	N	D	J	
1967-1968									311	231	92,1	32,5	
1968-1969	59,2	(88,0)	(362)	232	112	104	213	136	99,0	65,5	39,6	19,1	127
1969-1970	54,2	188	103	179	36,4	95,1	215	164	69,3	45,6	14,0	16,1	98,8
1970-1971	22,0	170	207	126	25,5	54,6	294	242	180	68,9	18,0	11,5	119
1971-1972	8,77	7,54	88,6	129	78,9	124	192	171	132	88,4	28,6	14,1	89,0
Average	36,0	113	190	166	63,2	94,4	228	178	120	67,1	25,0	15,2	108

Year	Characteristic discharges in m3/s								
	Minimum low flow		characteristic discharges					maximum high flow	
	Q	DATE	DCE	DC9	DC6	DC3	DCC	Q	DATE
1967-1968	21,8	10-2-68						608*	12-10-67
1968-1969	15,7	28-1-69	17,0	42,2	97,6	165	515	590	25- 4-68
1969-1970	7,77	20-1-70	8,50	24,9	70,9	165	278	480	5- 5-69
1970-1971	4,01	29-3-71	4,28	20,0	80,7	183	442	594	22- 4-70
1971-1972				17,6	80,1	132	244	428	8- 5-71

* Maximum discharge observed during the four last months of the water year 1967 -1968.

4.1.7. The Wabi Shebelle at Kelafo (139 100 km2)

Three complete observation years (not including 1968-1969 as for Imi) are available.

- long term average discharge for three years 91,7 m3 or 0,66 L/s.km2
- Minimum low flow discharge 3,01 m3/s or 0,02 L/s.km2
- Maximum high water discharge : 322 m3 or 2.30 L/s.km2

- The mean annual discharge and the characteristic discharges decrease owing to the flooding which occurs upstream from the station.

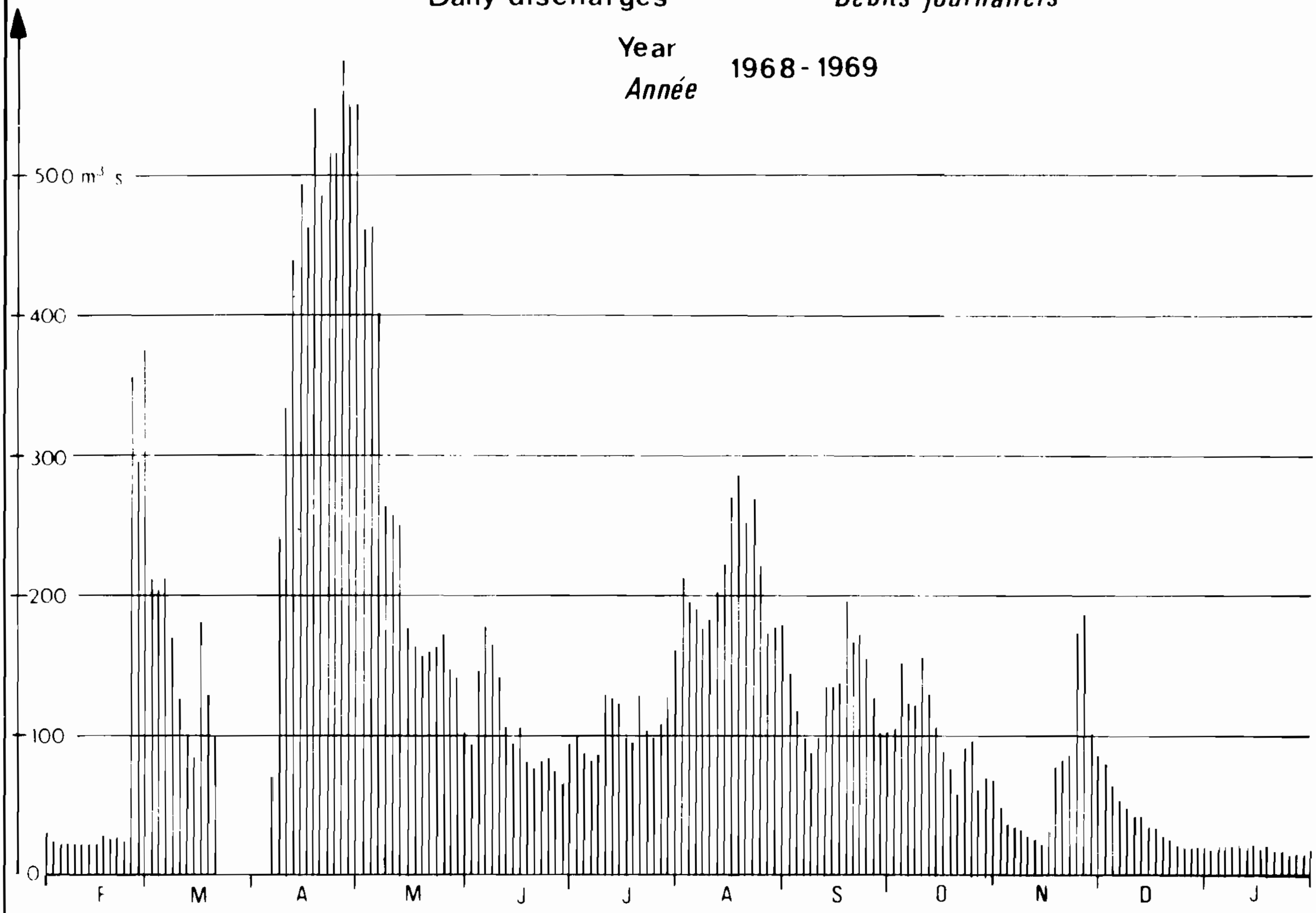
- The low water discharges continue decreasing owing to infiltration and evaporation;

Year	Mean monthly discharges in m3/s												mean annual discharge in m3/s
	F	M	A	M	J	J	A	S	O	N	D	J	
1967-1968												30,1	
1968-1969												17,3	
1969-1970	48,5	191	115	176	33,3	87,8	202	162	69,5	46,2	14,0	12,4	96,9
1970-1971	20,7	132	179	129	22,8	42,9	240	223	159	64,2	15,3	9,22	104
1971-1972	6,87	3,93	73,4	113	61,1	99,5	160	149	112	73,0	22,9	11,1	74,2
Average	25,4	109	122	139	39,1	76,7	201	178	113	61,2	17,4	10,9	91,7

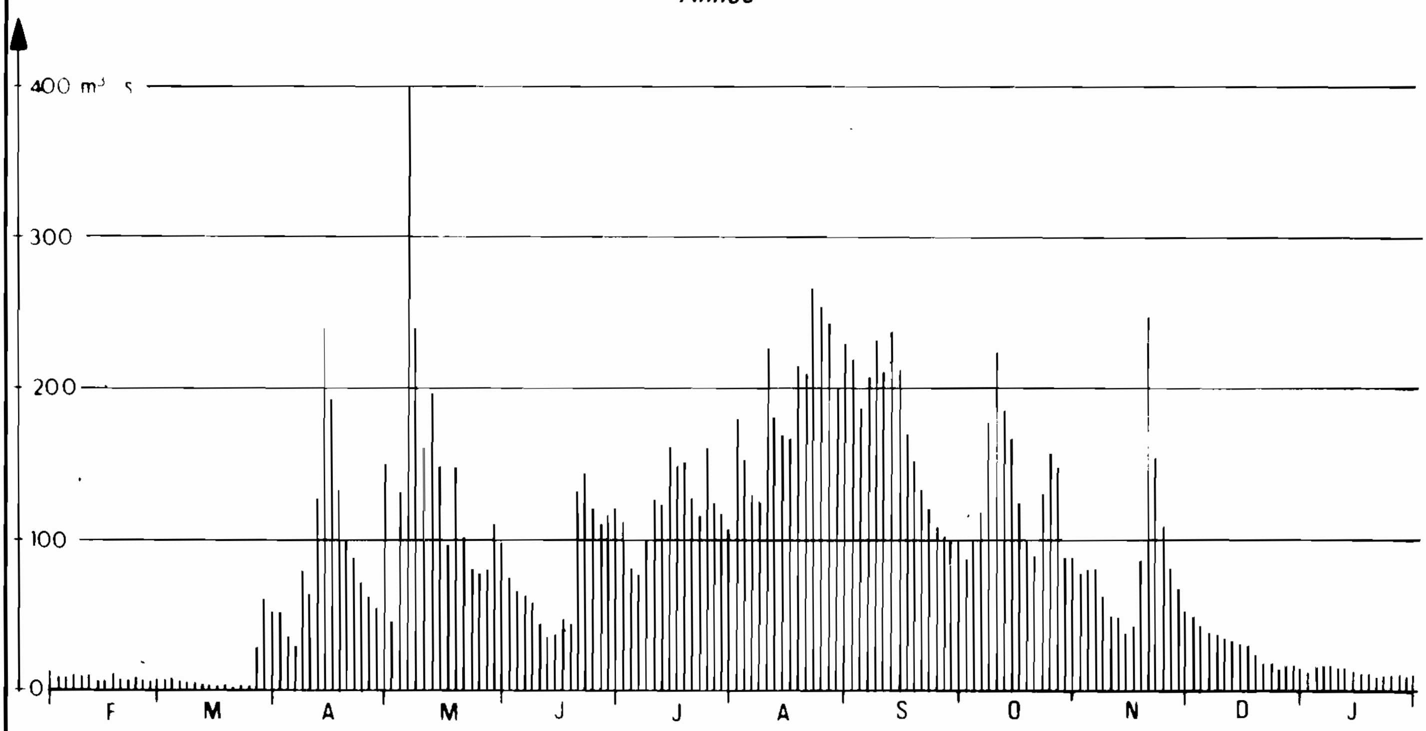
WABI SHEBELLE AT GODE

Daily discharges *Débits journaliers*

Year *Année* 1968 - 1969



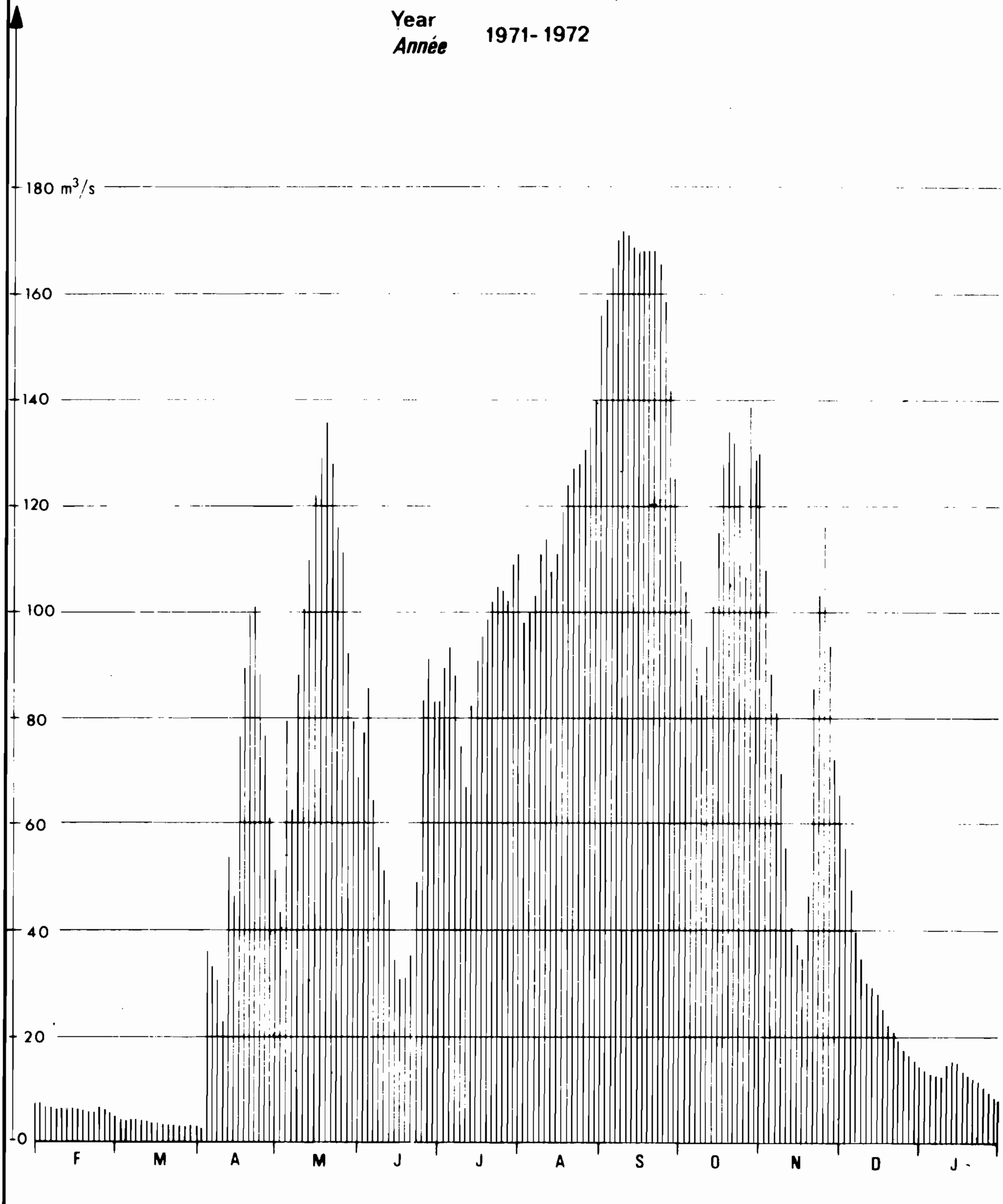
Year *Année* 1971 - 1972



WABI SHEBELLE AT BURKUR

Daily discharges *Débits journaliers*

Year *Année* 1971- 1972



Year	Characteristic discharges in m3/s								
	Minimum low flow		Characteristic discharges					Maximum high flow	
	Q	Date	DCE	DC9	DC6	DC3	DCC	Q	Date
1967-1968	18,8	15-2-68							
1968-1969	13,7	30-1-69							
1969-1970	7,26	23-1-70	7,89	21,2	70,5	169	264	306	6-5-68
1970-1971	3,01	28-3-71	3,23	17,4	74,5	170	308	322	24-4-69
1971-1972				13,2	65,9	114	198	289	9-5-70

4.1.8. <u>The Wabi Shebelle at Burkur</u> (144 000 km2)

Three complete observation years are available (not including 1968 1969)

- Long term average discharge for three years : 81,4 m3/s or 0,56 L/s km2
- Minimum low water discharge : 2,71 m3/s or 0,02 L/s km2
- Maximum high water discharge : 244 m3/s or 1,70 L/s km2
- The mean annual discharges and the characteristic discharges continue decreasing owing to losses due to flooding in the Shebelle plain. The quantity of water supplied between Kelafo and Burkur is practically insignificant.

Minimum low water discharge decreases owing to infiltration and evaporation.

Graph IV.4 shows the daily distribution of discharge for the water-year 1971-1972.

Year	Mean monthly discharges in m3/s												Mean annual discharge in m3/s
	F	M	A	M	J	J	A	S	O	N	D	J	
1969-1970	29,4	134	115	151	40,7	64,0	148	166	82,4	41,7	14,7	9,68	83,3
1970-1971	21,3	76,4	115	166	26,3	30,0	142	226	171	91,4	17,7	9,71	91,4
1971-1972	6,46	3,76	56,6	96,9	60,0	94,0	122	160	114	76,1	29,8	12,1	69,6
Average	19,1	71,4	95,5	138	42,3	62,7	137	184	122	69,7	20,7	10,5	81,4

Year	Characteristic discharges in m3/s								
	Minimum low flow		characteristic discharges					Maximum high flow	
	Q	Date	DCE	DC9	DC6	DC3	DCC	Q	Date
1968-1969	17,1	22-2-69							
1969-1970	6,80	25-1-70	7,67	24,9	73,9	138	199	215	23-8-69
1970-1971	2,71	3-4-71	3,17	18,2	75,0	157	237	244	9-9-70
1971-1972				15,0	72,0	108	168	172	7-9-71

4.2. STATIONS OF THE TRIBUTARIES OF THE WABI SHEBELLE

4.2.1. The Maribo at the Bridge Road of Dodola (260 km2)

5 complete observation years are available

- long term average discharge for five years : 4,63 m3/s or 17,8 L/s km2
- Minimum low water discharge : 0,08 m3/s or 0,31 L/s km2
- Maximum high water discharge : 35,2 m3/s or 135 L/s km2

For the values of the minimum low water discharges and of the DCE, the minimum discharges obtained during the long dry winter season (December to March) are given. A secondary and marked minimum flow exists in June and sometimes results into weaker mean daily discharges. This is the case for 1969-1970 for which the minimum mean daily discharge was observed on the 19 th of June 1969 with 0,34 m3/s

Year	Mean monthly discharges in m3/s												Mean annual discharge in m3
	F	M	A	M	J	J	A	S	O	N	D	J	
1967-1968	0,14	0,35	1,69	3,67	0,99	7,27	10,5	10,1	7,74	5,60	0,92	0,21	4,13
1968-1969	2,36	3,21	14,5	5,84	4,22	7,86	9,85	8,16	5,02	2,22	0,68	1,05	5,41
1969-1970	2,65	7,56	5,63	3,37	0,99	5,21	7,65	7,42	3,32	0,88	0,67	0,82	3,86
1970-1971	0,64	7,72	7,99	3,37	0,46	5,28	10,3	13,0	8,78	1,97	0,31	0,27	5,03
1971-1972	0,22	0,34	3,28	5,25	4,42	7,37	12,6	9,67	9,51	2,22	0,79	0,40	4,71
Average	1,20	3,84	6,62	4,30	2,22	6,60	10,2	9,67	6,87	2,58	0,67	0,55	4,63

Year	Characteristic discharges in m3/s								
	Minimum low flow		Characteristic discharges					Maximum high flow	
	Q	Date	DCE	DC9	DC6	DC3	DCC	Q	Date
1966-1967	0,08	2- 3-67							
1967-1968	0,12	20- 1-68	0,10	0,30	1,39	6,51	16,6	33,4	6-10-67
1968-1969	0,34	26-12-68	0,40	1,21	4,12	8,28	18,3	27,5	21- 4-68
1969-1970	0,50	20- 2-70	0,48	0,81	2,25	5,89	13,9	28,4	7- 9-69
1970-1971	0,12	11- 3-71	0,23	0,50	2,72	8,48	18,8	35,2	16- 4-70
1971-1972			0,12	0,60	2,78	7,61	18,4	28,4	6-10-71

4.2.2. The Maribo at the junction with the Wabi Shebelle (1 220 km2)

Four observation years are available. The gaps have been filled in through relations with the Maribo Station at the bridge Road of Dodola.

- long term average discharge for four years ; 12,1 m3/s or 9,90 L/s km2
- Minimum low water discharge : 0,43 m3/s or 0,35L/s km2
- Maximum high water discharge : 81,6 m3/s or 67,0 L.s km2

The specific mean annual discharge of this tributary is higher than that of the Wabi Shebelle for a same drainage basin (Bridge-road of Dodola for the Wabi) but the specific minimum flow is lower.

Year	Mean monthly discharges in m3/s												Mean annual discharge in m3/s
	F	M	A	M	J	J	A	S	O	N	D	J	
1968-1969	6,41	14,5	(33,1)	15,0	(7,61)	22,6	33,9	14,8	9,03	3,80	1,88	3,46	(13,9)
1969-1970	9,21	24,9	10,6	11,0	2,53	17,2	27,1	17,3	6,28	2,22	1,28	3,54	11,1
1970-1971	1,33	16,4	15,8	6,21	1,61	10,9	39,4	30,8	18,4	5,13	1,39	1,25	12,5
1971-1972	0,96	1,24	6,59	10,7	(10,5)	16,8	32,9	20,7	(22,0)	(5,00	4,25	1,36	(11,1)
Average	4,48	14,3	16,5	10,7	5,56	16,9	33,3	20,9	13,9	4,04	2,20	2,40	12,1

Year	Characteristic discharges in m3/s								
	Minimum low flow		Characteristic discharge					Maximum high flow	
	Q	Date	DCE	DC9	DC6	DC 3	DCC	Q	Date
1968-1969	1.12	24-12-68	1.56	3.50	10.5	18.0	42.0	81.6	31- 7-68
1969-1970	0.96	20- 2-70	1.24	2.49	6.45	18.1	39.8	53.6	31- 7-69
1970-1971	0.43	9- 3-71	0.52	1.49	6.34	18.0	52.4	83.4	20- 8-70
9171-1972				2.23	7.27	14.2	37.6	60.9	26- 8-71

4.2.3. <u>The Errer at Hamero Hedad</u> (14 200 km2)

Only two observation years are complete.

- The annual minimum flow is always approximately 1,50 m3/s which corresponds to the base flow supplied by the water-tables.

- Floods are very sudden and violent and occur between March and November with comparatively low-water during the month of July.

- The maximum high water discharge is 566 m3/s or 39,0 L/s km2.

Graph IV 5 shows the daily distribution of discharges for the 1971-1972 period.

Year	Mean monthly discharge in m3/s												Mean annual disch. in m3
	F	M	A	M	J	J	A	S	O	N	D	J	
1968-1969						13.2	19.6			(3.25)	2.97	2.70	
1969-1970	4.42			(12.0)	5.09				4.42		(1.76)	2.11	
1970-1971	1.67	5.97	10.1	9.01	2.66	2.33	8.62	13.7	8.68	2.28	1.98	1.95	5.76
9171-1972	1.71	1.83	5.08	9.42	4.73	2.96	5.71	6.57	4.67	3.13	1.99	1.82	4.15

Year	Characteristic discharges in m3/s								
	Minimum low flow		Characteristic discharges					Maximum high flow	
	Q	Date	DCE	DC9	DC6	DC3	DCC	Q	Date
1968-1969	2.70	1- 2-69	2.70					296 *	5- 6-68
1969-1970	1.60	18- 2-70	1.66					264 *	1-11-69
1970-1971	1.40	1- 5-71	1.40	1.98	2.57	5.97	27.9	556	25- 4-70
1971-1972				1.82	2.36	4.96	15.7	151	17- 5-71

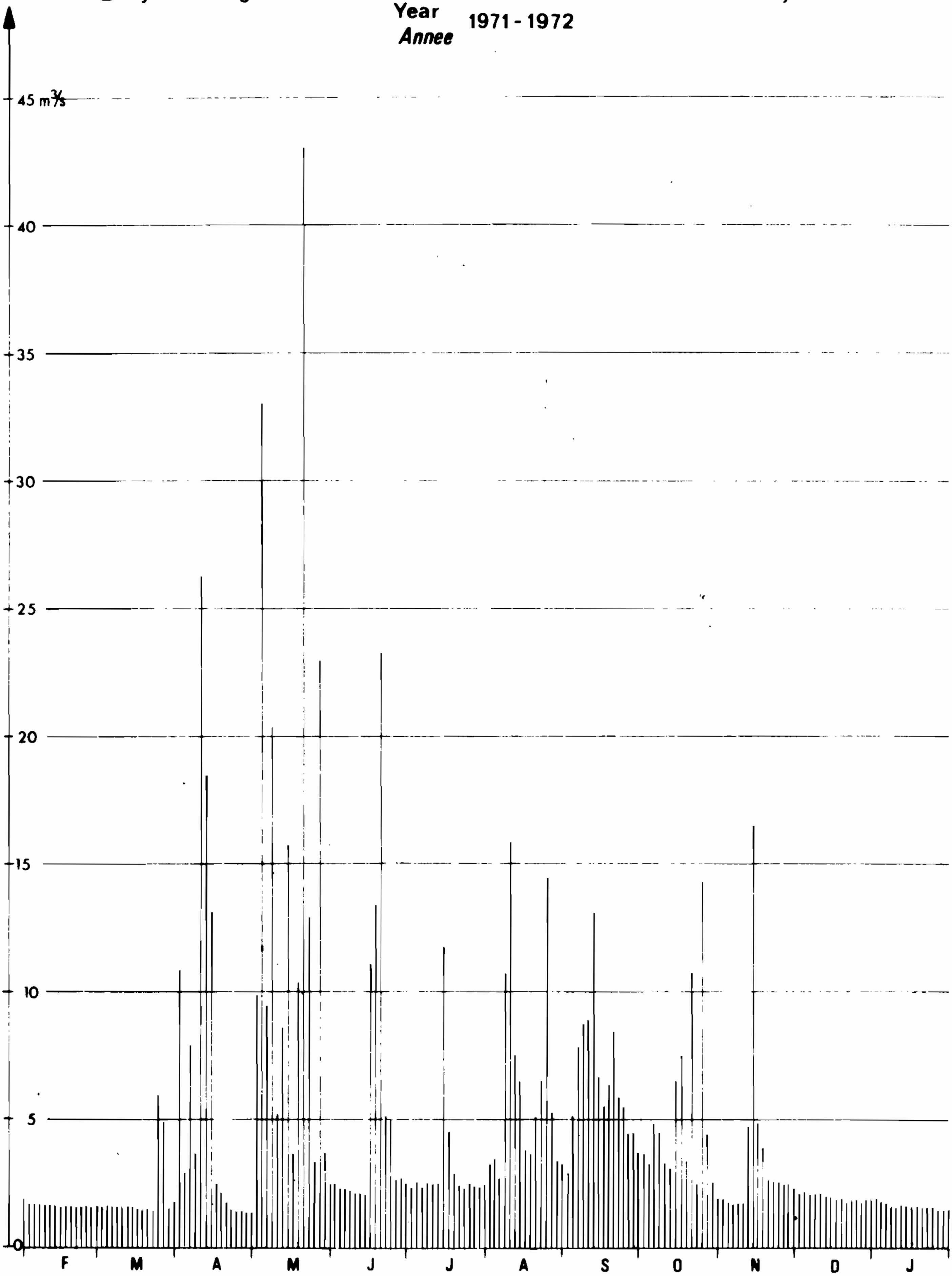
*Maximum high water discharge during the recording periods

Gr-IV-5

ERRER AT HAMERO-HEDAD

Daily discharges — *Débits journaliers*

Year / *Annee* 1971 - 1972

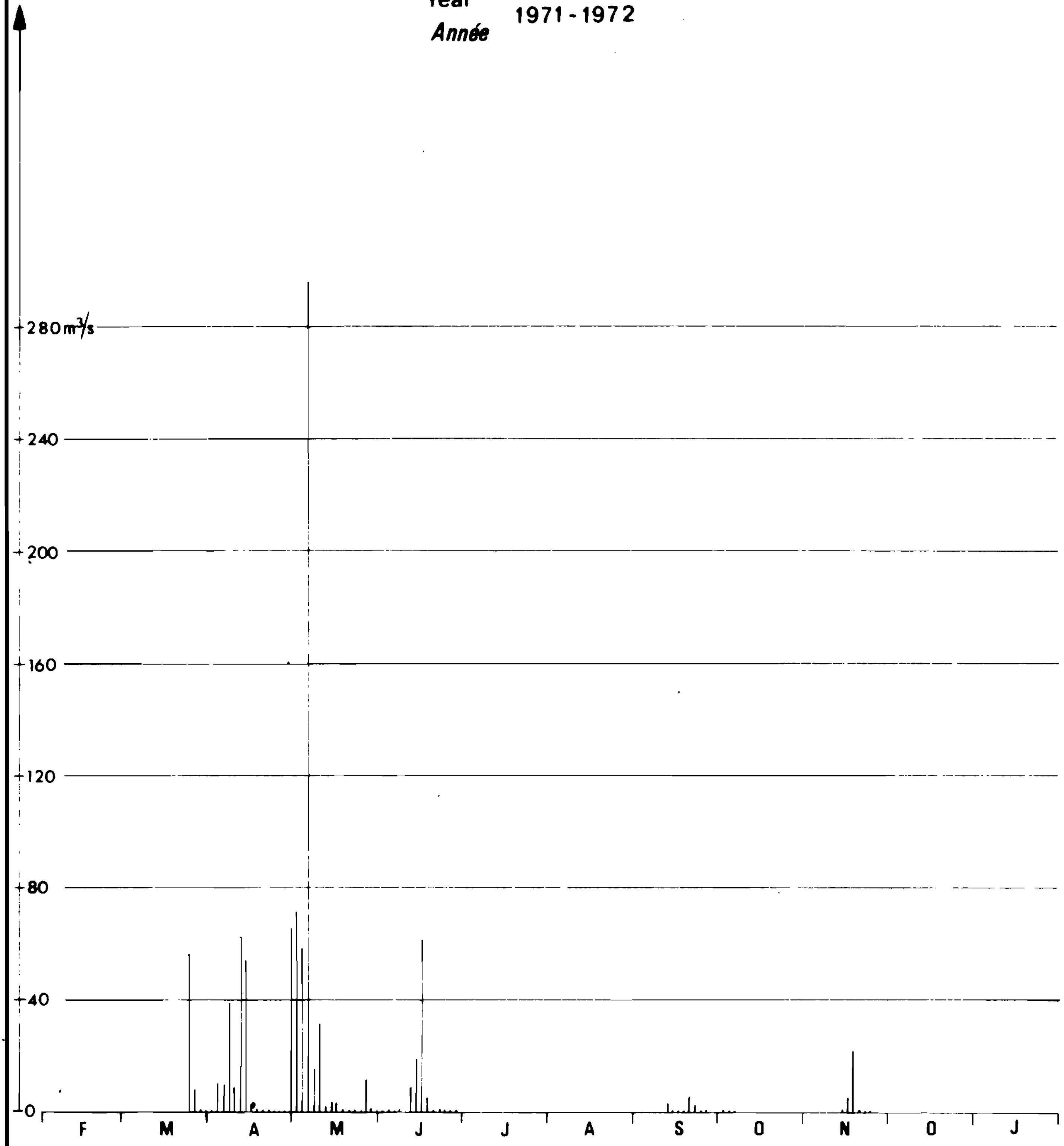


Gr -IV- 6

DAKETA AT HAMERO-HEDAD

Daily discharges *Débits journaliers*

Year *Année* 1971-1972



4.2.4. The Daketa at Hamero Hedad (14 200 km2)

Only one observation year is available for discharge.

For the water year 1970-1971 the floods of March, April and May 1970 were reconstituted graphically using the maximums of floods which are all recorded. The discharge data given here are therefore not very accurate.

The annual minimum flow is always inexistent. The flow occurs during two very distinct periods of three months each.

The first period corresponds to March,April, May and the second, to September, October and November.

As in the case of the Errer, floods are very swift. The maximum discharge observed is 834 m3/s or 59,0 L/s km2

Graph IV 6 shows the daily distribution of discharges for the water-year 1971-1972

Year	Mean monthly discharges in m3/s												mean annual dis-charge
	F	M	A	M	J	J	A	S	O	N	D	J	
1968-1969	(14.9)	0.90					0	0	1.28	0.58	0.02	0.14	(>1.50)
1969-1970	0.09	0.09	1.07	(>4.00)		0	0	0	(3.70)	(2.00)	0	2.06	(>1.10)
1970-1971	0	(>8.20)	(25.0)	(21.4)	(>0.00)	0	0	4.81	13.8	0.06	0	0	(6.10)
1971-1972	0	(2.21)	9.04	20.2	3.53	0	0	0.59	0.06	1.36	0	0	3.10

Year	Characteristic discharges in m3/s					Maximum high flow in m3/s	
	DCE	DC 9	DC 6	DC 3	DCC	Q	DATE
1968-1969	0	0	0			763 *	26- 2-68
1969-1970	0	0	0			358 *	2-11-69
1970-1971	0	0	0			494 *	26- 4-70
1971-1972	0	0	0	0.08	39.2	834	6- 5-71

* Maximum discharge for the period with records.

4.3.2. <u>The Fafen at Kebri Dahar</u> (25 600 km2)

Three complete observation years are available:

- Mean annual discharge for three years : 0,82 m3/s or 0,03 L/s km2
- the annual minimum flows are always inexistent
- the flood periods correspond to two very distinct seasons
  the maximum discharge observed is 64,5 m3/s or 2,52 L/skm2

Graph IV.7 shows the daily distribution of discharges for the water-year 1971-1972

years	Mean monthly discharge in m3/s												mean annual discharge m3/s
	F	M	A	M	J	J	A	S	O	N	D	J	
1968-1969						0	0	0	0.34	0.08	0	0	
1969-1970	0	0.10	0	5.47	0	0	0	0	0.19	1.44	0	0	0.61
1970-1971	0	1.85	5.47	4.30	0.04	0	0	0.30	1.75	0.04	0	0	1.15
1971-1972	0	0	1.05	4.32	0.59	0.03	0	0.26	1.98	0.12	0	0	0.70
Average	0	0.65	2.17	4.70	0.21	0.01	0	0.19	1.31	0.53	0	0	0.82

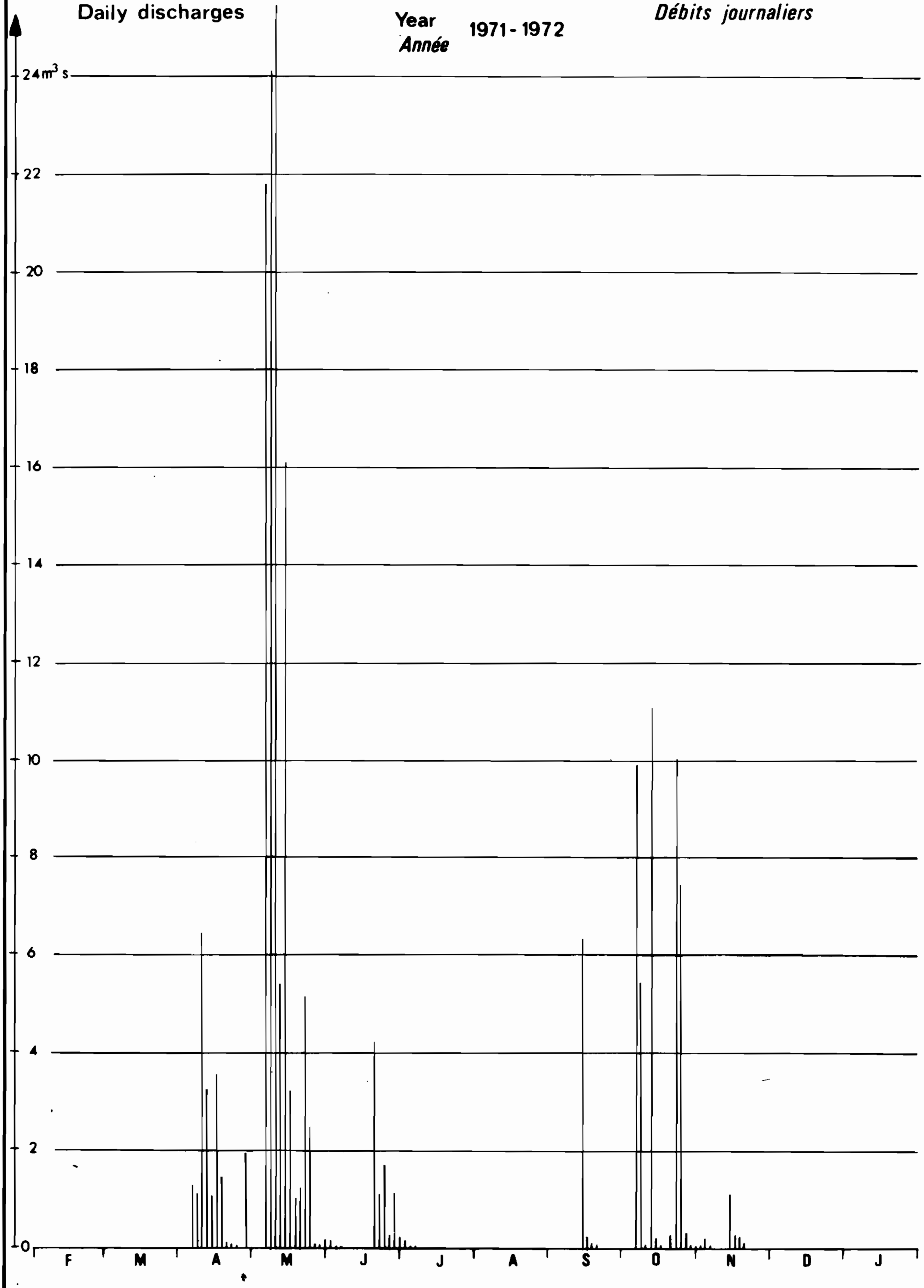
Year	Characteristic discharges in m3/s					Maximum high flow im m3/s	
	DCE	DC9	DC6	DC3	DCC	Q	Date
1968-1969	0	0	0	(0)		10.0*	30-10-68
1969-1970	0	0	0	0	6.68	64.5	8- 5-69
1970-1971	0	0	0	0.23	13.0	37.3	12- 5-70
1971-1972	0	0	0	0.05	7.12	32.3	8- 5-71

* Maximum discharge recorded for the period from July 1968 to January 1969

Gr-IV-7

FAFEN AT KEBRI-DAHAR

Daily discharges — Year / *Année* 1971-1972 — *Débits journaliers*



THIRD PART

Analysis of Hydrological Conditions

CHAPTER V

ANALYSIS OF RUNOFF AND ANNUAL BALANCE

FOR THE OBSERVATION PERIOD

The purpose in this chapter is to analyse, in the light of the results achieved during the survey years, the mechanism of supplies and losses and to determine the annual balance of runoff for each basin or portion of a basin.

In this end, six large natural regions presenting comparatively homogeneous geological and rainfall features have been distinguished.

a) The upper basin upstream from Malka-Wacana :

It only occupies 5.300 km2, but it provides alone practically one third of the supply of the whole basin.

Its outlet marks the limit of volcanic and limestone formations. It is entirely covered with volcanic rocks and receives the largest amount of rainfall (rainfall zones I II III)*

b) the upper basin between Malka Wacana and Lege Hida:

This partial basin covers 16 200 km2 and provides half of the total supply of the basin. 55 per cent of this area is occupied by basalt series and 45 per cent by limestone and sandstone . The amount of rainfall is still considerable (rainfall areas I II ans IV)

c) The middle basin between Lege Hida and Hamero Hedad:

This part of the basin covers 42 900 km2 and only provides 15 per cent of the total supply of the basin, 80 per cent is occupied by limestone formations and the rest of the basin by basalt (12 per cent), granite (6 per cent) and sandstone (2 per cent). It largely stretches on rainfall areas IV and V.

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* The characteristics and locations are given in paragraph 2.8.1. (map III)

TABLE 5.1

The upper basin upstream from
MALKA-WAKANA
Annual balance of runoff

Basin	Year	Mean annual discharge in m^3/s	specific mean annual discharge $l/s.km^2$	Volume of runoff 10^6 m^3	Depth of runoff mm	Average rain fall mm	Deficit of runoff mm	Runoff coef-ficient per-cent
WABI SHEBELLE at the bridge of DODOLA $1\ 260\ km^2$	1967-1968	8.60	6.8	271	214			
	1968-1969	7.75	6.1	244	193			
	1969-1970	7.81	6.2	246	195	1 225	1 030	15.9
	1970-1971	7.97	6.3	252	199	1 100	901	18.0
	1971-1972	8.97	7.1	282	224	1 160	936	19.3
MARIBO at the bridge - road of DODOLA $260\ km^2$	1967-1968	4.13	15.9	130	500			
	1968-1969	5.41	20.8	170	658			
	1969-1970	3.86	14.8	123	468	(1 100)	(632)	(42.5)
	1970-1971	5.03	19.3	158	610	(1 300)	(690)	(46.9)
	1971-1972	4.71	18.1	148	571	(1 200)	(629)	(47.6)
MARIBO at the confluence $1\ 220\ km^2$	1968-1969	13.9	11.4	438	360			
	1969-1970	11.1	9.1	350	287	(1 000)	(713)	(28.7)
	1970-1971	12.5	10.2	394	323	(1 100)	(777)	(29.3)
	1971-1972	(11.1)	(9.1)	(350)	(287)	(1 000)	(713)	(28.7)
Residuary basin MALKA-WAKANA -WABI-SHEBELLE at the bridge -MARIBO confluence) $2\ 810\ km^2$	1968-1969	9.0	3.2	284	101			
	1969-1970	8.4	3.0	265	94	(1 000)	(906)	9.4
	1970-1971	8.5	3.0	268	95	(845)	(750)	11.2
	1971-1972	8.7	3.1	274	98	(1 020)	(922)	9.6
WABI-SHEBELLE at MALKA-WAKANA $5\ 290\ km^2$	1967-1968	(28.5)	5.4	899	170			
	1968-1969	30.7	5.8	971	183			
	1969-1970	27.3	5.2	861	164	1 060	896	15.4
	1970-1971	29.0	5.5	915	173	965	792	17.9
	1971-1972	28.8	5.4	908	170	1 050	880	16.1

Runoff condition in this basin may be compared to those of the Upper Basin upstream from Malka Wacana. However, the annual inflow is not so regular. This seems in relation to the greater heterogeneity of rainfall in this part of the basin. The specific mean annual discharges decrease noticeably as well as the runoff coefficient. Their values are close to those of the left bank tributaries of the basin upstream from Malka Wacana, though they seem lower.

The annual distribution of inflow is identical to that of the upper basin i, e a first high flow season from March to May and a second more abundant season from July to October. In June, the discharge weakens except for certain years.

5.3. The Middle Basin between Lege-Hida and Hamero Hedad

Most of the inflows of the Wabi Shebelle are supplied by the left bank tributaries issued from the high plateaus of Chercher such as the UN-GWATA, the RAMIS and the ERRER whereas there is only one right bank tributary : the Ledae.

The annual balance of runoff on the basins or on portions of basins is given below :

Basin	Year	Mean annual dis-charge m3/s	Specific mean annual discharge L/s	Runoff volume 10^6m3	Depth of runoff mm	Average rainfall mm	Deficient of runoff mm	Coefficient of runoff in per cent
ERRER to HAMERO-HEDAD 14 200 km2	1970-1971	5,76	0,41	182	13	670	657	1,9
	1971-1972	4,15	0,29	131	9	650	641	1,4
Intermediate Basin (WABI SHEBELLE to HAMERO-HEDAD -LEGE-HIDA -ERRER) 28 700 km2	1970-1971	16,2	0,56	511	18	696	678	2,6
	1971-1972	18,0	0,63	568	20	792	772	2,5
WABI SHEBELLE to HAMERO-HEDAD 64 400 km2	1968-1969	133	2,1	4 206	66			
	1969-1970	104	1,6	3 280	50	(900)	(850)	5,6
	1970-1971	105	1,6	3 311	50	(800)	(750)	6,3
	1971-1972	81,6	1,3	2 573	41	(800)	(759)	5,1

Basin	Year	Mean Annual discharge m3/s	Specific Mean annual discharge L/S km2	Volume of runoff mm 10^6m3	Depth of runoff mm	Average rainfall mm	Runoff deficient mm	Coefficient of runoff in per cent
DAKETA at HAMERO HEDAD 14 200 km2	1970-1971 1971-1972	6.1 3.1	0.43 0.22	192 98	13.5 7.0	460 410	446 403	2.9 1.7

The runoff periods stretch from March to June for the first season and from September to November for the second season.

The specific discharges and the coefficients of runoff are comparable to those of the Errer for a same drainage area but they are more irregular owing to the rainfall conditions.

5.4.2. Inflows and losses between Hamero Hedad and Gode

In order to understand the mechanism and importance of flood losses as well as to estimate the volumes of runoff due to the tributaries of Ogaden, the transmission of volumes for periods of five days between the stations of Hamero Hedad and Gode was studied taking into account the time-limit for the routing of runoff which is approximately five days. Graph V.1 gives the results achieved. The fluctuations of inflows and losses are also shown on this graph opposite to the hydrograph of inflows at Hamero Hedad.

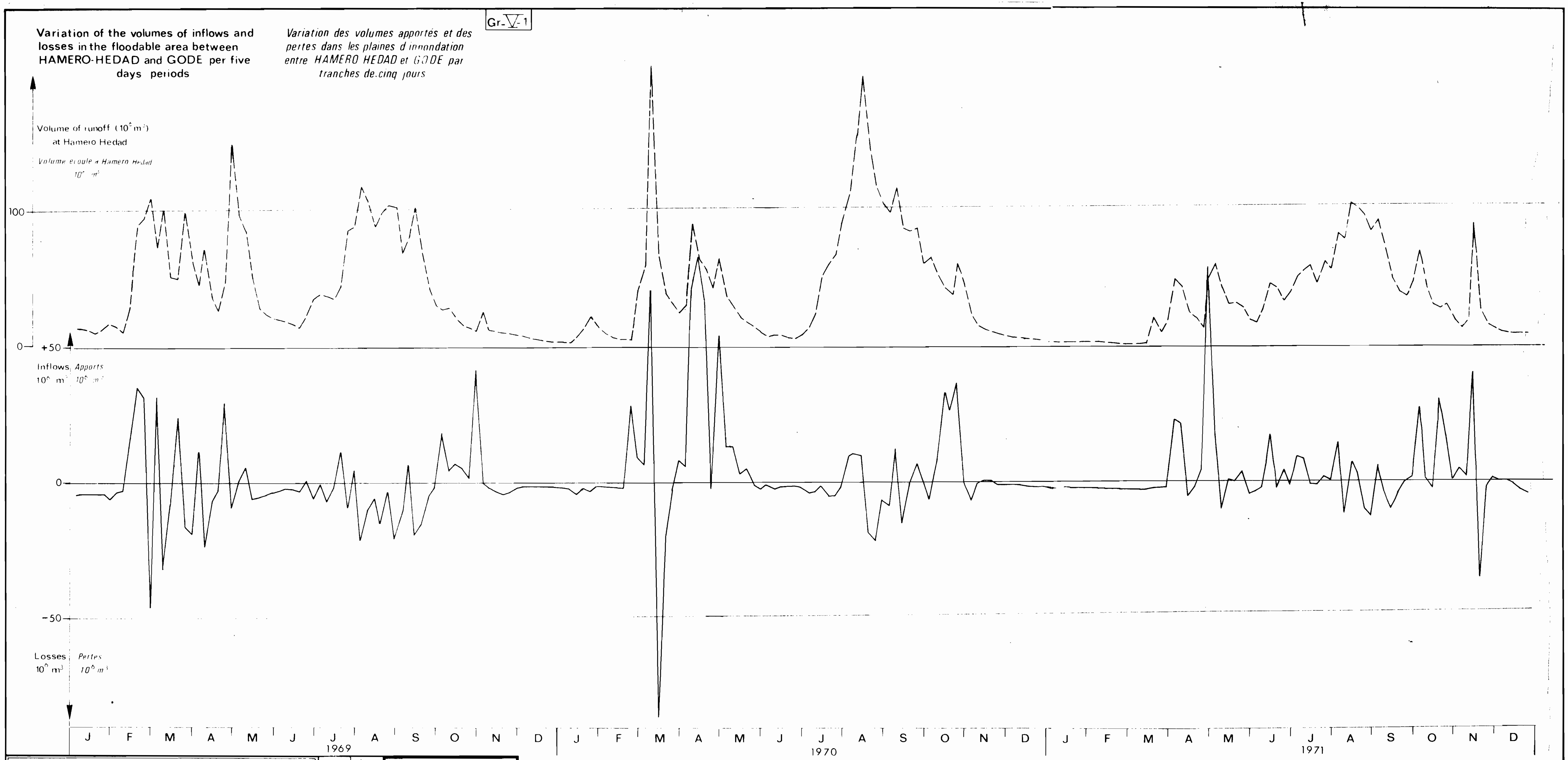
The Daketa, which shows gaps in the discharges for periods of five days was scarcely mentioned in the balance since it is considered as one of the tributaries of Ogaden.

Examining this graph leads to the following observations :

- the inflows between Hamero-Hedad and Gode occur during the two seasons : March to October and August to November. Nevertheless, the main inflows occur later than on the upper and middle basin, in April and May and in October and November, these periods corresponding to rainfall in Ogaden. The annual volumes of inflows are very irregular as may be observed in the following tables.

- the losses in the flood zones of Imi are not linked to the volume of runoff but to the maximum depth of floods originating in the middle basin

- During the low-flow period, from November to February or March and for certain years in June and July, the losses observed between Hamero-Hedad and Gode are due to seepage and evaporation in the channel.



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to the river whereas short overflowing is definitively lost. This assumption may not be easily checked with the available data and all the more so since the lack of precision concerning discharge at Imi leaves this station out of the balance.

The net balance between local inflows and losses in the reach is some times positive, sometimes negative.

- positive with 443 10^6 m3 in 1970-1971, a year with very abundant runoff in Ogaden, as well as in 1971-1972 (+ 232.10^6 m3)

- negative with 162.10^6 m3 in 1969-1970, a year with moderate local runoff.

The net balance therefore depends on the flood conditions of the Wabi Shebelle, of the tributaries of Ogaden (Daketa, Degahbour, Darole ...) and of local inflows. It is difficult to give now a statistical representation but the matter is examined further in the study of the average year (Chapter VI)

5.5. The Lower Valley between Gode and Burkur

Between Gode and Burkur, inflows are practically inexistent : rainfall is very weak (150 to 300 mm) and most of the tributaries draining the basin do not join the river directly but spread in the vast alluvial plain or in closed endhoreic basins.

The stream-flow of the Wabi Shebelle is deeply modified by the existence of large flood plains stretching on approximately 600 km2 between Kelafo and Mustahil. 140 km2 of these plains are flooded throughout the year and form a permanent swamp.

These flood plains have a double effect, i.e :

- They control runoff by a reduction of flood peaks. An exemple of this action is given on graph V.2. for 1970 - 1971.

- They draw a considerable amount of the inflow at Gode. The water collected in the flood plains partly supplies the ground water table or evaporates.

The routing of volumes for periods of five days, between Gode and Burkur, has been studied taking into account an average time-limit for transmission corresponding to approximately four days. Graph V.3. represents the results achieved.

It is to be noted that the most considerable losses occur during the flood periods and are then followed by a slow restitution of part of the water stored in the flood plains.

The balance of losses for three successive years is given below :

Years	Runoff at Gode		Runoff at Burkur		Losses between Gode and Burkur	
	10^6 m3	m3/s	10^6 m3	m3/s	10^6 m3	m3/s
1969-1970	3 116	98.8	2 627	83.3	489	15.5
1970-1971	3 753	119	2 883	91.4	870	27.6
1971-1972	2 807	89.0	2 195	69.6	612	19.4

One may also note that the volume of losses is not proportional to the volume of inflows in the flood plains. The latter play an important role as regards long-term regulation since the volume of losses is not only linked to inflows in the plains but also to the filling stage of these plains at the end of the dry season. It is easy to understand that the shorter the low flow period is the less evaporation and seepage empties the plains and consequently, for an equal volume of inflow losses are weaker.

When examining the observation years, 1969-1970 appears as the year presenting the weakest losses though its mean annual discharge is relatively high (98,8 m3/s at Gode). The preceding year (1968-1969) was very abundant (127 m3/s at Gode) and was followed by a very short low flow period of a month. Hence, plains are relatively full at the beginning of the season and losses are moderate.

Considerable losses are observed for 1970-1971 : the mean annual discharge at Gode is high (119 m3/s) and the previous low flow period of three months left the plains relatively empty.

Finally, the 1971-1972 water-year comes after a very long dry season of four months. Inflows are weak (89 m3/s at Gode) and find an empty plain. Losses are very high.

One may therefore consider that the losses between Gode and Burkur increase proportionally with the inflows at Gode, and are all the more intense when the preceding flow is very pronounced at Gode.

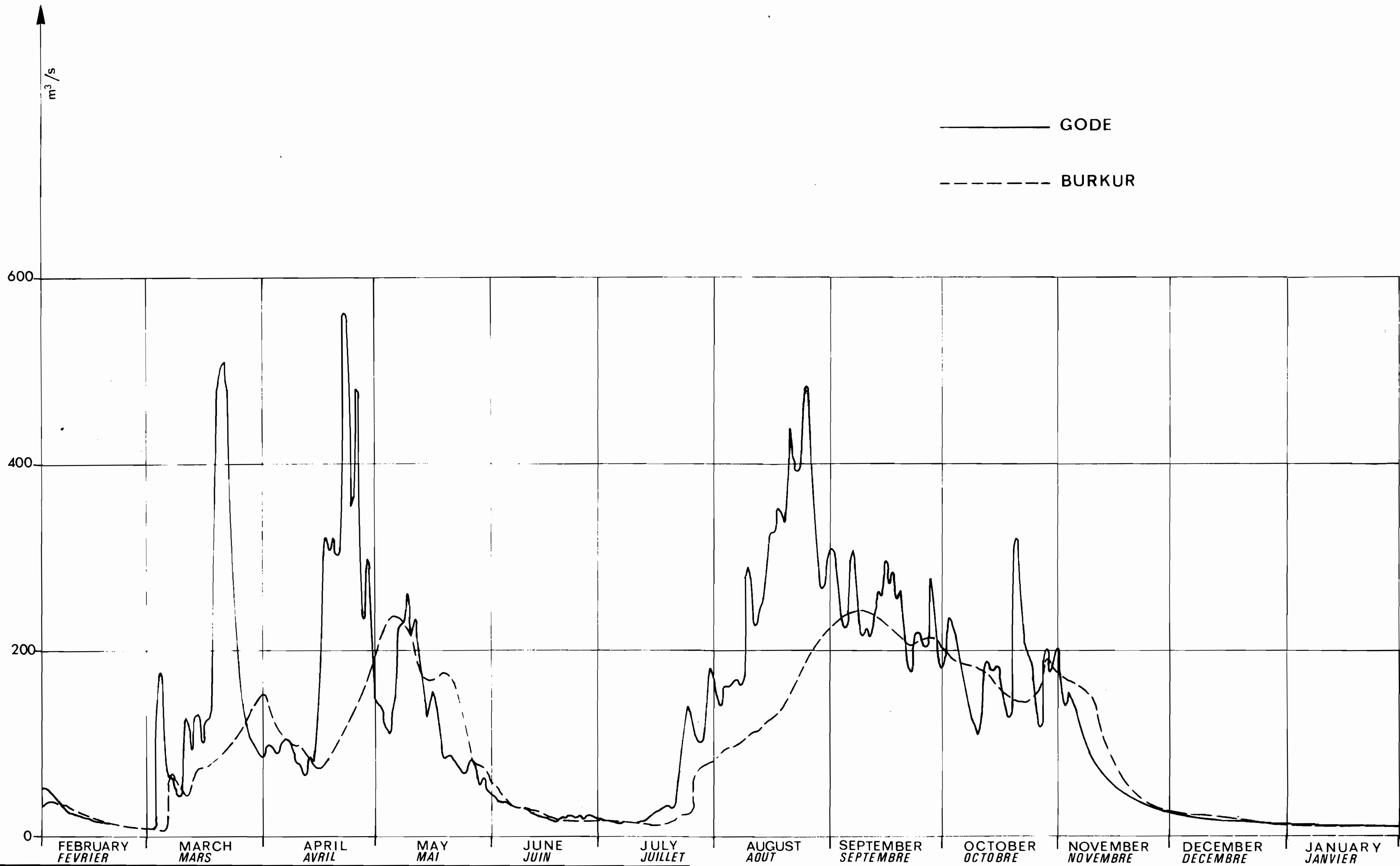
If one considers as a reference of low water discharge the maximum discharge for the ten minimum consecutive days Q 10 (see chapter VIII on low flow table 8.1.), one may verify that this variable clearly accounts for the curve deviate relating the losses to the mean annual discharge at Gode.

For 1968-1969 the mean annual discharge at Burkur was estimated from that of Belet Uen. The point representing the losses of this year is well plotted.

The conditions of losses are finally represented on graph V.4. linked to the mean annual discharge at Gode for three different statistical levels of previous low water discharge (Q 10) : average and ten year occurences. Anticipating the next chapter (chapter VI), it may be noted that for an average year with a mean annual discharge of 87 m3/s at Gode, the losses upstream from Burkur correspond to 550 million m3

INFLUENCE OF THE FLOODABLE AREA ON THE HYDROGRAPH OF BURKUR (YEAR 1970-71)

INFLUENCE DES PLAINES D'INONDATION SUR L'HYDROGRAMME DE BURKUR (ANNEE 1970_71)



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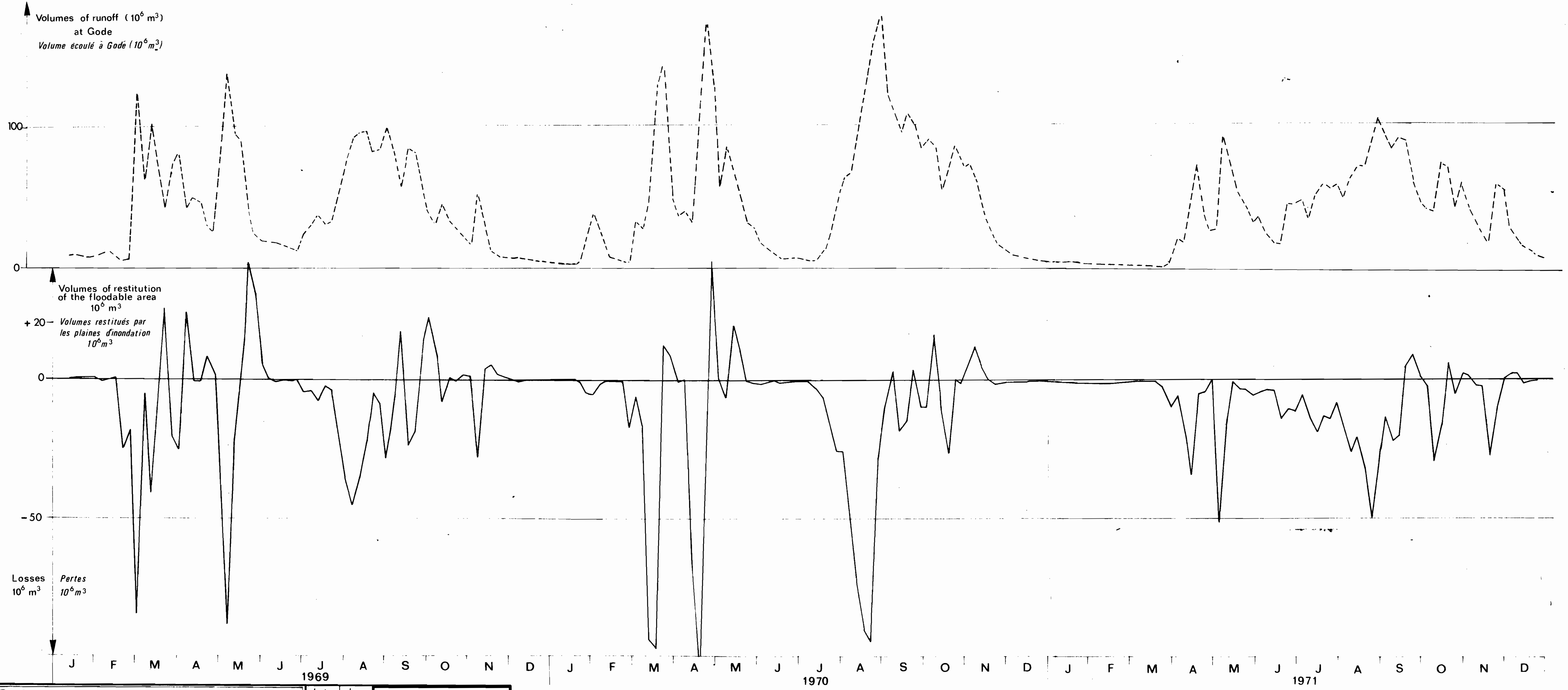
Gr-V 3

Variation of the volumes of losses in the floodable area between GODE and BURKUR per five days periods

Variation des volumes de pertes dans les plaines d'inondation entre GODE et BURKUR par tranches de cinq jours



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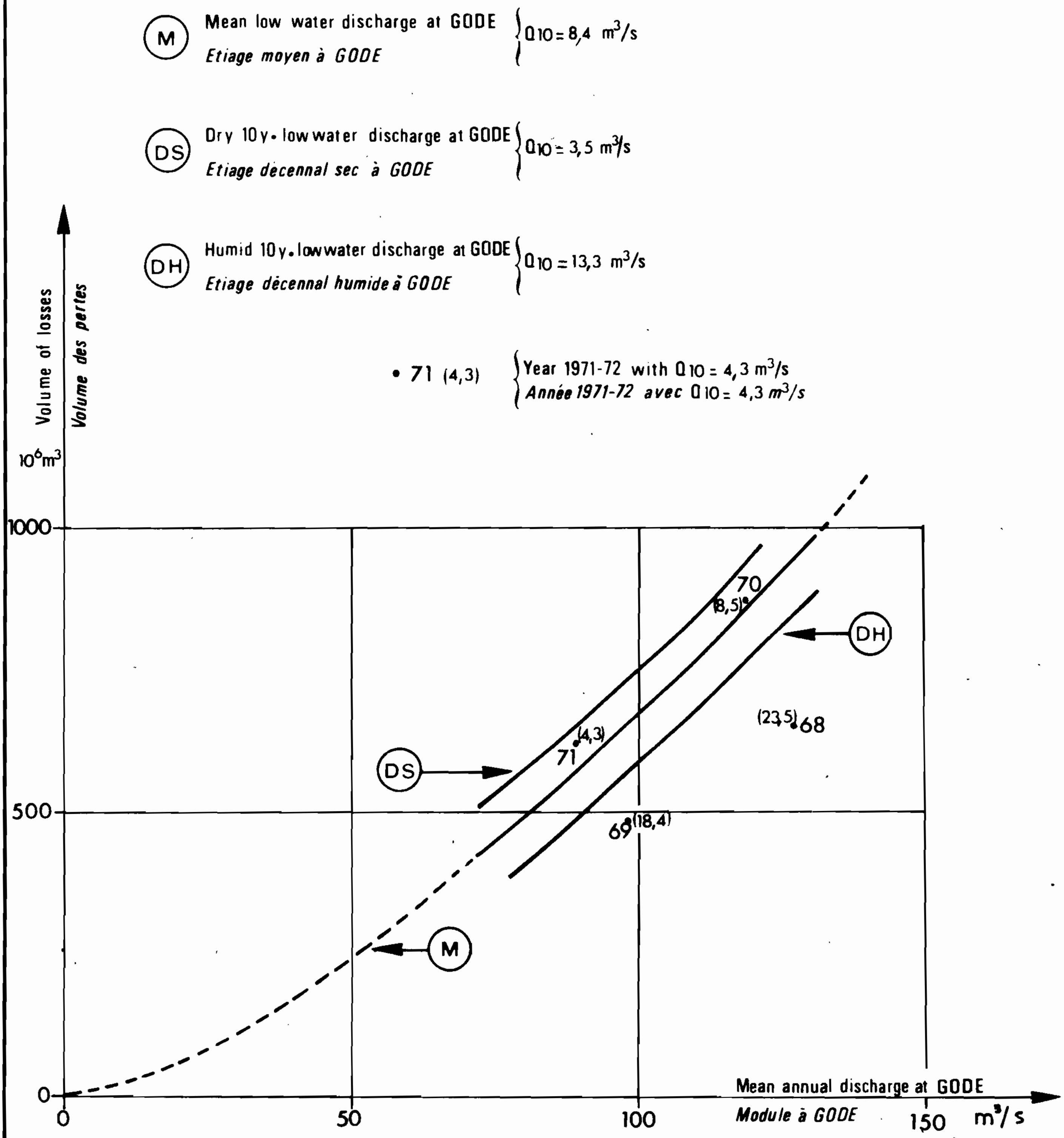
YEARLY LOSSES BETWEEN GODE AND BURKUR

PERTES ANNUELLES ENTRE GODE ET BURKUR



(approximately 17 m3/s) for a preceding mean low water discharge (Q 1Q = 8.4 m3/s) but may attain 630 million m3 for a dry 10 year minimum discharge (Q 10 = 3.5 m3/s) or only 470 million m3s for a wet 10 year minimum discharge (Q10 = 13.3 m3/s). Besides, for an average year, losses vary from approximately 55o million m3 to 80 million m3 (+15 per cent) within a confidence interval of 80 per cent (20 per cent of the occurence probability of low water discharges outside the interdecile range). The influence gradient of low water discharge is approximately 16 million m3 per m3/s. One may assume that this influence of low flow is practically identical for mean annual discharges only slightly different from the average.

Theses losses for an average year represent 20 per cent of the inflows at Gode for a mean low water discharge (from 17 to 23 per cent with the deciles of low water discharge Q 10) but should proportionately increase for abundant years at Gode and likewise decrease for dry years.

It must be noted that the losses thus computed correspond very well to what could be expected from the summary balance of evaporation for permanent flood zones between Kelafo and Mustahil. In fact the result is 350 million m3 for 140 km2 with an annual rate of 2.50 m corresponding to a free ground water table.

Finally, as in the reach above Gode, the intermediate station which is Kelafo, was not taken into account in the balance of five day periods since the discharge data are not accurate enough.

5.6. The Basin of the Fafen

The Fafen basin is an endhoreic basin unconnected with the basin of the Wabi Shebelle. It is drained by intermittent tributaries presenting the same flow conditions as the rivers of Ogaden. The Jerer is the main tributary of the Fafen and both these rivers flow practically all along in the middle of an alluvial plain. As in the case of the Lower Valley of the Wabi Shebelle, most of the tributaries do not directly join the Fafen, but spread in the alluvial plain where the income water seeps into the soil or evaporates. Downstream from Kebri Dahar, the Fafen flows into a series of three basins where it finally disappears.

5.6.1. Number and duration of floods

The basin of the Jerer at Degahbour covers 6 470 km2. Runoff takes place during the two rainy seasons, the first from February to June and the second from September to November. They are characterized by short and violent floods followed by a quick drying-up of the channel, between February and June and between September and November.

The basin of the Fafen at Kebri Dahar covers 25 600 km2. Runoff is of the same type as in the basin of the Jerer, i.e ; short floods separated by a quick drying-up of the channel. These floods occur from March to May and from September to November and slightly later (approximately 15 days) than at Degahbour.

The number and duration of these floods resulting from rainy episods depend on the number and duration of these precipitations.

Tables 5.2 and 5.3 give the number of floods, their duration in days for all the observation period as well as their location and occurrence month (or in the case of overlap, the month presenting the greater number of days of runoff). As a comparison, for the Daketa , the water year 1971-1972, is given in table 5.3. These tables mainly show the great long-term irregularity of runoff in the basin of the Fafen.

Yet, several general conclusions on runoff conditions may be drawn very carefully owing to the incompleteness of the data.

The first rainy season is far more abundant than the second. The following table presents the average values of the number of days of runoff for each season and for each flood and the number of floods.

	JERER	FAFEN
Average annual number of floods	9	6
- for the first season ...	6	3
- for the second season ..	3	3
Average annual number of days of runoff	62	90
- first season	50	60
Average duration of a flood (in days)	7	15
- first season	8	20
- second season	4	9

The floods of the Jerer are more numerous than those of the Fafen but do not last so long which is probably due to the size of the basins, one of them being four times larger than the other.

This tendency is more pronounced for the Daketa(fewer and longer floods) but in this case it is probably due to more abundant rainfall (showers are more numerous and more abundant).

For a given month the average occurence probability of a flood is as follows, i.e :

February	March	April	May	June	September	October	November
4	15	20	25	10	3	13	10

Table 5.2

Inventary and duration of the floods of the Jerer

Month, period	1967-1968	1968-1969	1969-1970	1970-1971	1971-1972
February	-	1	5		
March	-		9	6 - 12	
April	-	40		12 - 13	15 - 3
May	-	4 - 7	2 - 3 - 2	13 - 3 - 8	18 - 8
June	-	8 - 9		2 - 1	9
February-June	-	6/69	5/21	9/60	5/53
September	*	1			
October	5	4	8	2 - 6 - 13	2 - 2
November	6 - 6 - 2	2	3		2 - 2
September-Novem	4/19	3/7	2/11	3/21	4/8
Year	-	9/76	7/32	12/81	9/61

This table shows the duration in days of floods for the occurence months.

The total seasonal and annual sums represent the number of floods and their total duration, for instance : 6/69 corresponds to 6 floods during 69 days.

* Starting of observations.

Table 5.3

Inventory and duration of the floods of the Fafen

Month, Period	1968-1969	1969-1970	1970-1971	1971-1972	Daketa 1971-1972
March		5	7 - 13		
April			63	19 - 4	78
May		21		32	
June				17	15
March - June		2/26	3/83	4/72	2/93
September	*		5	7	15
October	3	7	24	13 - 9	6
November	6 - 10	7		6 - 7	10
Septemb-Novemb	3/19	2/14	2/29	5/42	3/31
Year	-	4/40	5/112	9/114	5/124

This table shows the duration in days of floods for the occurrence months. The total seasonal and annual sums represent the number of floods and their total duration, for instance : 2/26 corresponds to 2 floods during 26 days.

* Starting of observations

These figures are very approximate.

It is difficult to know from these observations whether there merely exists a concomitance of the floods of the Jerer with those of the Fafen (due to a concomitance with rainy phases) or if the floods of the Fafen contribute to the formation of those of the Fafen without disappearing before.

Tables 5.2 and 5.3 clearly show a tendency to concomitance but examples are given of distinctly localized floods either for the Jerer (February 1970) or for the Fafen (September 1970, November 1971) with no interference.

5.6.2. Annual Balance of runoff

The balance of runoff of the Jerer at Degahbour is available for four years.

Year	Mean Annual dis-charge m3/s	Specific Mean Annual dischar. l/s km2	Volume of runoff 10^6 m3	Depth of runoff mm	Average rainfall mm	Deficit of runoff mm	Coefficient of runoff in per cent.
1968-1969	0.366	0.06	11.5	1.8			
1969-1970	0.106	0.02	3.3	0.5	465	464	0.1
1970-1971	0.434	0.07	13.7	2.1	475	473	0.4
1971-1972	(0.480)	0.07	15.1	2.3	640	638	0.4

The weakness of the specific mean annual discharges and of the coefficients of runoff (comparatively to those of the direct tributaries of the Wabi Shebelle in Ogaden) is due to the preponderating effect of the alluvial plains which drain most of the runoff.

The results for the Fafen at Kebri Dahar only concern the three last years

Year	Mean Annual dischar. m3/s	Specific Mean Annual dischar. l/s km2	Volume of runoff 10^6 M3	Depth of runoff mm	Average rainfall mm	Deficit of runoff mm	Coefficient of runoff mm
1969-1970	0,608	0,024	19,2	0,6	415	414	0,14
1970-1971	1,15	0,045	36,3	1,4	390	389	0,36
1971-1972	0,704	0,027	22,2	0,9	380	379	0,24

It may be noted that the specific mean annual discharges and the coefficient of runoff are still very weak. A large quantity of the surface runoff contributes to the recharging of the alluvial water table through water spreading and influent seepage.

CHAPTER VI

ESTIMATE OF INFLOWS FOR AN AVERAGE YEAR

AND IRREGULARITY FROM YEAR TO YEAR

The purpose in this chapter is to specify the values which may be accepted for long-term average discharges at the main stations as well as their dispersion characteristics (long term irregularity).

Most of the hydrological data presented in the second part only correspond to three observation years and at best to six years. Consequently they are inadequate for the determination of runoff for an average year and for a statistical study on mean annual discharges. Besides, as we have already seen in chapter 2.8 on the study of rainfall, the available data on rainfall being too incomplete and lacking precision may not be used for a valuable extension of the observation period through hydro-pluviometric correlations.

In order to complete the knowledge of mean annual discharges and of their variability,an attempt was made to relate the available data to those of stations located outside the basin but presenting longer observation periods

In fact, old records for the Wabi Shebelle in Somalia exist and one could expect finding a suitable relation between the flows at the various stations along the river. This is the case for the upper basin upstream from Malka Wacana which, since it is located in a high rainy country, is in fact affected by rainfall conditions more similar to those of the high Ethiopian plateaus than to those of the basin of the Wabi Shebelle.

Hence, it proved necessary to collect information in the neighbouring drainage basins located on the high plateaus : Awash and Blue Nile. This foreign information was not easily obtained and unfortunately the available data do not correspond to all existent observations. This is regrettable since common observations periods are consequently much reduced as the gaps often correspond to recent years.

Thus it has been possible to relate the monthly discharges of the Malka Wacana station located in the upper basin of the Wabi Shebelle to those of a station of Awash, the basin of which stretches to the border in the North. The discharges of the stations of the middle basin and of the Lower Valley were also related to those of the Belet Uen station on the Wabi Shebelle at a short distance from the border in the Somalian country.

In the following paragraphs, the methods used to estimate the mean annual discharges are described and the results achieved are also given.

Owing to the incompleteness of the data,relations with the monthly discharges were necessary. Since successive months are not wholly independent, this method is not really accurate from the statistical point of view but may nevertheless be accepted, once the absence of seasonal tendencies is checked and if relations presenting high coefficients only are considered. Such processes are absolutly necessary when the incompleteness of data is as pronounced as in the basin of the Wabi Shebelle.

6.1. MEAN ANNUAL DISCHARGE OF THE WABI SHEBELLE AT MALKA WACANA

6.1.1. Long-term average discharge

The six mean annual discharges observed vary from 30.7 m3/s and 22.0 m3/s. The average is 27.7 m3/s. The standard deviation is 2.91 m3/s and the coefficient of variation (ratio of the standard deviation to the average) of 0.11.

In order to evaluate the hydraulicity of this sample, the monthly discharges at Malka Wacana have been related to those of stations located in neighbouring basins (Awash and Blue Nile) and presenting longer observation periods.

The only suitable relation (r = 0.92) was obtained with the Awash station at Hertale which controls a basin of 34 000 km2 (graph VI 1).Unfortunately this station only presents seven complete observation years (from 1963 to 1970 except 1966) and a better knowledge of the long term average discharge at Malka Wacana may not be expected from this station only.

Consequently, we tried extending the data of the Awash by relating the mean annual discharges observed with those of other stations presenting longer observation periods. The most satisfactory relation (r= o.94) was obtained with the Blue Nile station at Kessie (drainage basin = 65 000 km2) for which 14 observation years are available (from 1954 to 1968 except 1955) (see graph VI 2).

The new data thus obtained for the Awash at Hertale includes 16 observation years from 1954- to 1970 except 1955.

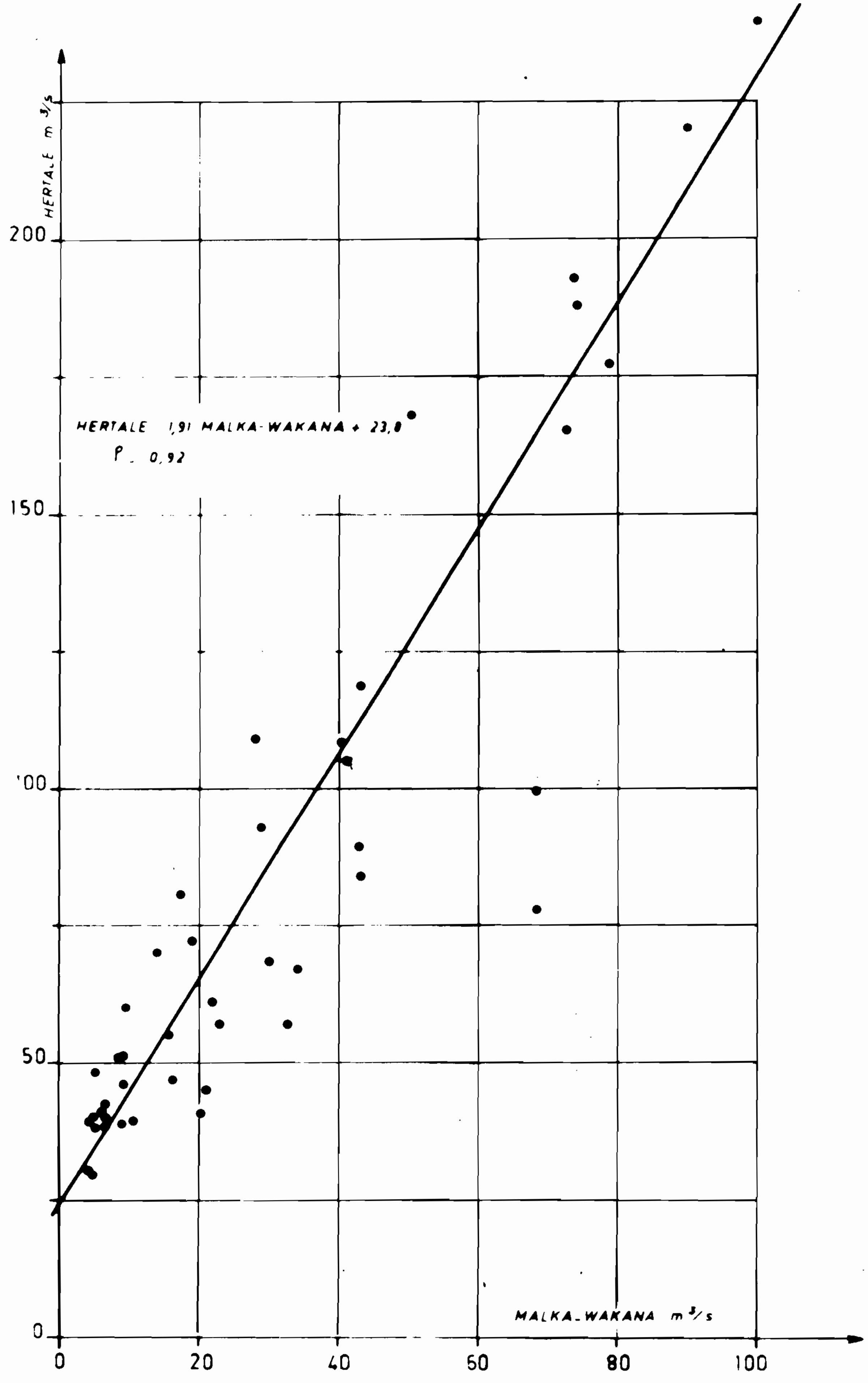
The average hydraulicity of the four last years observed (from 1967 to 1970) in relation to the data extended to 16 years, is 1.05 or slightly above the average.

In order to ameliorate the estimate of the hydraucility of these four years, study was made of the relation between the mean annual discharges of the Blue Nile at Kessie and those of the Blue Nile at Roseires (52 observation years from 1911 to 1962) for nine common years from 1954 to 1962. The relation obtained is rather loose (r=0.57) and does not allow extending usefully the data of Kessie nor of Hertale.

Gr-VI-1

Relation between monthly discharges of WABI-SHEBELLE at MALKA-WAKANA and AWASH at HERTALE

Corrélation des débits mensuels du WABI-SHEBELLE à MALKA-WAKANA et de l'AWASH à HERTALE



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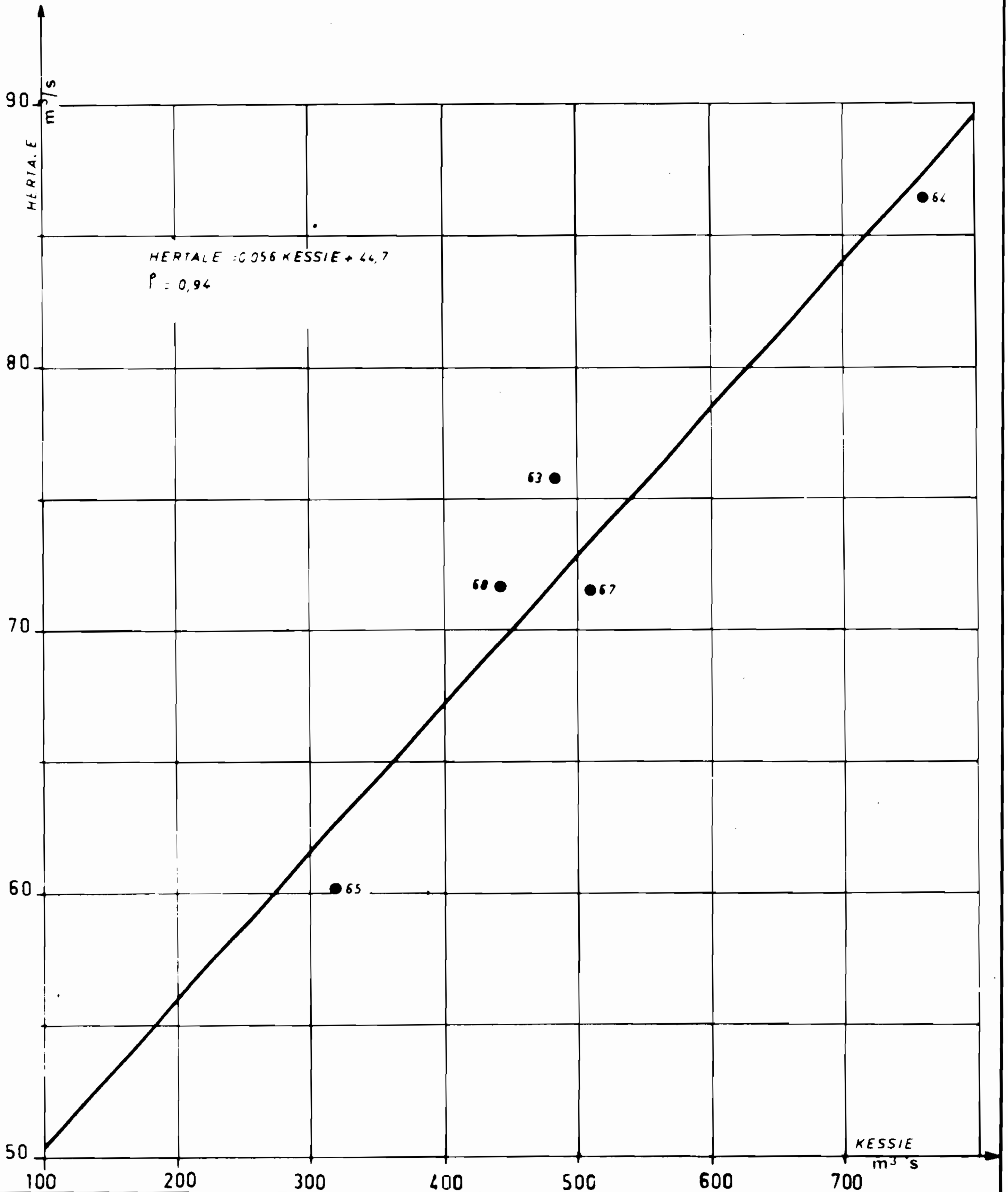
Relation between mean annual discharges of BLUE NILE at KESSIE and AWASH at HERTALE

Corrélation entre les modules du BLUE NILE à KESSIE et de L'AWASH à HERTALE



Nonetheless, it may be noted that the hydraulicities for the 1954-1962 period having being used for the relation with periods of different lengths (16 years at Hertale 52 years at Roseires) have the same value : 1.11 at both stations. The data extended to 16 years at Hertale therefore represents very well the average hydraulicity for a longer period.

To summarize, a suitable relation to the monthly staff-gauge may be observed between the hydraulicities at the station of the Wabi Shebelle at Malka Wacana and the Awash station at Hertale. Hydraulicity for 1967 - 1968, 1969, 1970 at Hertale corresponds to 1.05 in relation to the sample extended to 16 years. This figure will be expected for Malka Wacana. The average for these four years at Malka Wacana is 28.9 m3/s.

The long term average discharge being thus corrected by this last coefficient becomes 27,5 m3/s or a specific mean discharge of 5,2 l/s km2 and a runoff volume of 867 million m3 per year. This value of the mean annual discharge computed through these relations scarcely vary from the mean annual discharge of the six observation years which represents 27.7 m3/s.

These results are verified when examining the total long duration rainfall at Addis-Ababa. The mean annual rainfall computed for 62 years (from 1898 to 1971)is 1.185 mm. The mean rainfall from 1967 to 1971 is 1 253 mm which gives a rainfall excess of 1.06 for these five years.

6.1.2. Variation from year to year and annual discharges for a 10 year period

The mean annual discharges observed during the six years are very similar. Hence,it is difficult to have an idea, from this sample, of the coefficient of variation and consequently of interannual irregularity.

In order to obtain degrees of comparison, the statistical distribution of mean annual discharges was studied at several stations presenting long enough observation periods. The results are as follows,i.e :

BLUE NILE at ROSEIRES

- 52 years,from 1911 to 1962
- Incomplete Gamma distribution law (or Pearson III), Cv = 0.19

BLUE NILE at KESSIE

- 13 years from 1956 to 1968
- Normal distribution law with a hyper normal trend Cv = 0.35
  Cv = 0.25

WABI SHEBELLE at BELET UEN

- 16 years from 1952 to 1969 (except 1953 and 1960)
- Incomplete Gamma distribution law, Cv = 0.35.

The coefficients of variation are certainly much higher for Malka Wacana as the stations concerned are located at the outlet of basins presenting large zones where runoff of Sahelian type is very irregular. This is not the case for the basin of Malka Wacana where most of the rivers have a permanent stream flow.

The flow conditions at Malka Wacana are doubtless relatively regular owing to the pervious character of the basin which mainly consists of ash material and volcanic tuff favourable to a constantly high basin flow and to a distribution of rainfall in two distinct seasons.

The comparison of the mean annual discharges at Malka Wacana with those of the Awash at Hertale (the station presenting the best relation with Malka Wacana) confirms the assumption concerning the irregularity of flow. At Hertale, for the period 1967 to 1970, the relative deviation of the lowest mean annual discharges to the long term average discharge for the four years is 9 per cent, whereas it is only 5 per cent at Malka Wacana. The coefficient of variation for Hertale being approximately the same as for Kessie (0,25) a much lower coefficient : 0.12 will be considered for Malka Wacana. With such a coefficient of variation the assumption of a normal distribution of mean annual discharges presents some likelihood. Consequently one may put forward the following figures for mean annual discharges for a 10-year period.

Dry 10-year mean discharge : 23.3 m3/s
Humid 10-year discharge : 31,7 m3/s

From these results, the water year 1972-1973 (mean annual discharge 22 m3/s) appears slightly lower than the dry 10-year average discharge.

6.2. MEAN ANNUAL DISCHARGE OF THE MIDDLE BASIN AND OF THE LOWER VALLEY OF THE WABI SHEBELLE

The available data included a chronicle of discharge of the Wabi Shebelle per five day periods at Belet Uen, from 1952 to 1969 and a chronicle of monthly discharges of the same river more upstream at Mahaddei-Uen from 1919 to 1933 and from 1952 to 1964. Some uncertainty still exists concerning the site of the second station and the homogeneousness between the two observation periods.

Though a suitable relation exists between the mean annual discharges of the two stations for the same period, from 1952 to 1964, and though the average hydraulicity is similar between 1919-1933 and 1952-1964, the series from 1919-1933 could not be taken into account since it proved to be too irregular. In fact, another computation of the mean annual discharges at Belet Uen from 1919 to 1933 using the relation 1952-1964, gives exaggerated results : the series 1952 - 1969 varies from 35 to 101 m3/s whereas the old series, though it is not longer, presents extremes from 21 to 214 m3/s. The second figure is particularly aberrant if one recalls that the flood plain between Kelafo and Mustahil regulates the hydrograph so that the maximum flood is limited to approximately 250 m3/s. Therefore it was thought preferable not to use the 1919 - 1933 series.

6.2.1. Statistical study of mean annual discharge at Belet Uen

In order to determine the long-term average discharges in the middle basin and in the lower valley of the Wabi Shebelle, we used the available data for the 16 observation years (from 1952 to 1969 except 1953 and 1960) on the Wabi Shebelle at Belet-Uen which is a station located in Somalia at 40 km from the border and at approximately 70 km downstream from the Burkur station. Unfortunately, data for periods after 1969 were unavailable but would have been very useful to build up the correlations.

The characteristics of the sample for the 16 mean annual discharges are as follows, i.e :

Maximal mean annual discharge observed : 101 m3/s

Minimal mean annual discharge observed : 34,5 m3/s

Average mean annual discharge : 66,7 m3/s

Standard-deviation : 23,1 m3/s

Coefficient of variation : 0,35

The best fitting of a distribution law to this sample is an incomplete Gamma function with the following parameters :

Average : 66,7 m3/s

Shape : 7,360

Scale : 8,532

Location : 4 m3/s

Graph VI 3 represents the curve fitting this law to the sample.

The values of discharges corresponding to different return periods are given below :

Return period	Mean annual discharge (m3/s)
20 years dry	34
10 years dry	39
5 years dry	47
medium	64
5 years humid	85
10 years humid	98
20 years humid	109

The data observed at the Project stations may be extended from the sample and by using the relations between stations of monthly discharges for common observation periods and an estimate of long-term average discharges for a longer period can be made.

6.2.2. Correlations used

a) Correlation Belet-Uen Burkur.

First, the monthly discharges of the Belet Uen station have been related to those of Burkur, the nearest station. This linear relation is based on 11 pairs of monthly values, from February to December 1969 and its equation is :

Q (Burkur) = 1,06 Q (Belet-Uen) (graph VI. 4)

Q represents the monthly discharges in m3/s.

This very close relation allowed reconstructing the monthly discharges and the mean annual discharges for fifteen years.

The new sample includes discharges for 18 years (from 1952 to 1971 except 1953 and 1960)

b) Relation between Belet-Uen and Gode

The relation between the monthly discharges at Belet-Uen and Gode is relatively loose which could be expetted owing to the influence of the flood plains located between these two stations. In order to improve this relation various monthly relations were made taking into account the flow propagation between the two stations. The best link was obtained by relating the monthly discharges at Gode with those observed at Belet-Uen taking into account a time-log of 15 days. This relation based on 22 pairs of points is not linear but may be resolved into two straight lines of linear regression with the following equations :

For monthly discharges lower than 100 m3/s at Belet-Uen

Q Gode = 1,1 Q (Belet-Uen + I 5 d) + 3

For monthly discharges higher than 100 m3/s at Belet-Uen :

Q Gode = 1,8 Q (Belet-Uen + 1 5 d) - 67

These lines are represented on graph VI 5.

The break in the relation is due to the role played by flooding : above a certain monthly discharge of approximately 113 m3/s at Gode, the gradient of losses becomes much higher than it was previously. These relations allow reconstituting the discharges for 14 years. The new sample includes 18 years from 1952 to 1971 except 1953 and 1960).

c) Relation between stations.

In order to extend the reconstitution of the discharges to the other stations of the middle basin and of the lower valley, the relations between stations of monthly discharges havebeen examined. These usually satisfactory relations are linear and are summed up below :

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date 7.73 | des. D.JP

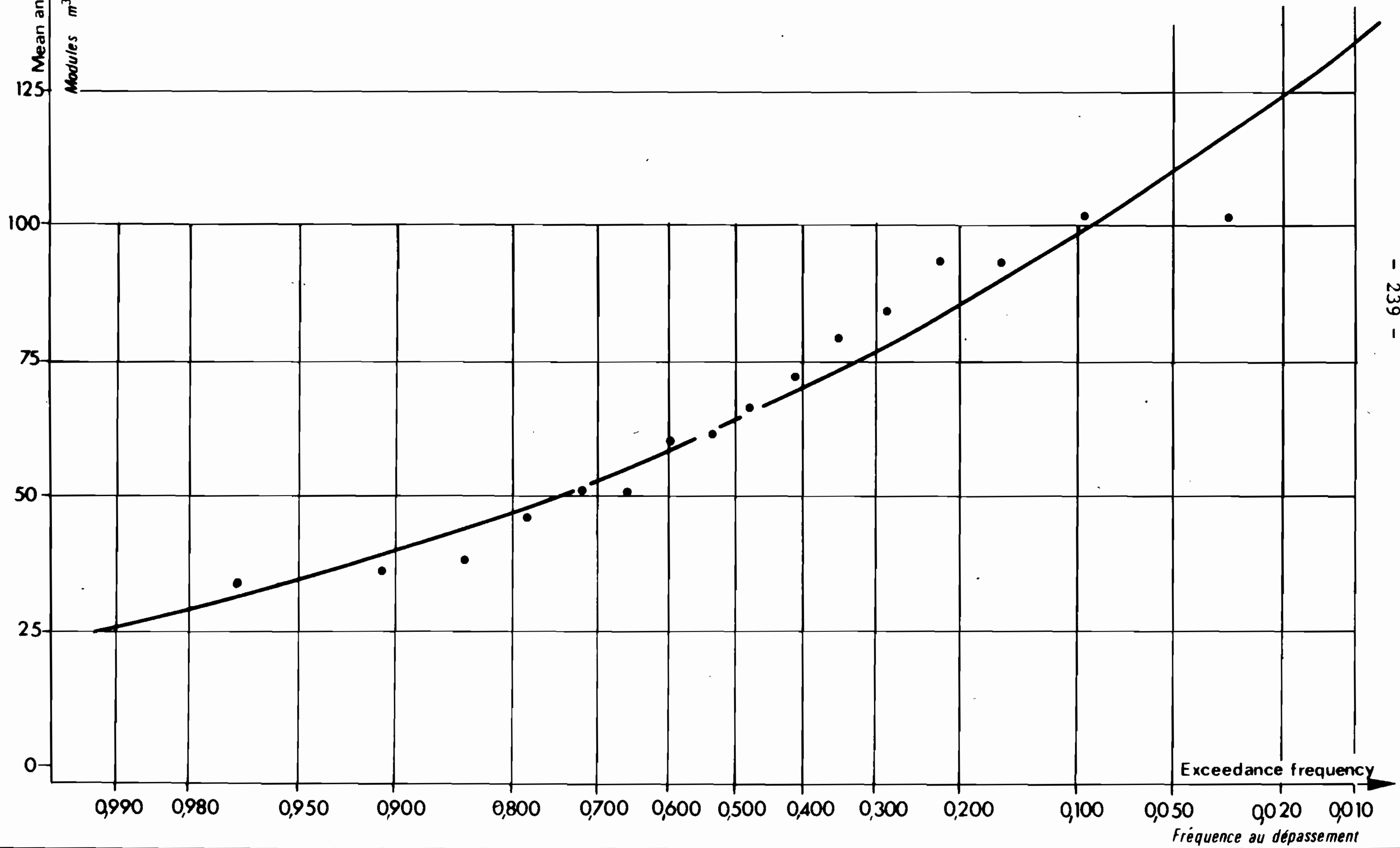
ETR. 291797

MEAN ANNUAL DISCHARGES OF WABI-SHEBELLE AT BELET UEN

MODULES DU WABI SHEBELLE A BELET UEN

FITTING OF A FREQUENCY CURVE OF PEARSON III

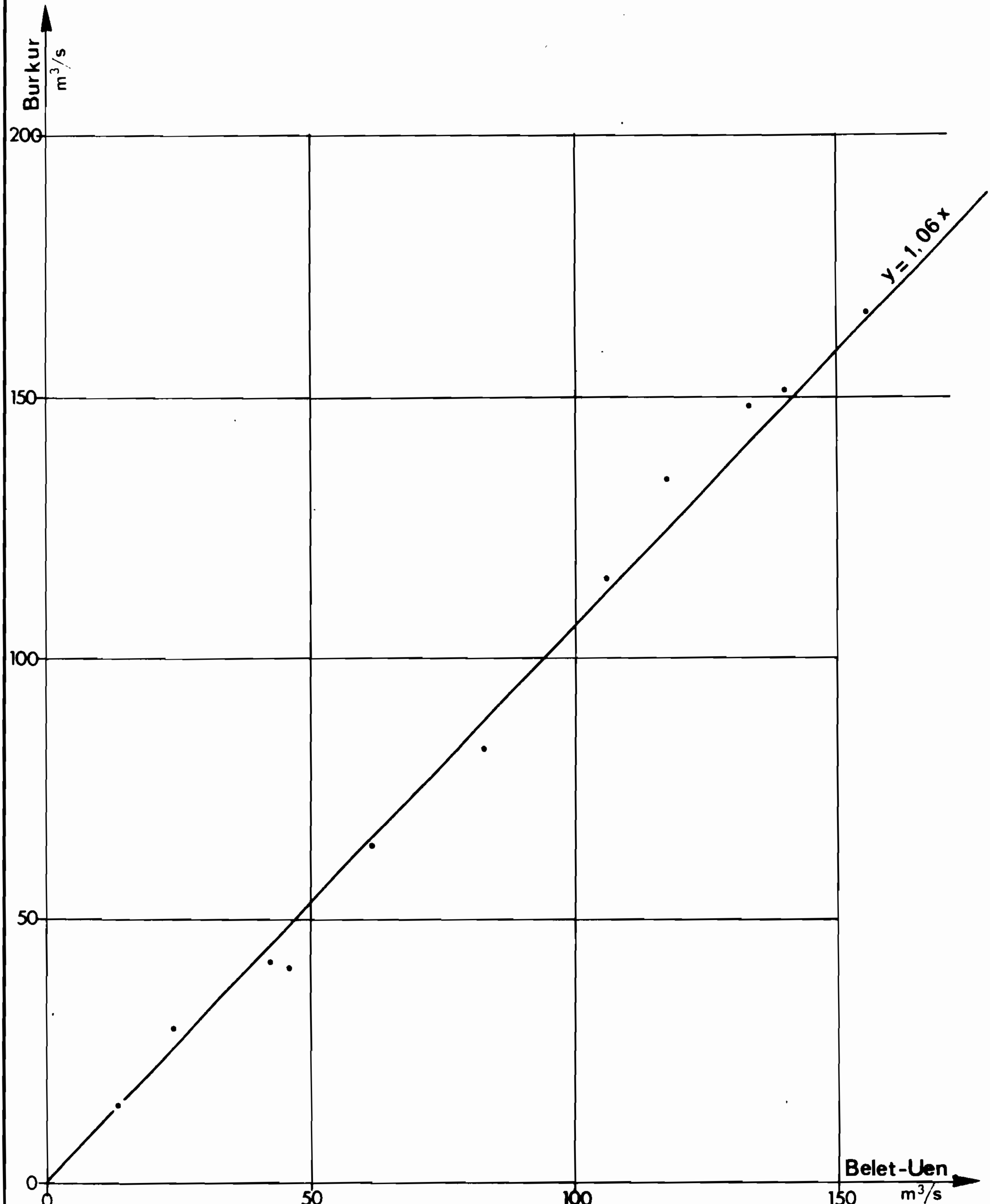
AJUSTEMENT D'UNE LOI DE PEARSON III



Gr. VI-3

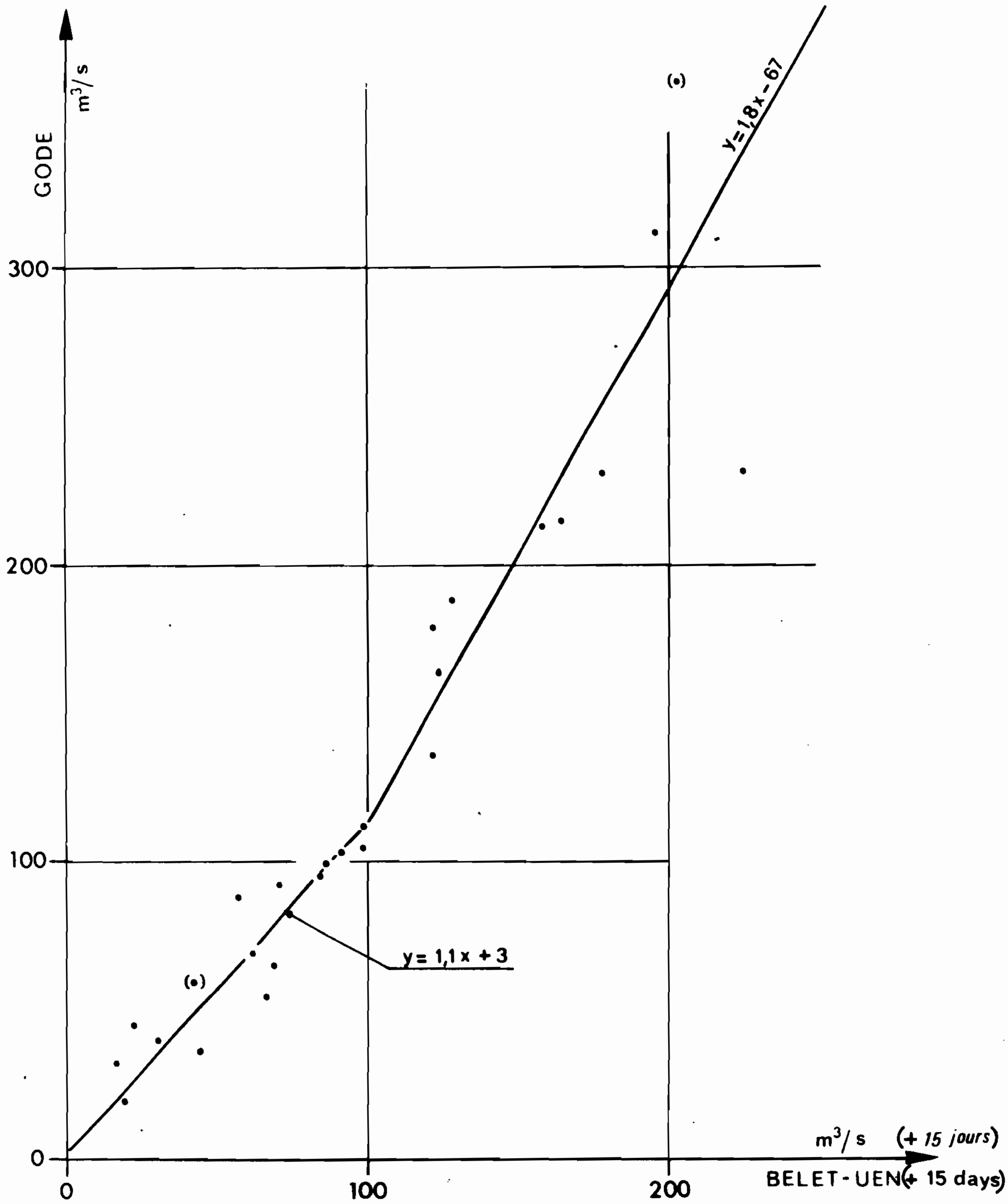
RELATION BETWEEN MEAN MONTHLY DISCHARGES AT BELET-UEN AND BURKUR

CORRELATION ENTRE LES DEBITS MOYENS MENSUELS A BELET-UEN ET A BURKUR



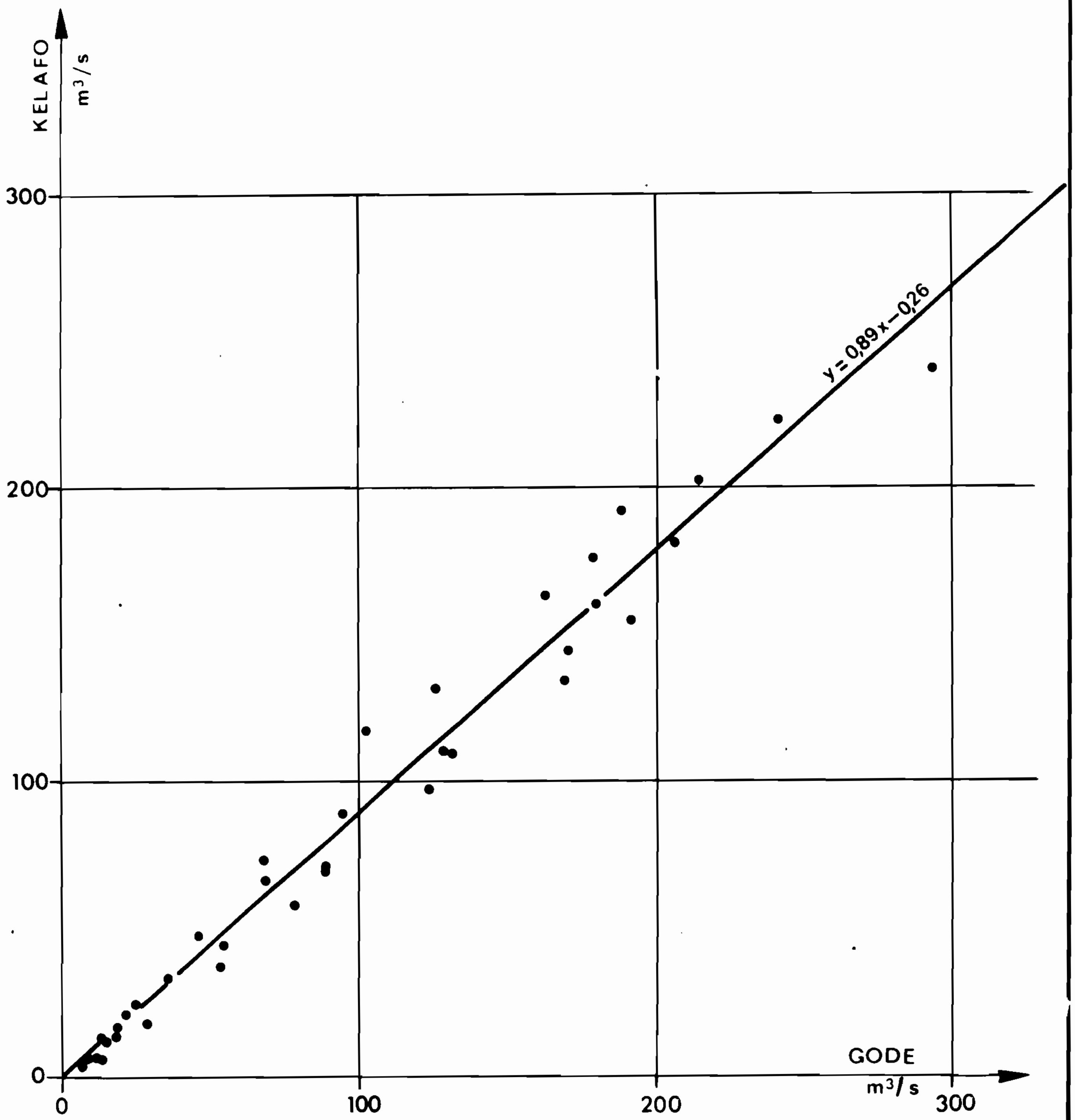
RELATION BETWEEN MEAN MONTHLY DISCHARGES AT BELET UEN AND GODE

CORRELATIONS ENTRE LES DEBITS MOYENS MENSUELS A BELET UEN ET GODE



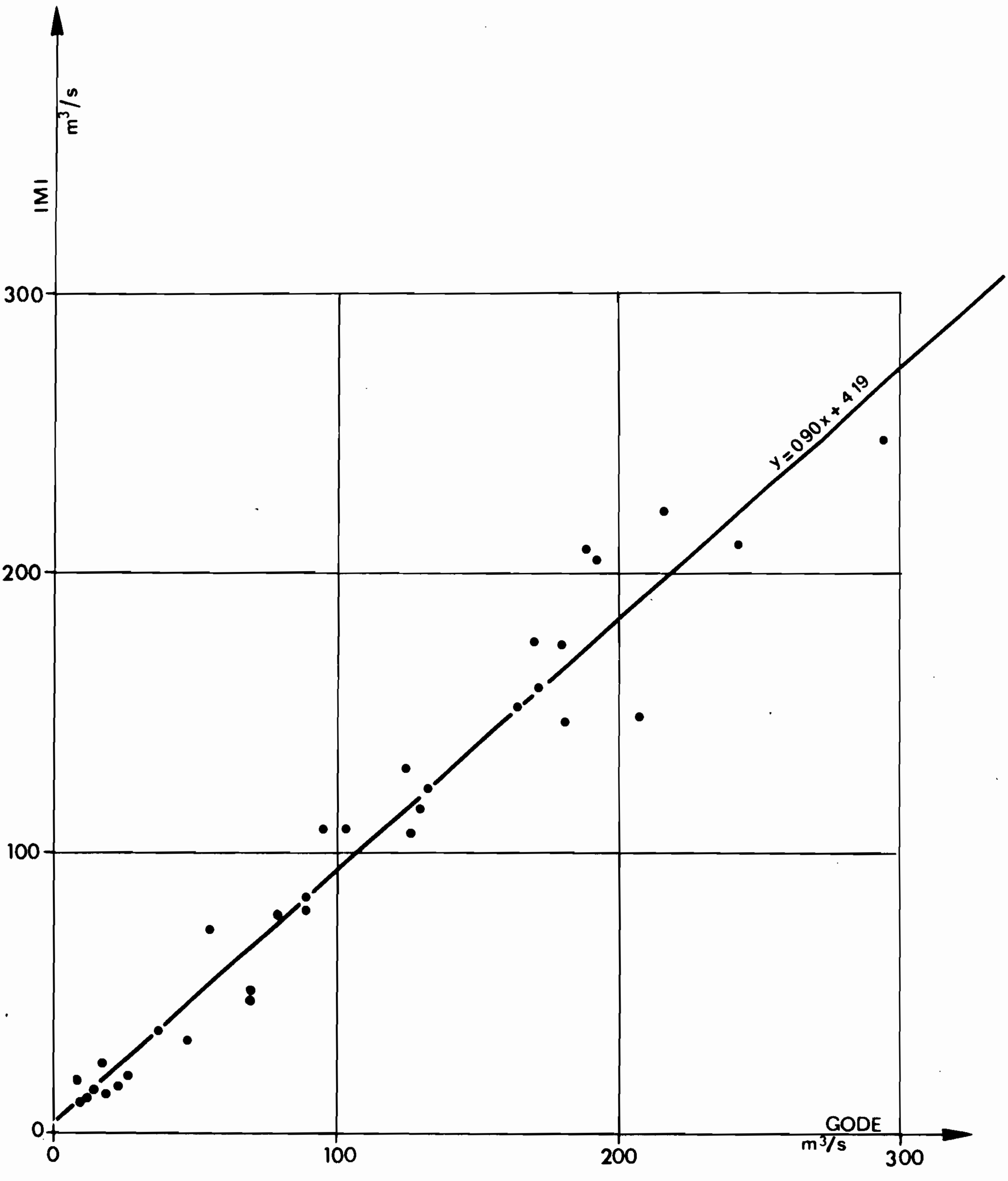
RELATION BETWEEN MEAN MONTHLY DISCHARGES AT GODE AND KELAFO

CORRELATION ENTRE LES DEBITS MOYENS MENSUELS A GODE ET KELAFO



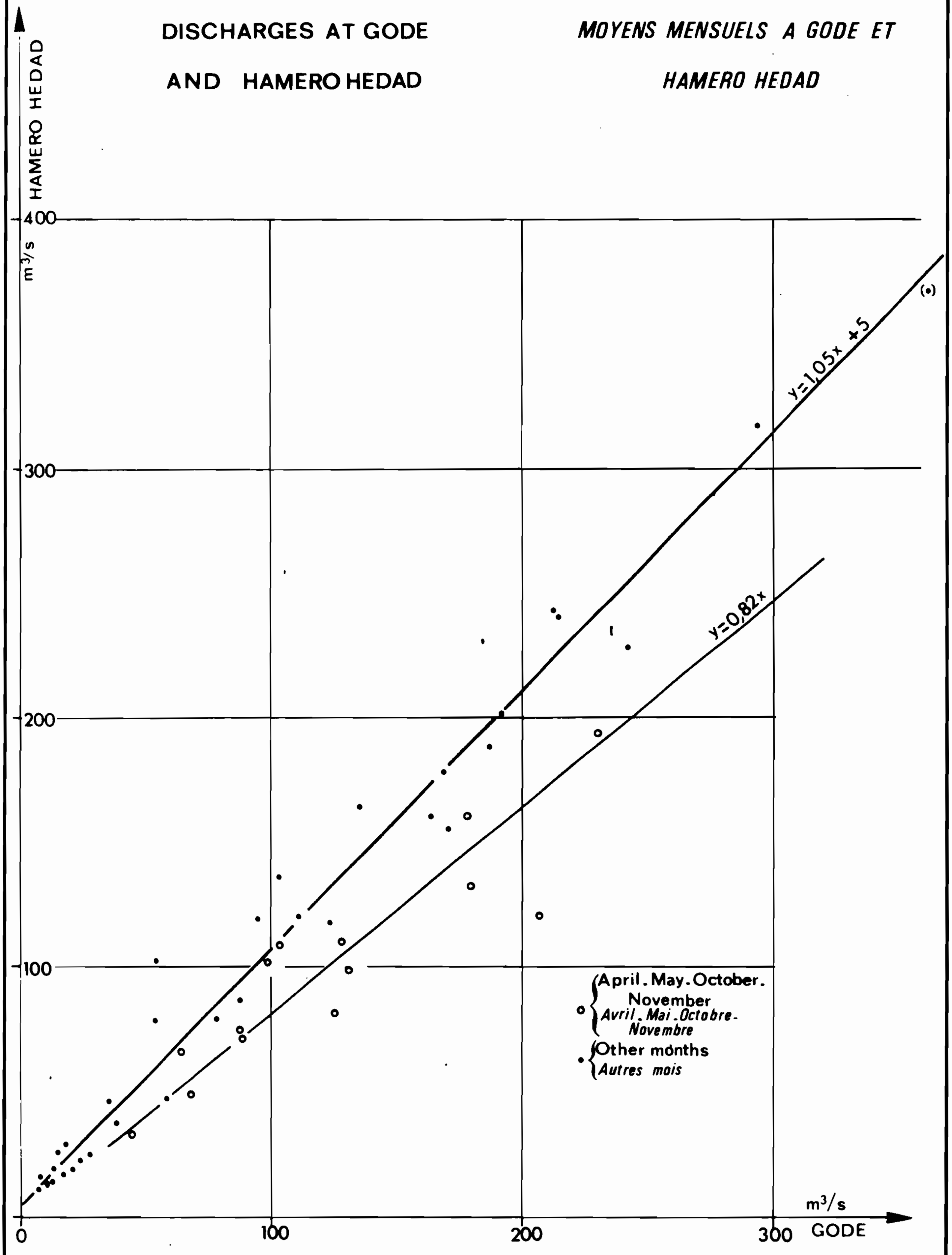
RELATION BETWEEN MEAN MONTHLY DISCHARGES AT GODE AND IMI

CORRELATION ENTRE LES DEBITS MOYENS MENSUELS A GODE ET IMI



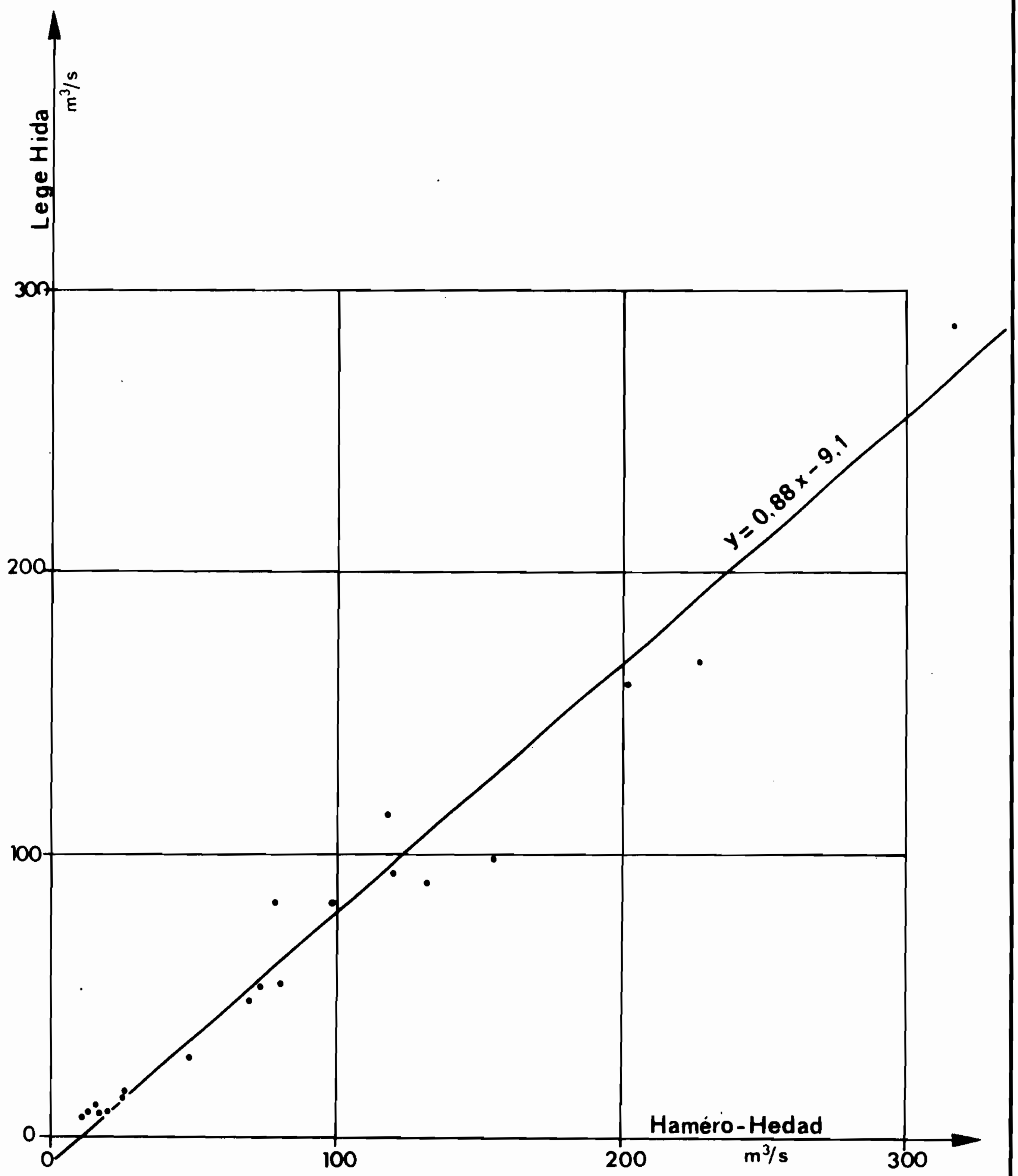
RELATIONS BETWEEN MEAN MONTHLY DISCHARGES AT GODE AND HAMERO HEDAD

CORRELATIONS ENTRE LES DEBITS MOYENS MENSUELS A GODE ET HAMERO HEDAD



RELATION BETWEEN MEAN MONTHLY DISCHARGES AT HAMERO-HEDAD AND LEGE-HIDA

CORRELATION ENTRE LES DEBITS MOYENS MENSUELS A HAMERO-HEDAD ET A LEGE-HIDA



Q (Kelafo) = 0,89 Q (Gode) - 0,26

Q (Imi) = 0,90 Q (Gode) + 4,19

Q (Hamero-Hedad) = 0,82 Q (Gode) for the rainy months of Ogaden (April, May, October, November)

Q (Hamero-Medad) = 1,05 Q (Gode) + 5 for the other months of the year.

Q (Lege-Hida) = 0,88 Q (Hamero-Hedad) - 9,1.

These relation lines are represented on graphs VI. 6, VI.7, VI.8, VI.9.

6.2.3. Long term average discharges estimated from the relations.

All the relations examined in the preceding paragraph allow estimating the mean annual discharges at the stations between Lege-Hida and Burkur for a same period made homogeneous for 18 years.

The results of these estimates, for stations presented from the upstream part to the downstream part, are given in the table below :

WABI-SHEBELLE Stations	Mean Annual Discharges in m3/s	Specific Mean Annual Discharges l/s.km2	Runoff volumes 10 6 m3
LEGE-HIDA	66,1	3,09	2 085
HAMERO-HEDAD	85,6	1,33	2 700
IMI	82,6	0,90	2 605
GODE	87,1	0,68	2 747
KELAFO	77,3	0,56	2 438
BURKUR	70,7	0,49	2 230

These results must be used carefully. In fact as the various relations between monthly discharges did not use samples corresponding to exactly the same period, heterogeneous results may be expected. The results are less accurate as one goes upstream.

In spite of this, the coherence of results is good for all the lower valley. As concerns the mean annual discharges observed (cf-chapter 4.1.4 and 4.1.6), the balance between Gode and Hamero-Hedad is successively - 6, - 5, + 14 and + 7 m3/s or an average of + 2,5 m3/s, whereas the positive balance for the mean annual discharges of the average year is 1,5 m3/s.

Besides, the relative weakness of the mean annual discharge at Imi, compared to that of the two stations commanding the reach, is due to the role of inflows and losses. If the inflows average (cf 6.3) 12 m3/s,(6 m3/s above Imi) this corresponds to a distribution of losses of 9 m3/s upstream from Imi and of 2 m3/s downstream (down to Cugno) which is consistent with what could be expected from the local topography.

6.2.4. Interannual irregularity and estimate of the mean annual discharges for a given frequency

The sample for 18 observation years reconstituted at the Wabi Shebelle stations from the series of Belet-Uen allows determining the interannual irregularity and estimating the mean annual discharges for various recurrence intervals. The results thus obtained are certainly not very accurate owing to the nature of the relations used to provide these samples, and because of the interannual influence of flood plains.

To the comment on the heterogeneous nature of the relations, one must also add that using them systematically in order to extend the short series (3 to 5 years) to 18 years entails a considerable reduction of the variance hence an underrating of abundant extreme mean annual discharges and an overrating of dry mean annual discharges.

Contrarily to what was observed for Belet-Uen, the best fitting to the series of mean annual discharges is not the frequency curve of Pearson III but a Goodrich curve.

The following table presents the mean annual discharges estimated at each station for various exceedance frequencies. For each station are also given the parameters characterizing the irregularity of the sample that is to say : the coefficient of variation Cv and the coefficient K3 which is the ratio of the humid 10-year mean annual discharge to the dry 10-year mean annual discharge.

Station	Mean annual discharges in m3/s for an exceedance frequency of							C_v	K_3
	0,99	0,98	0,90	0,50	0,10	0,02	0,01		
LEGE-HIDA	17	20	34	65	101	123	131	0,41	2,99
HAMERO-HEDAD	29	33	49	84	124	149	158	0,36	2,55
GODE	26	31	48	86	127	152	161	0,37	2,63
BURKUR	24	28	41	70	101	120	126	0,34	2,45

The results are satisfactory for Burkur. As to Gode and Hamero-Hedad, the normal increase of the irregularity of flow compared to what occurs in the downstream part of the flood plains of the reach Kelafo-Mustahil, is slightly lessened here by the reduction of the variance since the coefficients of variation are only slightly greater than at Belet-Uen where the coefficient is 0,35.

On the other hand, the irregularity estimated for Lege-Hida (C_v= 0,41) seems all the more exaggerated since regular and abundant sources from very rainy volcanic regions are nearer as one goes upstream to Malka-Wakana. The coefficient of variation for Malka-Wakana being 0,12, and taking into account the observations made, one may suppose that the irregularity of the Wabi Shebelle flow increases progressively in the downstream part, consequently, the coefficient of variation at Lege-Hida cannot attain that of Hamero-Hedad (the latter being probably also underrated) and an approximate value of 0.30 seems more likely.

A new series of values for the mean annual discharges at Lege Hida was thus computed instead of those of the preceding table but, owing to a lack of precision, these values are limited to 10-year frequencies :

Frequency	Mean annual discharge (m3/s)	
0.90	40	
0.50	65	$K_3 = 2.30$
0.10	92	

The preceding bases allow expressing an opinion concerning the occurence probabilities of the observation years.

In the Lower Valley, all the observation years are above the average, 1971-1972 being the closest to this average whereas 1969-1970 presents a decennial character.

Upstream from the Lower Valley, conditions are not so simple. Though all the water years from 1967-1968 to 1971-1972 are above the average at MALKA-WAKANA, 1969-1970 is the closest to this average. One must also remember that 1972-1973 was still more severe than the dry decennial water-year.

6.3. Mean annual discharges of the ERRER, of the DAKETA and of the basin of the FAFEN

It is difficult to estimate the average values of the mean annual discharges of this group of rivers, the arid character and irregularity of which increase from the West to the East and South.

Only two complete observation years are available for the Errer and no strict relation could be made between its monthly discharges and those of the intermediate basin between Hamero Hedad and Lege Hida. Though the Errer has a permanent flow, it often presents sudden and violent floods and its regime is very different from those of the other tributaries of the Wabi Shebelle.

The average mean annual discharge of the Wabi Shebelle is slightly higher than that of 1971- 1972 and considerably lower than for 1970-1971. If one takes into consideration this relatively uncertain indication, one may put forth a value of 5 m3/s for the mean annual discharge of the Errer, or 0.35 l/s km2.

If rainfall in the North of the basin at Deder and Harar is also taken into account, the following characteristics may be noted :

Year	Errer (m3/s)	Deder (mm)	Harar (mm)
1970-1971	5.8	994	742
1971-1972	4.2	1 119	888
Average	-	1 083	880

namely : the relation between rainfall and flow is relatively loose at the annual scale, which neither confirms or modifies the figure above mentioned.

The Daketa being a temporary river is still more difficult to estimate. The mean annual discharges for 1970-1971 are respectively 6.1 and 3.1 m3/s They can be compared to the rainfall of Harar (further above mentioned) and of Jijiga which are respectively 405 and 713 mm thereas the average is 672 mm. The contradiction between rainfall and discharge on the annual scale is still more distinct here and all the more so since there are no old rain gauging stations in the middle part and in the downstream part of the basin.

At a rough estimate more than by reasoning we suggest for the Daketa an average mean annual discharge of 4 m3/s or 0.28 L/s km2. On these lines one may assume that the average specific annual discharge is approximately 0.15 l/s km2 for the other tributaries of Ogaden (Degahbour, Darole, Madiso...) Taking these figures into account, the inflows of the intermediate basin between Hamero Hedad and the beginning of the flood plains North of Imi correspond to 6 m3/s as well as the inflows downstream from Imi and down to Gode.

The mean annual discharges observed for the Jerer and the Fafen present a great irregularity linked to subarid rainfall conditions. For the Jerer the mean annual discharge of 1969 (0.106 m3/s) is four times less than the mean annual discharges of 1970 (0.434 m3/s) and of 1971 (0.480 m3/s). For the Fafen, the mean annual discharges of 1969 (0.608 m3/s) is twice smaller than the mean annual discharge of 1970 (1.15 m3/s).

The mean annual flows depend less on the mean annual rainfall than on the distribution areas of rainfall and grouping of storms in the year.

An approximate value of the long term average discharge may be estimated from the data provided by the rain-gauging stations of JIJIGA, DEGAHBOUR and KEBRI-DAHAR.

For the Jerer the mean annual discharges observed seem relatively well linked to the rainfall recorder at Degahbour station as may be seen below ;

Year	Mean annual discharges of the Jerer m3/s	Rainfall at Dagahbour mm
1969	0.106	247
1970	0.434	346
1971	0.480	363

The average rainfall at Degahbour being 314 mm, the long-term average discharge of the Jerer at Degahbour may be estimated as approximately 0,350 m3/s.

The relation between rainfall and mean annual discharges of the Fafen at Kebri Dahar is not so good. The values of the mean annual discharges observed at Degahbour and the corresponding annual rainfall at the Degahbour and Kebri Dahar stations are given below :

YEAR	Mean annual discharges of the FAFEN (m3/s)	Rainf. KEBRI-DAHAR (mm)	Rainf. DEGAHBOUR (mm)
1969	0,608	422	247
1970	1,15	288	346
1971	0,704	262	363

Rainfall for an average year is :

314 mm at DEGAHBOUR

277 mm at KEBRI-DAHAR

From these observations, it seems that the long-term average discharge is approximately 0,700 m3/s.

It is difficult to have a quantitative knowledge of the interannual irregularity of these rivers. If the ERRER does probably not present a considerably higher coefficient of variation than those of the WABI-SHEBELLE (from 0,35 to 0,40), on the other hand, the DAKETA, JERER and FAFEN probably attain twice higher values but the risk of an absence of flow may be considered as improbable.

CHAPTER VII

SURVEY OF MONTHLY DISCHARGES

7.1. MONTHLY COEFFICIENTS OF DISCHARGE - SEASONAL VARIATIONS

The monthly coefficients of discharge computed from the-year-to-year averages allow characterizing the seasonnal variations of flow without taking into account the maximum values of discharges. They are represented as follows :

$$Ci \text{ (per cent)} = \frac{100\ qi}{12\ q}$$

with Ci = Monthly coefficient in per cent
Qi = mean monthly discharge of month "i"
Q = long-term average discharge

The total coefficients Ci of a station corresponds to 100 per cent.

Table 7.1. presents the monthly coefficients from year to year for the main stations under study. For the stations located on the Wabi Shebelle between Lege-Hida and Bukur these coefficients were computed from the 18 years partly reconstituted through the observations of the Belet-Uen station. For the other stations they were computed using the observation years and may only be used for guidance.

The main characteristics of flow in the basin of the Wabi Shebelle may be drawm from these figures. All the rivers present two high flow seasons corresponding to the two rainy seasons. The relative abundance of these two seasons varies according to the drainage basins : the second rainy season is more abundant than the first on the upper basin and in the Southern part of the basin, the first season becomes more abundant than the second. Furthemore, the highest flow of the second season occuring in August in the upper basin is progressively delayed until September and October to the South of the basin.

7.1.1. Main-stream-flow of the WABI SHEBELLE

Table 7.1. shows the evolution of the flow of the Wabi Shebelle from the upstream part to the downstream part.

Upstream from Malka-Wacana the Wabi Shebelle presents the following flow-conditions :

Table 7.1.

Monthly coefficients of discharges (in per cent)

- average values -

Station	F	M	A	M	J	J	A	S	O	N	D	J	Number of years
WABI SHEBELLE													
Bridge of DODOLA	2,4	4,2	7,0	6,0	5,4	12,3	23,5	19,4	10,5	5,2	1,9	2,2	5
MALKA-WAKANA	3,1	5,8	9,3	6,2	3,9	12,5	24,4	16,9	9,6	4,5	1,9	1,9	6
LEGE-HIDA	1,9	3,6	9,2	9,1	3,5	7,3	18,8	19,5	13,7	7,5	3,7	2,2	18
HAMERO-HEDAD	2,6	4,2	9,8	9,4	4,0	7,2	17,3	18,2	13,2	7,7	4,2	2,2	18
GODE	1,9	3,6	11,3	11,1	3,5	6,1	15,8	16,6	15,8	9,1	3,6	1,6	18
BURKUR	1,3	3,0	5,5	14,9	5,5	4,2	11,6	17,6	16,3	12,0	6,3	1,8	18
The tributaries of WABI SHEBELLE													
MARIBO at bridge of DODOLA	2,2	6,9	11,9	7,8	4,0	12,0	18,5	17,4	12,4	4,7	1,2	1,0	4
Maribo confluence	3,1	9,8	11,4	7,4	3,8	11,6	22,9	14,4	9,6	2,8	1,5	1,7	4
ERRER	2,9	6,6	12,8	15,5	6,2	4,4	12,1	17,1	11,3	4,6	3,3	3,2	2
DAKETA	0	9,4	30,9	37,7	3,2	0	0	4,9	12,6	1,3	0	0	2
The basin of FAFEN													
JERER at DEGAHBOUR	4,5	10,4	30,4	38,1	7,8	0	0	0,3	7,2	1,3	0	0	3
FAFEN at KEBRI-DAHAR	0	6,7	22,2	48,1	2,2	0,1	0	1,9	13,4	5,4	0	0	3

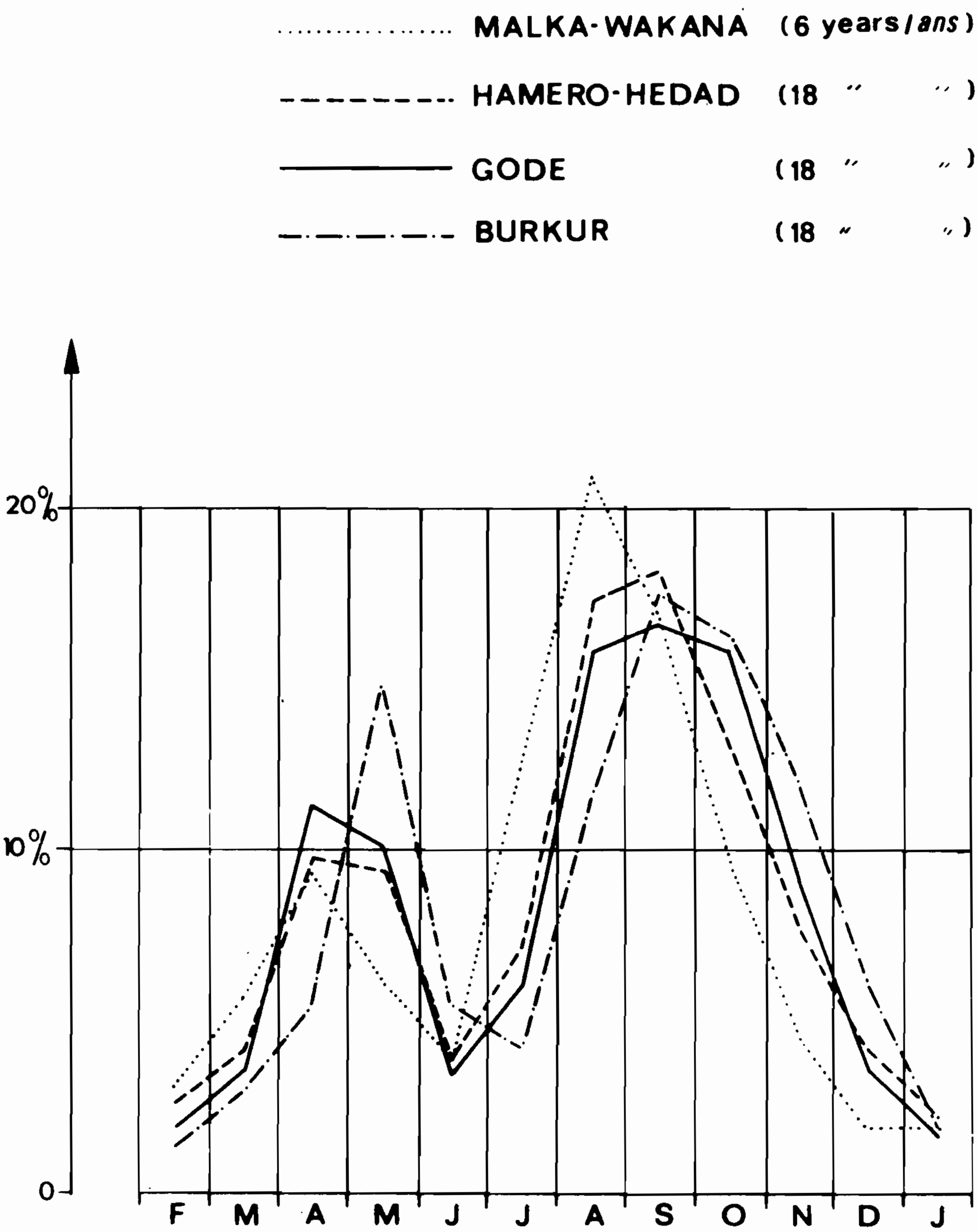
Nota : The coefficients of maximum discharges corresponding to the two rainy seasons are underlined.

MEAN MONTHLY COEFFICIENTS OF DISCHARGE

COEFFICIENTS MOYENS MENSUELS DE DEBIT

Evolution of the flow in the main reach of Wabi Shebelle

Evolution du régime dans le bief principal du Wabi Shebelle



- first high flow season from March to May with a maximum in April (9.3 per cent)

- short low flow season in June

- second high flow season from July to October with a maximum in August (24.4 per cent)

- low flow from November to February

- between Malka-Wacana and Hamero Hedad the inflows of the big tributaries from Chercher change the period of the second maximum which occurs in September 18.2 per cent). The flood and consequently the flood recession occur later.

- between Hamero-Hedad and Gode, the flood plains of the Imi region as well as the late inflows from the Daketa and from the tributaries of Ogaden produce a reduction of the hydrograph and the lenghthening of the high flow periods.

The first high flow season is more abundant than previously and lasts two months : April (11,3 per cent) and May (11,1 per cent).

The second high flow season presents three pratically equivalent months : August (15,8 per cent), September (16,6 per cent) and October (15,8 per cent).

- the flood plains located between Gode and Burkur delay the occurrence of the two maximums : the first in May (14,9 per cent); the second in September 17,6 per cent) and October (16,3 per cent). Besides, owing to the restitution of storage water of flood plains, flood recession is slower.

7.1.2. The Errer basin

The monthly coefficients were computed from only two observation years. It seems from these results that the two high flow seasons present equal maximums (15,5 per cent in May and 17,1 per cent in September) but the second season is more abundant than the first.

7.1.3. The basins of the Daketa and of the Fafen

The basins of the Daketa and of the Fafen present identical flow conditions and monthly distributions. The flow of both these rivers is inexistent during approximately 5 months in the year, from December to February and in July and August. The first rainy season provides the largest inflows with a maximum in May (approximately 40 per cent) and the second and less abundant season presents a maximum in October (approximately 13 per cent).

7.2. STATISTICAL DISTRIBUTION OF MEAN MONTHLY DISCHARGES

Table 7.2. presents for each month, several mean monthly discharges with different exceedance frequencies for the main stations of the main course of the Wabi Shebelle. These data derived directly from the study of available observations without curve fitting. The deviation between the values of 25 percent and those of 75 percent give the interquartile range, which related to the median (50 percent) gives an idea of the dispersion of the sample.

Graphs VII.2. and VII.3. interpret the figures presented in table 7.2.

TABLE 7.2

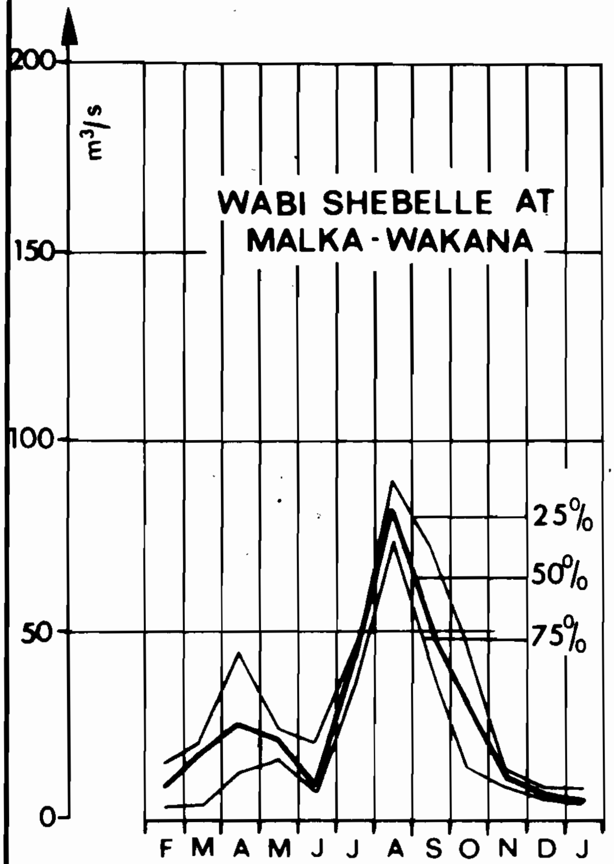
Mean monthly discharge with different exceedance frequencies (in m3/s)

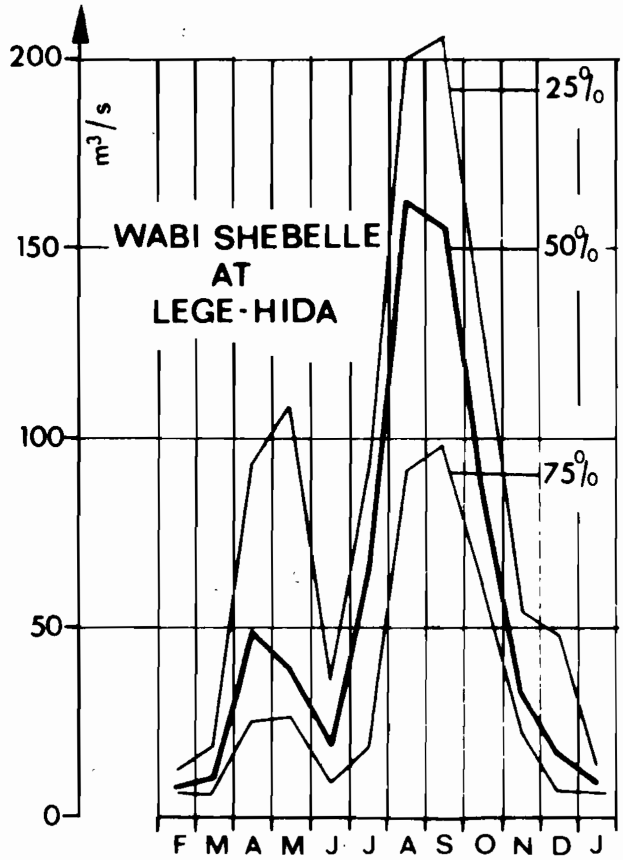
Station	F %	F	M	A	M	J	J	A	S	O	N	D	J
MALKA-WAKANA	25	15,6	21,1	43,7	22,7	20,3	43,9	90,2	72,8	47,3	12,4	7,27	8,50
1968-1972	50	9,3	17,9	25,1	20,6	9,18	41,2	81,8	51,2	28,8	10,2	5,43	5,06
(6 years)	75	4,6	4,55	12,9	16,4	6,63	35,0	74,3	43,0	14,0	7,77	4,76	4,35
LEGE-HIDA	25	12,0	18,2	93,0	107,8	36,4	82,9	199,7	206,2	129,4	53,5	47,3	14,3
1951-1971	50	7,0	10,2	48,6	39,1	17,9	64,3	162,3	155,3	86,2	31,5	16,5	7,8
(18 years)	75	6,2	5,9	25,0	26,3	8,0	17,7	90,7	97,8	61,3	22,3	6,3	5,9
HAMERO-HEDAD	25	18,9	30,1	120,0	132,8	50,2	97,8	230,4	237,6	157,4	74,2	62,2	25,9
1951-1971	50	17,4	19,0	68,3	54,8	29,3	78,7	193,7	181,5	109,5	49,4	28,3	18,4
(18 years)	75	16,2	16,3	38,8	40,2	18,9	29,6	110,2	147,8	80,0	35,7	17,0	16,5
GODE	25	22,0	24,6	165,0	162,0	44,3	91,0	213,0	228,0	192,0	88,4	56,1	19,4
1951-1971	50	12,2	14,2	84,8	66,9	25,9	67,0	185,0	173,0	139,0	63,2	26,6	13,1
(18 years)	75	11,0	10,9	47,3	49,0	13,6	24,1	103,1	136,0	97,6	44,0	14,0	11,3
BURKUR	25	14,4	27,9	64,4	166	57,2	54,9	132,0	168,0	171,0	118,0	63,8	21,3
1951-1971	50	9,0	8,8	38,3	96,3	28,6	28,4	118,0	160,0	125,0	84,0	30,5	10,0
(18 years)	75	7,5	6,0	10,1	57,6	17,1	9,2	76,7	133,0	92,1	59,8	14,7	8,4

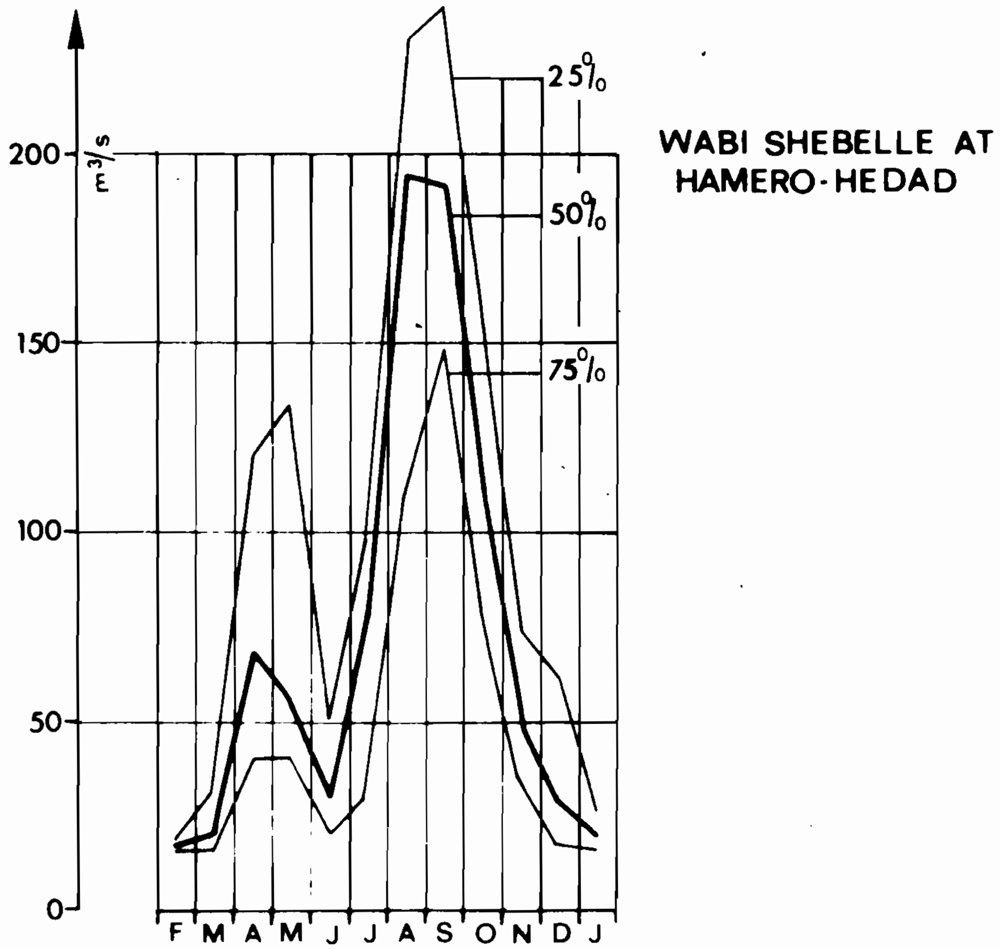
Gr-VII-2

MEAN MONTHLY DISCHARGES ACCORDING TO THEIR EXCEEDANCE FREQUENCY

DEBITS MOYENS MENSUELS D'APRES LEUR FREQUENCE AU DEPASSEMENT



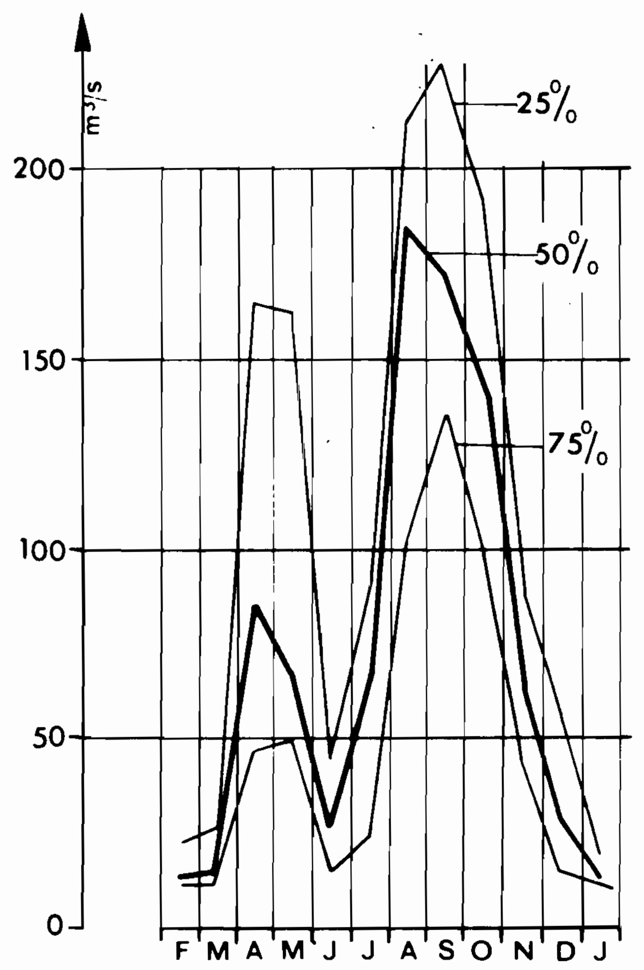




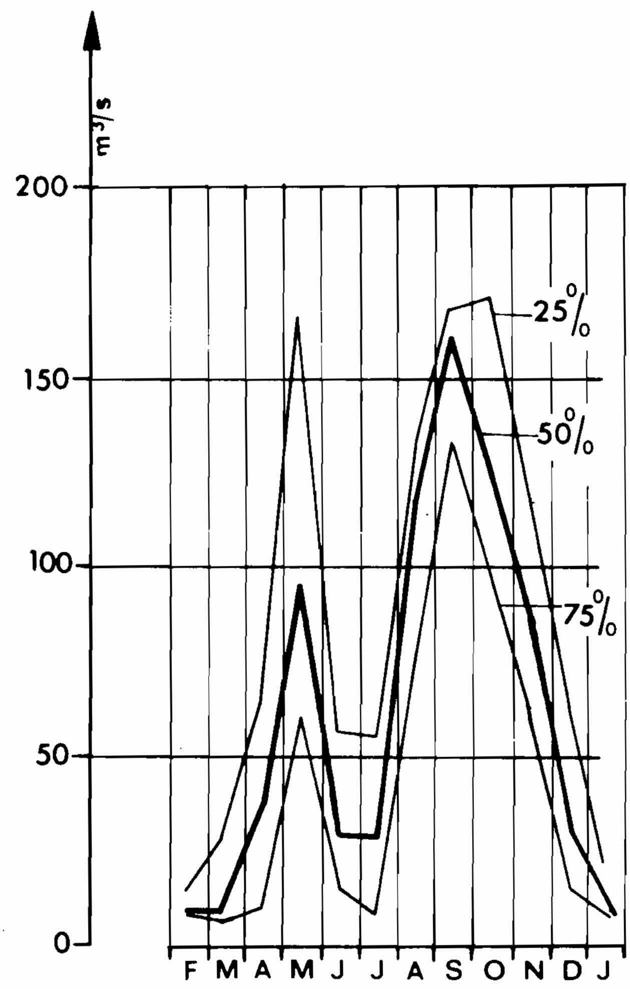
MEAN ANNUAL DISCHARGES ACCORDING TO THEIR EXCEEDANCE FREQUENCY

DEBITS MOYENS MENSUELS D'APRES LEUR FREQUENCE AU DEPASSEMENT

WABI SHEBELLE AT GODE



WABI SHEBELLE AT BURKUR



CHAPTER VIII

SURVEY OF LOW FLOW

8.1. DEPLETION

In this paragraph we consider that the recession discharges obey a depletion law such as :

$$Q_t = Q_o \, e - at$$

Q_t = discharge at moment "t", in m3/s

Q_o = discharge at moment "0", in m3/s

a = depletion coefficient in days "$^{-1}$" which signifies that the inverse of "a" is termed in days.

t = time in days.

Coefficient "a" is as a rule well defined when it applies to an homogeneous hydrogeological entity.

In the case of the basin of the WABI SHEBELLE, it is very variable since low flow is often supplied by the successive emptying of several hydrogeological basins.

This feature is complicated by the manifestation of floods from the upper basin during the depletion period and by the presence of floodable zones which restitute their storage water until a far-advanced recession period.

The depletion coefficients presented in the table below consist of average figures computed from often very scattered samples. The discharge at the beginning of the depletion indicated in this table corresponds to the mean discharge below which recession begins.

Station	Depletion coefficient in d-1	Average hinge discharge m3/s
- WABI SHEBELLE to MALKA-WAKANA	0,012	5,2
- WABI SHEBELLE to LEGE-HIDA	0,013	12,0
- WABI SHEBELLE to HAMERO-HEDAD	0,013	22,0
- WABI SHEBELLE to IMI	0,005	14,0
- WABI SHEBELLE to GODE	0,013	15,0
- WABI SHEBELLE to KELAFO	0,022	14,0
- WABI SHEBELLE to BURKUR	0,020	20,0
- ERRER to HAMERO-HEDAD	0,003	2,70

This table shows that, from MALKA-WAKANA to HAMERO-HEDAD, the depletion coefficients are close to 0,013. At IMI, a sudden discontinuity appears and the coefficient falls to 0,005. This is due to the slow restitution of the storage water of the flood plains and by the slow emptying of the alluvial water-table oversupplied during the flooding periods. After IMI, the depletion coefficients increase again owing to the influent seepage of low water discharge in the channel. The coefficient slightly decreases between KELAFO and BURKUR because of the restitution role of flood-plains.

8.2. LOW WATER DISCHARGES

Table 8.1. sums up the values of characteristic low water discharges observed at the main stations of the basin. The DAKETA, the FAFEN and the JERER are not mentioned in this table since their low water discharge is inexistent. The main characteristic discharges presented here are : the minimum flow (Q min), the maximum discharge for the 10 lowest consecutive days (Q 10) and the maximum discharge for the 30 lowest consecutive days (Q 30). Next to Q min, the date when this minimum discharge occurs is given.

8.2.1. Low water discharges in the upper basin.

The six low water discharges observed at MALKA-WAKANA present a great regularity. Minimum flows vary from 3,01 to 4,62 m3, Q 10 from 3,23 to 5,12 m3/s and Q 30 from 3,67 to 7,45 m3/s. The minimum flow value is only linked to the length of the dry season. The highest low water discharge observed in 1968 - 1969 (4,62 m3/s) corresponds to an unusually short dry season of only one month. The weakest low flow observed in 1970 - 1971(3,01 m3/s) corresponded to a very long dry season of three and a half months and lasted until the beginning of March. Rainfall observations show that the average dry season lasts 75 days (from the 15th of November to the 31st of January). The average minimum low flow at MALKA-WACANA is therefore approximately 3,75 m3/s (about 0,7 1/s. Km2).

Between MALKA-WAKANA and LEGE-HIDA, low water discharges are scarcely greater. In 1970-1971 (severe low flow) the low water discharge at LEGE-HIDA is only 2,2 m3/s greater than at MALKA-WAKANA. One may therefore consider that the minimum low water discharge at LEGE-HIDA is approximately 5,80 m3/s (or 0,27 1/s. km2). The inflow of 2 m3/s from the middle basin (ULUL, SIYANAN...) is probably not more than 0,12 1/s. km2.

8.2.2. Low water discharges from HAMERO-HEDAD to BURKUR.

Between LEGE-HIDA and HAMERO-HEDAD, the low water discharge increases owing to the inflows of the permanent tributaries from Chercher, for instance the ERRER which supplies an average of 2 m3/s or 0,14 1/s. km2.

TABLE 8-1

CHARACTERISTIC LOW WATER DISCHARGES IN m3/s

Station	Year	Date	Q min	Q 10	Q 30
WABI SHEBELLE					
Bridge of DODOLA	1966-1967	26- 3-1967	1.10	1.24	1.24
	1967-1968	29- 1-1968	1.24	1.38	1.52
	1968-1969	27-12-1968	1.38	1.38	1.66
	1969-1970	17- 2-1970	1.24	1.38	(1.38)
	1970-1971	10- 3-1971	1.10		
MALKA-WAKANA	1967-1968	31- 1-1968	3.90	4.13	4.37
	1968-1969	27-12-1968	4.62	5.12	7.45
	1969-1970	21- 2-1970	3.90	4.37	4.62
	1970-1971	6- 3-1971	3.01	3.23	3.67
	1971-1972	1- 2-1972	4.37	4.62	7.10
	1972-1973		< 3.67		
LEGE-HIDA	1970-1971	15- 3-1971	5.21	5.21	6.57
	1971-1972	29- 1-1972	6.3	(7.6)	(13.6)
HAMERO-HEDAD	1968-1969	15- 2-1969	19.5	24.8	34.8
	1969-1970	13- 1-1970	11.1	11.5	13.5
	1970-1971	17- 3-1971	7.59	7.92	10.6
IMI	1969-1970	14- 1-1970	12.4	12.6	13.4
	1970-1971	19- 3-1971	9.84	10.0	10.9
GODE	1967-1968	10- 2-1968	21.8	23.5	31.2
	1968-1969	20- 2-1969	12.3	18.4	22.1
	1969-1970	20- 1-1970	7.77	8.5	11.7
	1970-1971	29- 3-1971	4.01	4.28	6.72
	1971-1972			(9.0)	(14.8)
KELAFO	1967-1968	15- 2-1968	18.8		
	1968-1969	20- 2-1969	10.6	(15.8)	(18.0)
	1969-1970	23- 1-1970	7.26	7.89	10.9
	1970-1971	30- 3-1971	3.01	3.31	5.31
BURKUR	1968-1969	22- 2-1969	17.1	(19,9)	(24,0)
	1969-1970	25- 1-1970	6.8	7.7	11.4
	1970-1971	3- 4-1971	2.71	3.18	4.47
TRIBUTAIRES					
MARIBO at bridge of DODOLA	1966-1967	2- 3-1967	0.080	0.100	0.336
	1967-1968	20- 1-1968	0.123	0.265	0.375
	1968-1969	26-12-1968	0.336	0.502	2.10
	1969-1970	20- 2-1970	0.502	0.648	1.47
	1970-1971	11- 3-1971	0.123	0.123	0.202
MARIBO confluence	1968-1969	24-12-1968	1.12	1.56	5.48
	1969-1970	20- 2-1970	0.96	1.24	11.4
	1970-1971	9- 3-1971	0.431	0.516	1.07
ERRER to HAMERO-HEDAD	1968-1969	1- 2-1969	2.70	2.70	2.70
	1969-1970	17- 2-1970	1.60	1.62	1.70
	1970-1971	1- 5-1971	1.40	1.41	1.60

The considerable dispersion of the low water discharges of the WABI-SHEBELLE downstream from HAMERO-HEDAD is due to these relatively irregular inflows. Below HAMERO-HEDAD, the WABI-SHEBELLE receives no more inflows during the low flow period since all its tributaries are intermittent. Consequently, it is possible to estimate the 10-year and mean annual low water discharges using the observations of Belet-UEN.

The available data for an estimate of these discharges include, i.e :

- 16 years of mean discharges (per five day periods) at the BELET-UEN station in Somalia ;

- The mean daily discharges observed during three consecutive low flow periods (1968-1969-1970 and 1970-1971) at the stations of the lower valley (IMI, GODE, KELAFO and BURKUR).

8.2.2.1. Statistical survey of the low water discharges at BELET-UEN.

Discharge data for periods of five days are available but they are very inaccurate especially for the years preceding 1963. In fact, the same values often represent the low water discharges for several consecutive periods of five days. Consequently the results achieved through statistical analysis must be used very carefully.

The observations of the lowest consecutive discharges for five days present 16 annual values. The normal distribution curve for these 16 values present the following parameters :

- average : 6,5 m3/s

- standard-deviation : 3,54 m3/s

The coefficient of variation is very high : 0,54.

The low water discharge per five day periods for a dry decennial frequency is 1,95 m3/s.

Taking into account the limited character of the discharge data and their poor quality, the uncertainly margin concerning the results is very high and certainly attains ± 20 per cent.

Furthermore, according to the observations made on the low-water discharges at the BURKUR station, the minimum low flow is only 2 to 4 per cent lower than the mean discharge of the five lowest days.

The following values are given for the minimum low flow at BELET-UEN :

Mean annual low water discharge : 6,5 ± 1,3 m3/s.

Dry 10-year low water discharge : 1,95 ± 0,4 m3/s.

8.2.2.2. Low-water discharges observed from HAMERO-HEDAD to BURKUR.

The results given in table 8.1. show the considerable variability of low flow. At GODE, the low-water discharge for 1967 - 1968 is five times higher than the low water discharge for 1970 - 1971. This is due to the fact that no completely dry season exists on the high plateaus and that depletion periods are very often interrupted by floods.

Low water discharges for 1969 - 1970 and 1970 - 1971 are less affected by floods occurring outside the season and they allow studying the evolution of the characteristic low water discharges in the lower valley. This evolution is clearly comparable for the two years and it is represented on graph VIII.1. which also gives the characteristic discharges (Q min and Q 30), function of the length of the reach between stations.

On this graph distinctly stands out :

- the increasing low water discharges from HAMERO-HEDAD to IMI.

- the decreasing low water discharges from IMI to BURKUR this feature being more pronounced upstream from GODE than downstream.

The greater low water discharges and especially minimum low water discharges between HAMERO-HEDAD and IMI are not due to inflows from the tributaries below HAMERO-HEDAD since low flow is inexistent for all of them. It is due to the water supplied by the ground water table which is recharged by flooding in the IMI region. This is proved by the depletion coefficients at IMI.

Between IMI and GODE, the low water discharges decrease very distinctly.

The decrease of the minimum low water discharge between IMI and GODE is 4,6 m3/s for 1969 - 1970 and 5,8 m3/s for 1970 - 1971.

This is due to evaporation losses and particularly to infiltration in the channel.

The decrease of low water discharges between GODE and BURKUR is far less pronounced and Q 30 of low water discharge for 1969 - 1970 even increases between KELAFO and BURKUR. This is due to the slow restitution of storage water in the flood plains located between KELAFO and MUSTAHIL which partly compensates for evaporation losses and infiltration in the channel.

Between BURKUR and BELET UEN, the low water discharges probably present a comparable evolution with that of the reach of KELAFO-BURKUR.

Consequently, the minimum low-water discharges at BELET-UEN should approximately be :

6,5 m3/s for low flow in 1969 - 1970

and 2,5 m3/s for low flow in 1970 - 1971.

8.2.2.3. Estimate of the 10-year dry and average low water discharges

The previous observations on the evolution of the low water discharges between HAMERO-HEDAD and BELET-UEN and the statistical study of low water discharges at BELET-UEN allow roughly estimating the mean annual low water discharges. The latter correspond, within approximately ± 20 per cent, to the observations of low flow in 1969 - 1970.

The results are as follows, i, e :

Station	Minimum low flow m3/s	Q 30 days m3/s.
HAMERO-HEDAD	11,0 ± 2,2	13,5 ± 2,7
IMI	12,5 ± 2,5	13,5 ± 2,7
GODE	7,8 ± 1,5	11,7 ± 2,3
KELAFO	7,3 ± 1,5	11,0 ± 2,2
BURKUR	6,8 ± 1,4	11,0 ± 2,2

One may note that the average minimum low flow increases from 5,80 to 11 m3/s between LEGE-HIDA and HAMERO-HEDAD and that the contribution of the middle basin (UNGWATA, RAMIS...) represents approximately 3 m3/s or 0,1 l/s. km2, since the ERRER supplies 2 m3/s. Downstream from MALKA-WACANA all the perennial tributaries present weak specific low water discharges, from 0,10 to 0,14 l/s. km2.

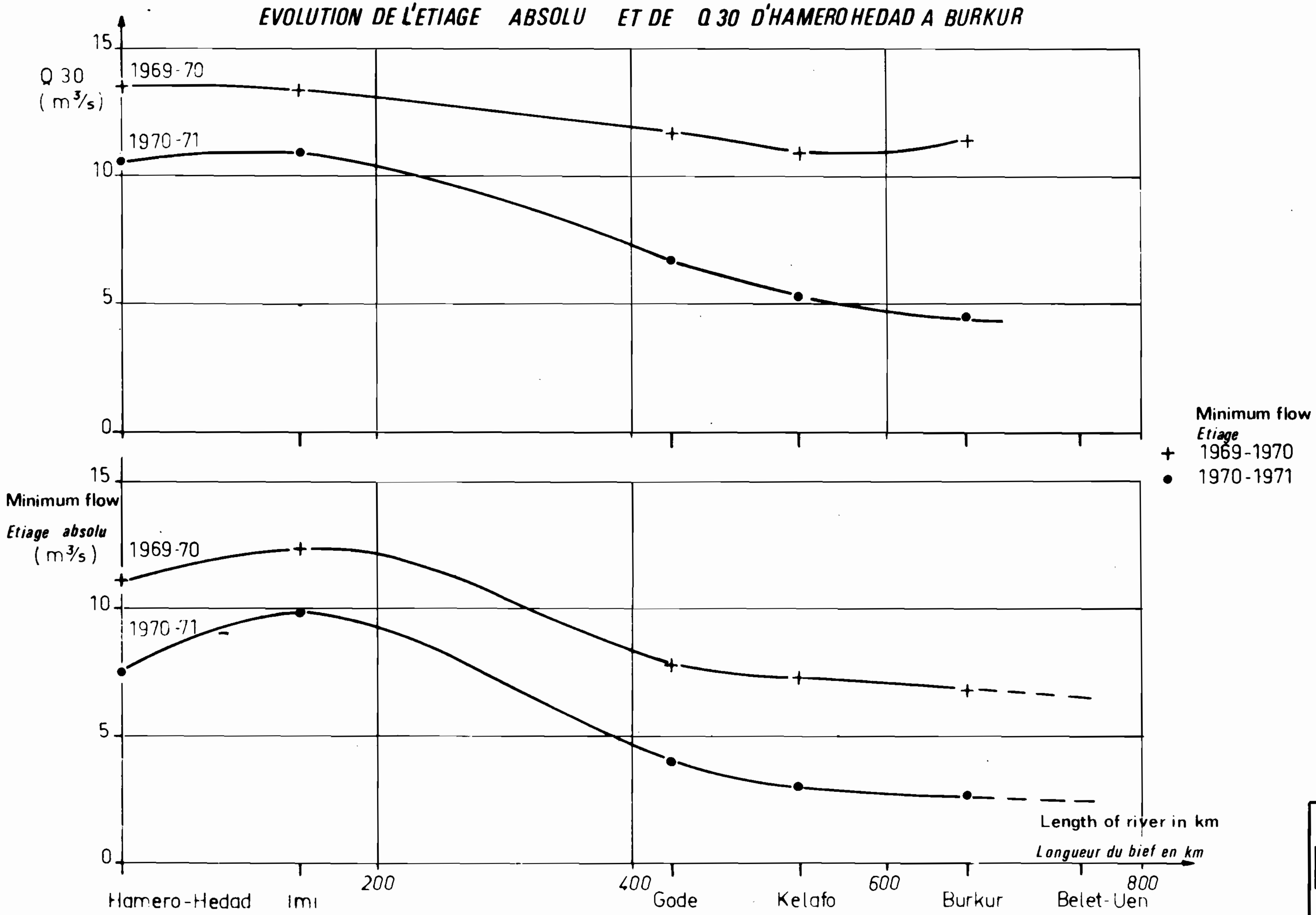
The 10 year dry water discharge at BELET-UEN is 1,95 ± 0,4 m3/s and approximately 20 per cent less than the low water discharge of 1970 - 1971 which corresponds to 2,5 m3/s.

If this difference of 20 per cent is applied to the low water discharges observed in 1970 - 1971 in the lower valley, the following results are achieved :

Station	Dry 10th year occurence :	
	Minimum low flow m3/s	Q 30 days m3/s
HAMERO-HEDAD	6,1 ± 1,3	8,5 ± 1,7
IMI	7,9 ± 1,6	8,7 ± 1,7
GODE	3,2 ± 0,6	5,4 ± 1,1
KELAFO	2,4 ± 0,5	4,2 ± 0,8
BURKUR	2,2 ± 0,4	3,6 ± 0,7

EVOLUTION OF MINIMUM FLOW AND Q 30 BETWEEN HAMERO HEDAD AND BURKUR

EVOLUTION DE L'ETIAGE ABSOLU ET DE Q 30 D'HAMERO HEDAD A BURKUR



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8.3. DATE OF MINIMUM LOW FLOWS.

Table 8.1. shows that the date of minimum low flows varies considerably from year to year and is conditioned by the date when the first rainy season begins on the high plateaus, this being linked to the movement to the North of the Intertropical Front or FIT.

In the upper basin, for the observation period, it occurs between the end of December and the beginning of March and in the lower valley, between the 15th of December and the beginning of April.

A longer observation period would be necessary in order to determine with more precision the occurrence probabilities of low water discharges in the basin.

The low water discharges of the upper basin, which receives abundant rainfall, depend on the local rainfall conditions and consequently, they occur at variable times in the various under-basins.

From HAMERO-HEDAD and downstream, the absence of inflows limits the problem of low water discharges to a mere question of flow propagation. The latter is not easily analysed for a period of two or three years but may be roughly estimated from the very severe low flow of 1970 - 1971, the total propagation of which lasted 17 days between HAMERO-HEDAD and BURKUR, hence for approximately 650 km, 35 to 40 km daily or 0,40 m/s.

8.4. SECONDARY LOW WATER DISCHARGE OF JUNE.

The intermission between the two rainy seasons of spring and autumn results in a decrease of discharges and in the manifestation of a secondary low water discharge.

Table 8.2 gives the minimum daily observations for this period at the main stations along the WABI SHEBELLE.

It must be noted that the time interval for the manifestation of secondary low water discharge is considerably shorter than for the main low water discharge : end of May to middle of June for MALKA-WAKANA, June for the middle waterway and from the end of June to the middle of July for the lower valley. The propagation rate downstream from HAMERO-HEDAD seems slightly higher than that of the main low water discharge (probably three days less until BURKUR).

The value of this secondary low water discharge of June is twice that of the main minimum low flow at MALKA-WAKANA; this proportion increases in the downstream part and is pparently three times more at HAMERO-HEDAD and four times more at BURKUR.

The duration of the secondary low water discharge is very short and consequently the corresponding characteristic discharges : Q 10 and Q 30 are proportionally much greater for a minimum daily low flow than the same characteristic discharge for the main low of January - March.

TABLE 8.2

CHARACTERISTICS OF THE SECONDARY LOW WATER DISCHARGE OF JUNE

Station	Year	Date of minimum flow	Q min (m3/s)
WABI SHEBELLE			
MALKA WAKANA	1968-1969	30- 5	9.56
	1969-1970	18- 6	6.00
	1970-1971	6- 6	5.58
	1971-1972	5- 6	11.2
	1972-1973	15- 6	5.81
LEGE-HIDA	1970-1971	8- 6	13.4
	1971-1972	8- 6	24.5
HAMERO-HEDAD	1968-1969	26- 6	85.0
	1969-1970	23- 6	31.6
	1970-1971	30- 6	17.3
IMI	1969-1970	25- 6	20.6
	1970-1971	2- 7	15.2
	1971-1972	10- 6	27.6
GODE	1968-1969	30- 6	68.4
	1969-1970	29- 6	24.4
	1970-1971	10- 7	14.5
	1971-1972	13- 6	37.7
KELAFO	1969-1970	1- 7	17.9
	1970-1971	12- 7	12.9
	1971-1972	14- 6	30.6
BURKUR	1969-1970	2- 7	24.9
	1970-1971	14- 7	12.8
	1971-1972	17- 6	30.5

CHAPTER IX

FLOOD SURVEY

The purpose in this chapter is to present :

- the formation mechanism of floods in the basin;
- the characteristic shape of flood hydrographs;
- an estimate of floods with annual, 10 - year, and for some stations, 20 - year, frequencies for each large natural zone.

The limited number of hydrological observations as well as the practically complete lack of daily rainfall recordings for long periods did not allow further estimating the floods presenting an unusual frequency.

In the following paragraphs, the maximum discharges surveyed correspond to instantaneous flood discharges and not to mean maximum daily discharges.

9.1. FLOODS OF THE UPPER BASIN UPSTREAM FROM MALKA-WAKANA

9.1.1. Formation conditions of floods and shape of flood hydrographs.

The general formation conditions of floods may be known by studying rainfall conditions on the high plateaus and floods at the four stream gauging stations controlling drainage basins of variable sizes : MARIBO at the bridge (260 km2), MARIBO confluence (1 220 km2), WABI SHEBELLE at the bridge (1 260 km2) WABI SHEBELLE at MALKA-WAKANA (5 290 km2). The high floods which may be considered as derived from a generalized runoff, occur after an average rainy phase of 10 days with a total rainfall depth exceeding 80 mm.

The rainfall intensity curve of this rainy phase does not present a well defined shape but always includes a maximum of two or three consecutive days with strong precipitations. The total maximum exceeds 60 mm. The position of this maximum is variable and is placed either at the beginning, in the middle, or at the end of the rainy phase.

Each strong flood only occurs when soil has been previously saturated with water after the rainy phase. In fact, it may be noted that the strongest floods observed during the first rainy season usually occur in April whereas rainfall begins in February. Likewise, during the second rainy season the strongest floods occur between August and October but rainfall begins in July.

The floods of the first rainy season and the late October floods are usually due to strong and very individualized storms. The flood hydrographs are relatively sharp with short rising-time (2 or five days according to the basin area) and base-times of approximately 14 days.

The floods of July, August and September are due to not very intense monsoon rains over the whole basin. The hydrographs usually present less pronounced shapes. The maximums occur in the middle of the rainy season consecutively to a more intense rainy phase.

Two examples of these flood hydrographs for the MALKA-WAKANA station are represented on graphs IX. 1 and IX. 2. Graph IX. 1 corresponds to a sharp flood of the first season and graph IX. 2., to a "smoother" flood of the second season.

9.1.2. Maximum discharges observed during the survey period.

Table 9.1 presents the maximum flood discharges for the first and second rainy seasons, as well as the corresponding specific discharges. For the stations of MARIBO and of the WABI-SHEBELLE bridge which are only equipped with a staff-gauge allowing observations twice a day, these discharges therefore do not correspond exactly to the peak flood discharge and may be slightly underrated.

This table shows that the annual peak discharges either occur during the first or the second rainy season. For instance, at Malka-Wacana, out of six values two annual maximum values were observed in April, two maximums in August and two maximums in October.

The specific discharges are relatively low for rivers presenting very steep slopes in a considerable part of their drainage basins. This weakness of specific flood discharges is due to the long but not very intense rainfall conditions (the most important rainfall on the basin does not exceed 80 mm/h). It is also due to the considerable perviousness of soil and to the reduction effect in the alluvial plain for the downstream stations of the MARIBO of the WABI-SHEBELLE.

9.1.3. Flood estimate for a given frequency.

An elaborate study of rainy phases would have facilitated the estimating of floods for an unusual frequency, but this is not possible owing to the lack of uninterrupted recordings at the rain-gauging stations of the basin.

However, an approximated estimate of annual and 10-year floods at MALKA-WAKANA may be obtained from the study of flood hydrographs and of the data of rainy phases on the basin and at ADDIS-ABEBA.

Gr-IX-1

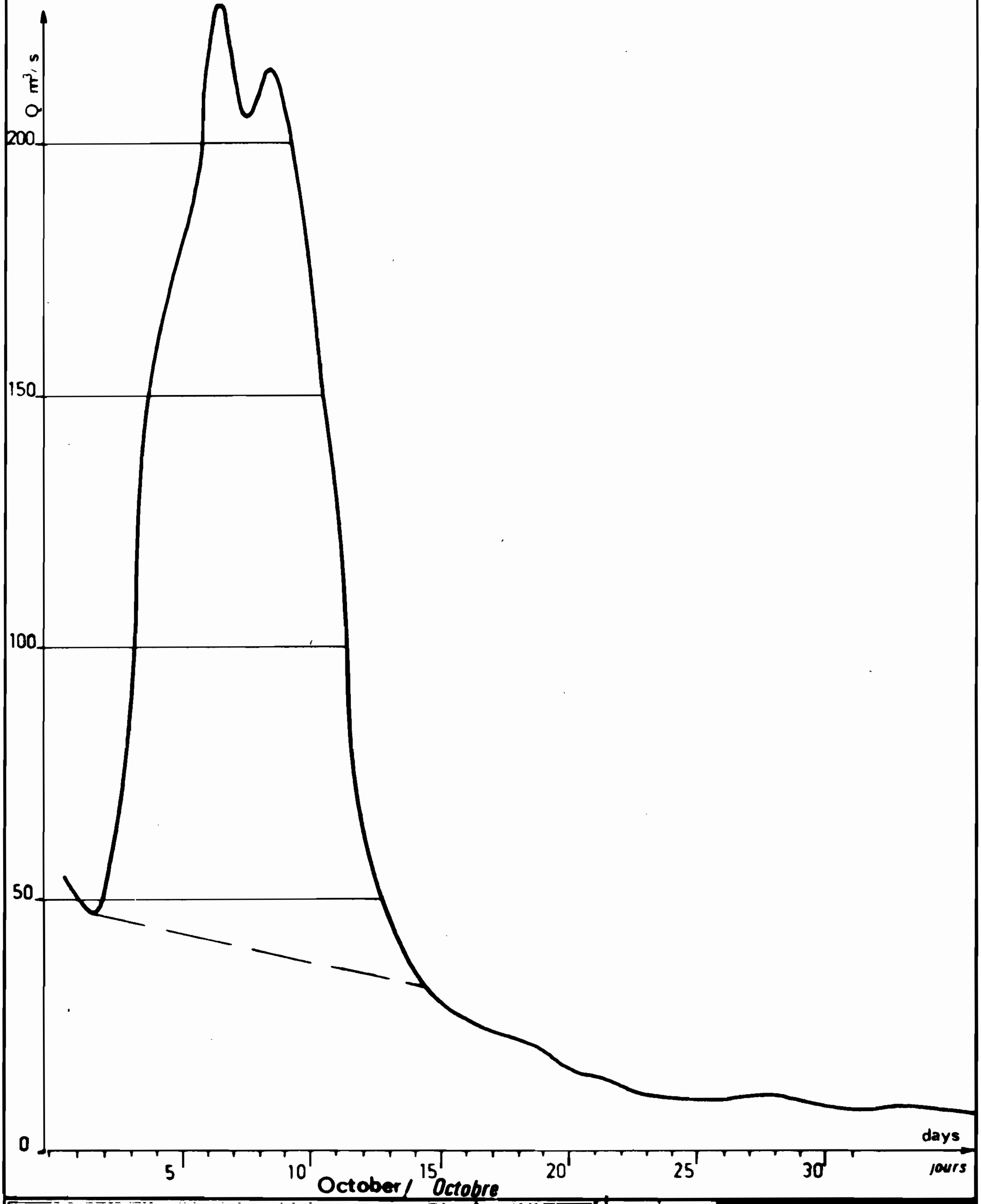
WABI SHEBELLE AT MALKA-WAKANA

FLOOD HYDROGRAPH OCTOBER 2-15

1967

Le WABI SHEBELLE à MALKA-WAKANA

Crue du 2 au 15 Octobre 1967



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WABI SHEBELLE AT MALKA-WAKANA

Flood hydrograph. August 7- September 6, 1970 *Crue du 7 Aout au 6 Septembre 1970*

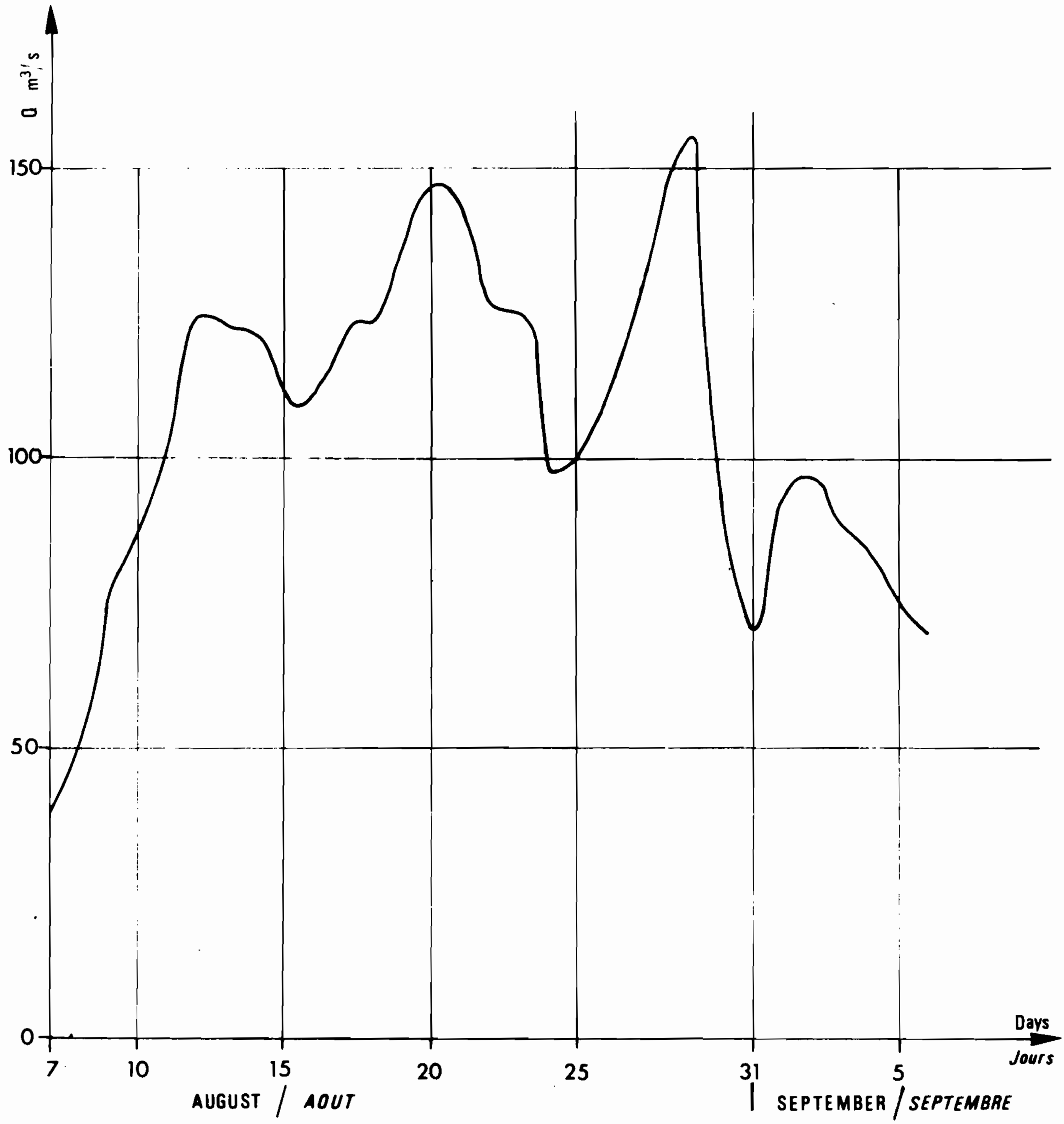


TABLE 9.1

Maximal flood discharges at the stations of the upper basin upstream from MALKA-WAKANA.

Station	Year	1st rainy season		second rainy season	
		Q max m3/s	Q specific l/s.km2	Q max m3/s	Q specific l/s.km2
Wabi Shebelle at the bridge of Dodola 1 260 km2	1967-1968	-	-	106	84.1
	1968-1969	59.7	47.3	50.0	39.7
	1969-1970	23.5	18.6	71.9	57.1
	1970-1971	16.4	13.0	90.9	72.1
	1971-1972	17.7	14.0	67.5	53.6
Wabi Shebelle at Malka-Wakana 5 290 km2	1967-1968	-	-	228	43.1
	1968-1969	133	25.1	104	19.7
	1969-1970	72	13.6	147	27.7
	1970-1971	90	17.0	180	34.0
	1971-1972	51	9.6	143	27.0
	1972-1973	106	20.0	103	19.5
Maribo at the bridge of Dodola 260 km2	1967-1968	11.7	45	33.4	128
	1968-1969	27.5	106	20.0	77
	1969-1970	17.6	68	28.4	109
	1970-1971	35.2	135	24.4	94
	1971-1972	14.2	55	28.4	109
Maribo at the confluence of the Wabi Shebel-le 1 220 km2	1968-1969	-	-	81.6	67
	1969-1970	44.8	36.7	53.6	44
	1970-1971	63.5	52.0	83.4	68
	1971-1972	36.4	29.8	60.9	50

The maximal annual discharges are underlined.

Four important floods have been studied as well as the rainy phases from which they result. The informations thus collected are given in the table below.

The symbols used are as follows, i.e :

P_m : mean rainfall on the basin, in mm.

V_r : overland flow in m3.

H_r : rainfall excess in mm.

Q_{max} : peak flood discharge in m3/s.

K_r : overland flow coefficient.

$\frac{Q_{max}}{Q_{aver.}}$: ratio of the peak flood discharge to the mean flood discharge, this ratio determines the shape of the flood hydrograph.

Date	Pm mm	Vr 10^6 m3	Hr mm	Q max m3/s	Kr per cent	$\frac{Q\ max}{Q\ aver}$
2 to 15-10-1967	100	109	20.7	228	20	2.34
9 to 28-11-1967	100	74	14	143	14	2.86
11 to 23-03-1970	65	23	4.4	86	7	2.93
26.9 to 19-10-1971	75	52	9.9	105	13	2.94

Each of these floods are due to a generalized rainy phase over all the basin lasting approximately 10 days, and the base-time varies from 12 to 17 days.

Taking into account the available observations on rainfall at the rain-gauging stations of the basin and at ADDIS-ABEBA, the following values may be given for the mass rainfall depths of unfrequent rainy phases :

Rainy phase with a bi-annual frequency (occurrence 1 year out of 2) 80 mm.

Rainy phase with a 10 year frequency : 130 mm.

These figures, as well as the characteristics of the floods observed allow producing a rough estimate of floods with bi-annual or decennial frequencies. These floods present the following features :

Flood	Pm mm	Vr 10^6 m3	Hr mm	Q max m3/s	Kr per cent	$\frac{Q\ max}{Q\ aver.}$
Bi-annual (median)	80	63	12	150	15	2,80
Decennial	30	127	26	300	20	2,50

For the four stations of the upper basin the following estimates may be given. They are deduced analogically from the preceding values taking into account the observations made.

Station	Bi-annual flood (1 year out of 2)		10 year flood (1 year out of 10)	
	Q m3/s	Q l/s.km2	Q m3/s	Q l/s.km2
WABI SHEBELLE at bridge	80	63	200	160
WABI SHEBELLE to MALKA-WAKANA	150	29	300	58
MARIBO at bridge	30	115	75	290
MARIBO at confluence	70	57	170	140

9.2. WABI SHEBELLE FLOODS AT LEGE-HIDA.

9.2.1. Origin and shape of floods.

Between MALKA-WAKANA and LEGE-HIDA, the WABI-SHEBELLE receives the most abundant tributaries of its drainage basin, such as the ULUL, HADIDA and SIYANAN. These tributaries flowing from the most rainy regions of the basin (the high plateaus from TICHO to GOLOLCHA) considerably increase the peak discharges of the WABI-SHEBELLE.

The rainfall conditions on these high plateaus being similar to those of the basin of MALKA-WAKANA, floods occur during the same periods and the flood hydrographs are scarcely different from those observed at MALKA-WAKANA. The floods of the first season are swifter and more violent than the floods of the second season. As in the case of MALKA-WACANA, annual maximums may be observed in the first season as well as in the second rainy season.

9.2.2. Maximal discharges observed during the survey period.

The following table presents the peak discharges above 100 m3/s recorded during the two observation years. These peak discharges correspond to well individualized floods. For July, August and September, during which the discharge is always more than 150 m3/s, only the maximum recorded during the period is given.

Year	Date	Peak discharge m3/s	Specific discharge l/s.km2	
1970-1971	17 March	717	33.3	
	16 April	288	13.4	
	17 August	627	29.2	Discharge above 100 m3/s
	30 October	130	6.0	from July 18 to October 12
1971-1972	13 April	170	7.9	
	10 May	135	6.3	
	18 June	154	7.2	
	19 August	253	11.8	Discharge above 100 m3/s
	7 October	215	10.0	from July 29 to September 12
	16 November	327	15.2	

Maximal annual discharges are underlined.

Despite a larger basin area which from 5 290 km2 at MALKA-WAKANA extends to 21 500 km2 at LEGE HIDA, the specific flood discharges are practically the same as those observed at MALKA-WAKANA. This tends to show that the specific flood discharges of intermediate tributaries are greater, for a same drainage area, than those of the upper basin upstream from MALKA-WAKANA. Their drainage basins receive a greater amount of rainfall, soil is not so pervious and there is no flood reduction by an alluvial plain.

Floods with an unusual frequency are not evaluated in this paragraph but in paragraph 9.6 which presents the data of peak discharges for all the stations from LEGE-HIDA to BURKUR.

9.3 FLOODS OF THE MIDDLE BASIN BETWEEN LEGE-HIDA AND HAMERO-HEDAD

Between LEGE-HIDA and HAMERO-HEDAD, the WABI SHEBELLE is joined by the big tributaries from the CHERCHER plateaus, such as the UNGWATA, the RAMIS, and the ERRER. These tributaries present a subarid character which is gradually more pronounced from the West to the East, and flash floods sometimes producing high specific peak discharges.

The ERRER floods are examined before the WABI SHEBELLE floods at both the stations of the sector near HAMERO-HEDAD.

9.3.1. The ERRER floods at HAMERO-HEDAD.

9.3.1.1. Origin and shape of floods.

The ERRER floods are consecutive to a rainy phase of two or three days presenting at least one very intense storm. These rainy phases are usually localized on part of the basin and give rise to very sharp floods with a short rise time, from half an hour to three hours and a recession lasting from four to twelve hours. They are followed by a subsurface runoff corresponding to approximately a dozen m3/s for several days. The volumes of runoff during these floods are very moderate. These floods occur between March and November.

An example of a flood hydrograph is represented on graph IX.3.

9.3.1.2. Maximal discharges observed during the survey-period.

The peak discharges above 100 m3/s recorded during the observation period are presented in the following table. 1968 - 1969 and 1969 - 1970 are incomplete (some gaps in the recording).

Year	Date	Maximum discharge m3/s	Specific maximum discharge 1/s.km2
1968-1969	June 5	296	20.8
1969-1970	June 26	126	8.9
	November 1	264	18.6
	November 2	134	9.4
1970-1971	April 16	176	12.4
	April 25	556	39.1
	May 4	250	17.6
	August 20	128	9.0
1971-1972	April 12	107	7.5
	May 3	131	9.2
	May 17	151	10.6
	May 23	120	8.4

The maximal annual discharges for the two complete years are underlined.

Though this table is incomplete, it nevertheless shows the great irregularity of annual flood discharges.

These results allow estimating approximately the maximal annual and 10 year flood discharges :

Bi-annual flood : 425 m3/s or 30 l/s. km2

10-year flood :1000 m3/s or 70 l/s. km2

The specific discharges are greater than those of the MALKA-WAKANA basin since floods are more violent here (greater rainfall intensity and more impervious soil) and though the ERRER basin with its 14 200 km2 is twice larger.

9.3.2. Floods of the WABI SHEBELLE at HAMERO-HEDAD.

9.3.2.1. Origin and shape of floods.

The comparison of flood hydrographs between LEGE-HIDA and HAMERO-HEDAD showsthat the floods of the intermediate basin scarcely affect the peak floods recorded at HAMERO-HEDAD. The ERRER floods are practically completely abated in the channel of the WABI SHEBELLE between the two stations which are nevertheless only at a few dozen kilometers distance from each other. For instance, the maximal flood recorded for the ERRER on the 25th of April 1970 (556 m3/s) only produced an increase of 50 m3/s of the discharge of the WABI SHEBELLE at HAMERO-HEDAD. The shapes of the flood hydrographs of the WABI SHEBELLE at HAMERO-HEDAD are therefore comparable to those of LEGE-HIDA with however a slight abatement of peak discharges in the channel of the WABI-SHEBELLE.

Two flood types may be observed, i.e :

- The floods of the first rainy season (from March to May) and the late November floods due to rainy phases, well individualized in time and place and presenting a stormy character. These very sharp floods have a relatively short rising time of three or five days.

- The floods of the second rainy season (from July to October) resulting from more regular rainy phases with a larger distribution on the high plateaus These floods occur in the middle of a high flow-period and their hydrographs present less pronounced shapes than the previous flood hydrographs.

Both types of floods are represented on graphs IX.4 and IX.5.

9.3.2.2. Maximal discharges observed during the survey-period

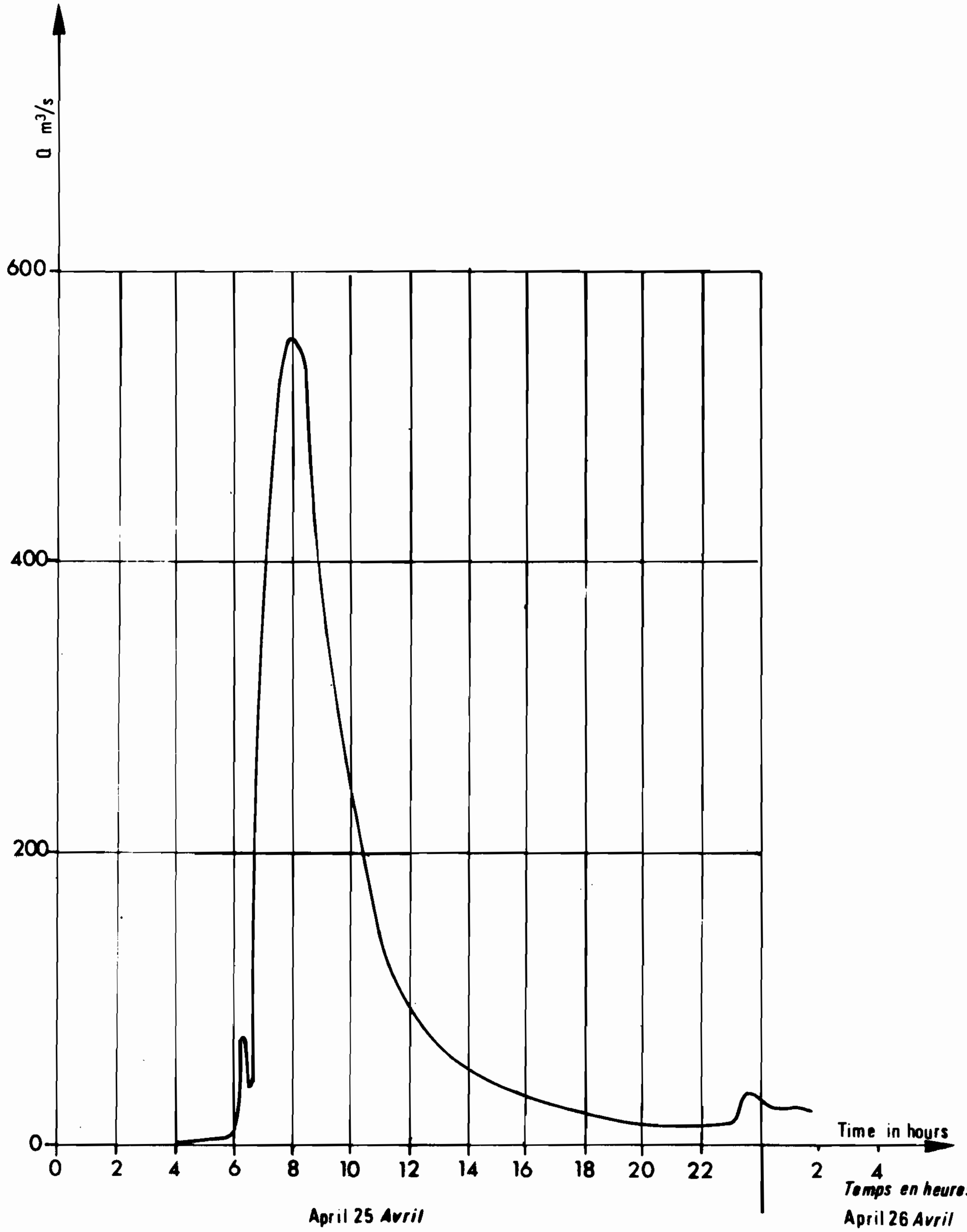
The table below presents the peak discharges above or approximately 200 m3/s recorded during the survey period for well-individualized floods.

ERRER AT HAMERO-HEDAD

FLOOD HYDROGRAPH APRIL 25-26 ,1970

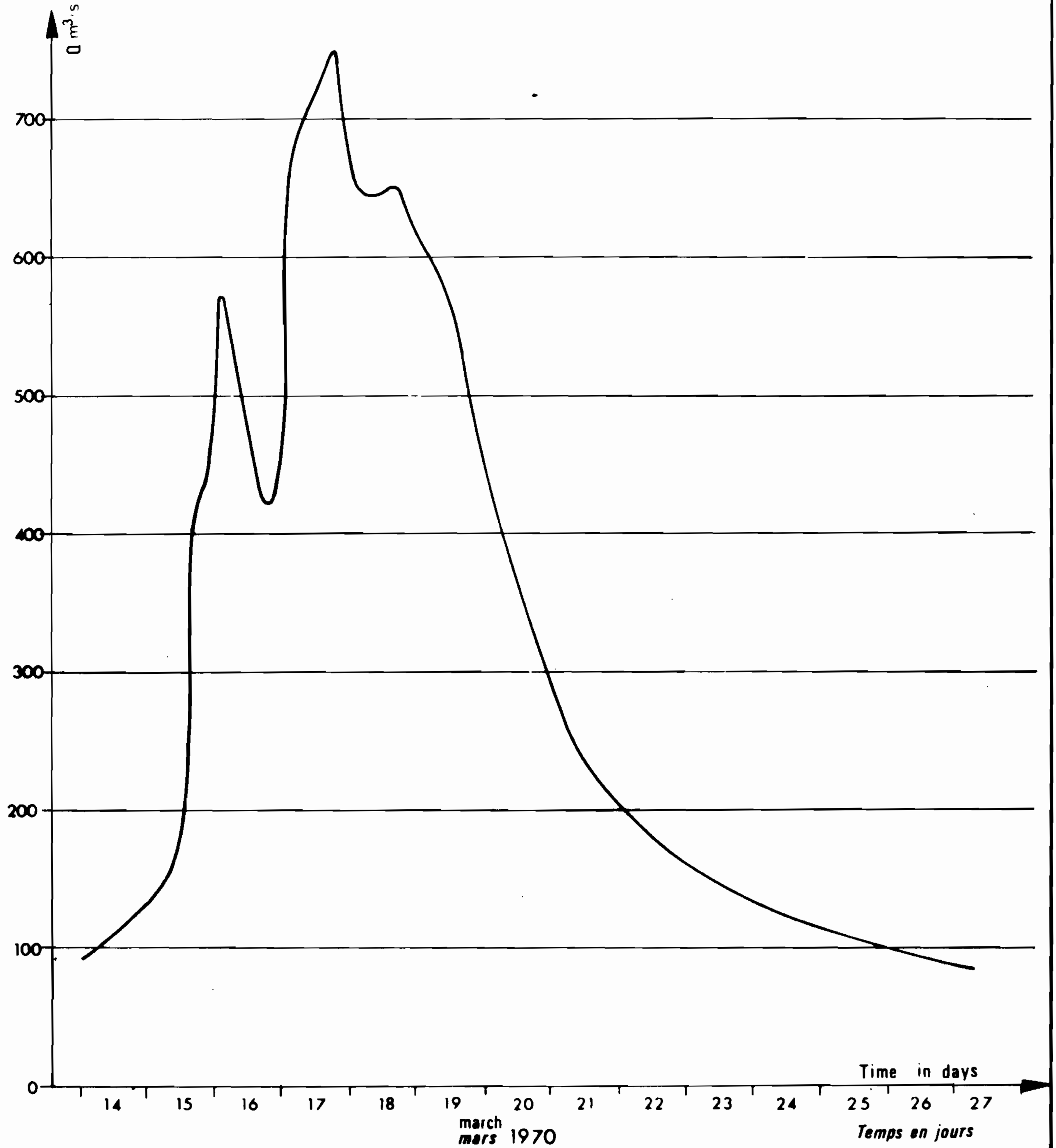
ERRER A HAMERO-HEDAD

CRUE DU 25-26 AVRIL 1970



WABI SHEBELLE AT HAMERO-HEDAD *WABI SHEBELLE A HAMERO HEDAD*

Flood hydrograph March 14-27, 1970 *Crue du 14 au 27 mars 1970*

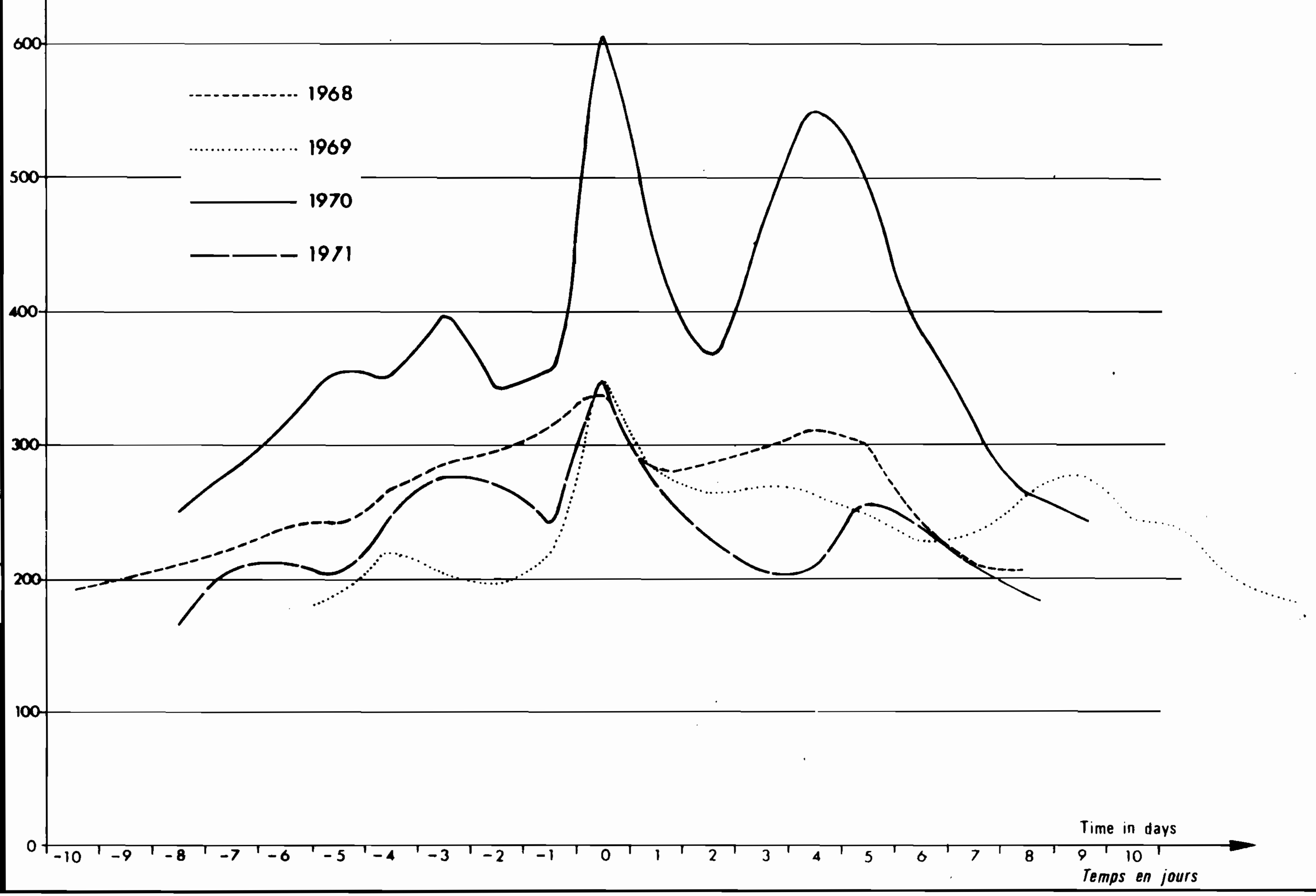


WABI SHEBELLE AT HAMERO HEDAD

WABI SHEBELLE A HAMERO HEDAD

Maximal annual floods of the 2d season

Crues maximales annuelles de la 2e saison

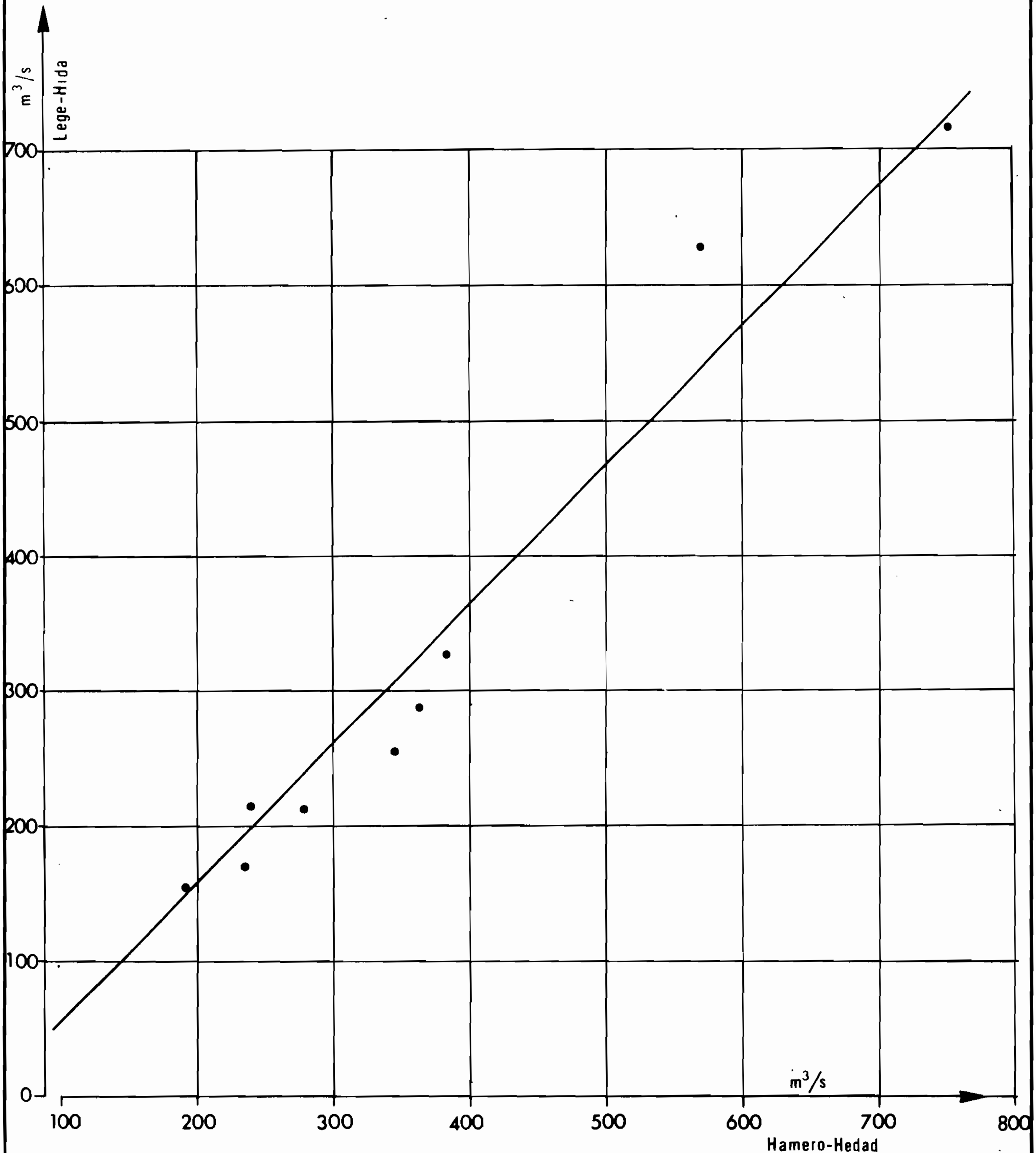


Gr-IX-5

Gr-IX-6

RELATION BETWEEN PEAK DISCHARGES OF LEGE-HIDA AND HAMERO-HEDAD

CORRESPONDANCE DES DEBITS DE POINTE DE CRUES ENTRE LEGE-HIDA ET HAMERO-HEDAD



The relation between the peak flood discharges at HAMERO-HEDAD and the corresponding flood peaks at LEGE-HIDA shows that the floods of HAMERO-HEDAD are only 5 to 10 per cent higher than those of LEGE-HIDA (see graph IX.6). The specific discharges of maximal annual floods are three times smaller than the specific discharges of the floods at LEGE-HIDA.

For an estimate of floods with an unusual frequency, see paragraph 9.6.

Year	Date	Max. dischar. (m3/s)	Specific maximum discharge (1/s.km2	
1968-1969	March 2	244	3.8	
	April 11	894	13.9	Discharge above 100 m3/s
	August 18	338	5.2	from June 28 to October 10
1969-1970	February 28	404	6.3	
	March 13	377	5.8	
	March 28	346	5.4	
	April 10	280	4.3	
	May 3	616	9.5	
	August 3	350	5.4	Discharge above 100 m3/s
1970-1971	March 17	750	11.6	from July 22 to Sept 23
	April 17	365	5.7	
	May	242	3.8	
	August 22	600	9.3	
	October 28	220	3.4	
1971-1972	April 14	236	3.7	
	June 20	192	3.0	
	August 23	344	5.3	Discharge above 100 m3/s
	October 8	240	3.7	from July 7 to Sept 21
	November 17	384	6.0	

Maximal annual discharges are underlined.

9.4. Floods of the DAKETA

After HAMERO-HEDAD, the WABI SHEBELLE receives the inflows of the DAKETA, an intermittent tributary presenting floods similar to those of the ERRER and probably even more violent.

9.4.1. Origin and shape of floods

As in the case of the ERRER, the floods are consecutive to a very localized maximal rainfall period of three days. However greater rainfall intensities give rise to higher peak discharges for a same drainage area. The shape of the flood hydrograph is comparable to that of the ERRER, that is to say that :

- rising-time is from 30 minutes to 5 hours according to the origin of the flood;
- recession time is slightly longer : from 36 to 48 hours;
- subsurface runoff corresponds to a few m3/s for several days.

A characteristic example of a flood hydrograph is given on graph IX.7.

The basin of the DAKETA stretches from the North to the South and presents mixed rainfall conditions related to the conditions on the high plateaus and in OGADEN. The dates of flood occurences are variable. They may occur from February to November but are considerably more frequent in April and May and in September and October.

9.4.2. Maximal discharges observed during the survey period.

The maximal floods exceeding 100 m3/s are presented below. For 1968 - 1969 and 1969 - 1970 the data are incomplete owing to gaps in the observations.

Year	Date	Maximal discharge (m3/s)	Specific maximal discharge (l/s.km2)
1968-1969	February 26	763	53.7
1969-1970	May 16	169	11.9
	October 10	205	14.4
	November 2	358	25.2
1970-1971	March 1st	248	17.5
	March 8	202	14.2
	April 14	354	24.9
	April 21	294	20.7
	April 26	494	34.8
	May 4	298	21.0
	Sept 25	466	32.8
	October 18	203	14.3
	October 20	390	27.5
	October 21	250	17.6
1971-1972	March 25	192	13.5
	April 7	317	22.3
	April 11	239	16.8
	April 12	273	19.2
	May 3	225	15.8
	May 6	834	58.7
	June 18	178	12.5

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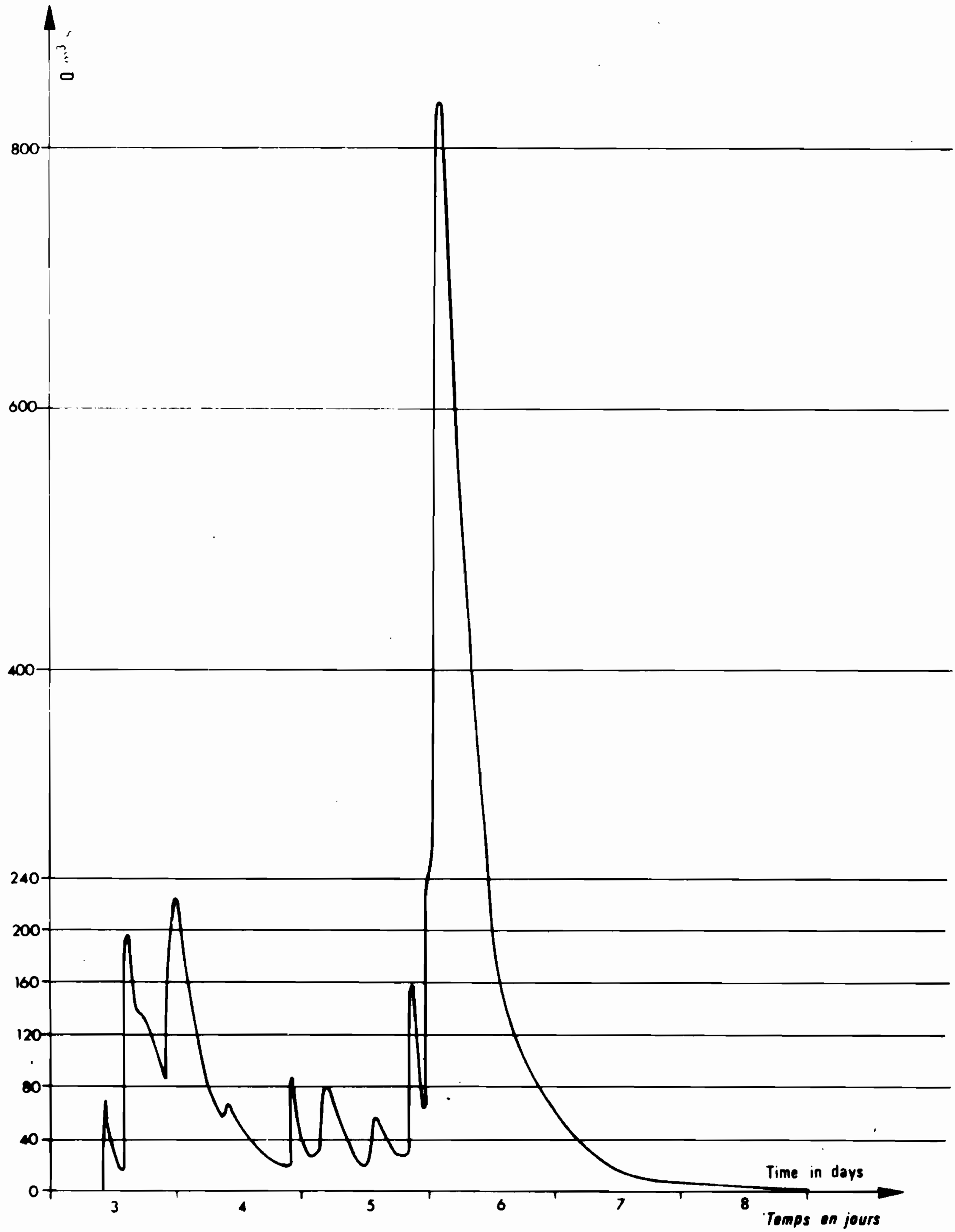
DAKETA AT HAMERO HEDAD

Flood hydrograph May 3-5,1971

DAKETA A HAMERO HEDAD

Crue du 3 au 5 mai 1971



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The data presented in this table show that the flood discharges are greater than those of the ERRER though the drainage basins have the same surface (14 200 km2). Irregularity is equally pronounced.

9.4.3. Flood estimate

The characteristics of five important floods have been studied as well as the rainy phase from which they result and they may be found in the following table with the same symbols as for MALKA-WAKANA (paragrap 9.1.3.)

Date	Pm mm	Vr 10^6m3	Hr mm	Q max m3/s	Kr per cent	max Q / aver Q
2.11.1969	48	20	1.41	358	3.0	4.6
1.03.1970	27	13.3	0.94	248	3.5	4.8
4.05.1970	31	20.4	2.93	298	9.5	2.6
25.09.1970	25	11.5	0.81	466	4.5	10.5
6.05.1971	25	32.4	2.3	834	9.2	6.7

For these five floods the reduction coefficient (ratio of the average rainfall to the maximum point rainfall) are very high : from 0,25 to 0,35. This is due to the fact that rain storms are never generalized over all the basin. From the observations for a long period at JIJIGA, an estimate has been made of the accumulated precipitation corresponding to 80 mm for a punctuated rainy phase of three days in an average year and to 120 mm for a rainy phase for a 10-year occurence. After reduction, the rainy phases present average rainfall depths of approximately 25 mm for the bi-annual flood and of 40 mm for the 10-year occurence flood.

These values of rainfall, the preceding observations on runoff coefficients as well as the shapes of flood hydrographs lead to the following estimates :

- for a bi-annual flood : 640 m3/s or 40 l/s. km2
- for the 10-year flood : 1 400 m3/s or 100 l/s. km2

These estimates are of course very approximated. It may be noted that they are 50 per cent higher than those of the ERRER.

9.5 FLOODS OF THE LOWER VALLEY OF THE WABI SHEBELLE

The DAKETA is the last big tributary which can produce considerable floods on the WABI SHEBELLE before it flows into the lower valley.

In the alluvial plains of the lower valley, floods are reduced by the flood plains. A first reduction of the flood maximums occurs in the plains of the IMI region. The floods then travel from CUGNO to the North of KELAFO practically without leaving the minor channel which is embanked in alluvial deposits. A second far more important reduction then takes place in the vast alluvial plains between KELAFO and MUSTAHIL.

The inflows in this sector (between IMI and MUSTAHIL) are not considerable and form sharp local floods with moderate peak discharges and small volumes. The annual flood hydrograph at BURKUR is considerably reduced and regularized so that it presents practically only two flood waves, one for each season.

A complete study of runoff in the lower valley may be found in chapter V (paragraph 5.5, and graph V.2).

The average time taken by floods to travel from IMI to BURKUR is as follows, i.e. :

Reach of IMI - GODE : 2 days
" " GODE - KELAFO : 1 day
" " KELAFO - BURKUR : 8 to 15 days depending on the height of the flood.

In order to account for this reduction of the flood hydrographs, the maximum floods of the first and second season for the four stations of the valley are given in the following table for the common observation period of 1969 - 1971.

Year	Season	IMI		GODE		KELAFO		BURKUR	
		m3/s	1/s km2	m3/s	1/s km2	m3/s	1/s km2	m3/s	1/s km2
1969-1970	1st	(400)	4.4	480	3.8	306	2.2	215	1.5
	2nd	318	3.5	278	2.2	250	1.8	188	1.3
1970-1971	1st	660	7.2	594	4.7	342	2.5	237	1.6
	2nd	542	5.9	489	3.8	313	2.3	244	1.7
1971-1972	1st	724	7.9	428	3.4	289	2.1	136	0.9
	2nd	306	3.3	293	2.3	216	1.6	172	1.2

Between IMI and BURKUR, the reduction of peak floods averages approximately 10 to 15 per cent. After GODE, floods are considerably reduced in the flood plains. For the observation period, the maximum floods do not exceed 350 m3/s at KELAFO and 240 m3/s at BURKUR. The reduction of the flood seems to increase together with the value of the latter and tends to approximately 40 per cent between GODE and KELAFO and once again 40 per cent between KELAFO and BURKUR.

The total reduction of the peak flood between IMI and BURKUR could probably attain a maximum of 60 to 80 per cent, depending on the importance of the flood and on the period during which it occurs. This reduction should be proportional to the filling level of the flood plains (cf parag. 9.6.2.)

9.6. FLOOD ESTIMATE AT THE WABI SHEBELLE STATIONS FROM LEGE-HIDA TO BURKUR

9.6.1. Estimate of floods presenting an unusual frequency at BURKUR

Mean discharge data for periods of five days are available at the BELET-UEN station downstream from BURKUR. These discharges are on an average 2 per cent lower than the maximum flood discharge. The flood maximums at BELET UEN are closely related to those of BURKUR, i.e :

$$Q\ BURKUR = 0{,}98\ Q\ BELET\text{-}UEN + 19\ (\text{in } m3/s).$$

This relation enabled drawing the data of 19 annual maximums at BURKUR, from 3 observation years and from 16 years reconstituted through BELET-UEN observations. These data are given in the following table :

Maximum annual flood discharges at BURKUR

Year	Q max (m3/s)	Year	Q max m3/s
1951	352	1961	391
1952	164	1962	254
1953	n. obs.	1963	340
1954	252	1964	202
1955	158	1965	180
1956	372	1966	179
1957	293	1967	291
1958	195	1968	329
1959	190	1969	215
1960	n. obs.	1970	244
		1971	172

Note : No observation for the maximum at BELET-UEN in 1953 and 1960.

The best fitting of a distribution curve to these data is an incomplete Gamma law with the following parameters.

average : 251 m3/s

shape : 2,84

scale : 45,3

location : 122 m3/s

It may be noted that the flood peak for 1970 is close to that of an average year whereas in 1971 the very moderate peak practically corresponds to a weak 10-year occurrence.

The discharge data for a given frequency obtained through this fitting are given below :

bi-annual frequency	: 250 m3/s or 1,7 l/s.km2
10-year frequency	: 350 m3/s or 2,4 l/s.km2
20-year frequency	: 400 m3/s or 2,8 l/s.km2

The highest flood included in these data is 391 m3/s for 1961 and falls in with the estimate for the 20-year return period. Suggesting a figure for a longer return period would be very hazardous; let us only mention that the fitting of the incomplete normal curve gives approximately 500 m3/s for a 100-year frequency, but this figure is not entirely reliable owing to the importance of the flood reduction process observed upstream from BURKUR.

9.6.2. Estimate of floods presenting an unusual frequency at GODE

We have already seen that the flood hydrograph at BURKUR was completely abated by the flood plains.

The comparison of flood hydrographs observed at GODE and BURKUR show that the peak discharges at BURKUR are not only linked to the maximal discharges recorded at GODE, but also to the shape of the inflow hydrograph in the flood plain and to the more or less high filling stage of these plains. We noted in particular that the first floods of the year travelling in a comparatively empty plain are far more reduced than the next floods.

In order to be able to use the series for 19 years at BURKUR, we set up an example of flow propagation between GODE and BURKUR using the equations of travel-time of MUSKINGUM.

This equation is presented as follows :

$$Q_{21} = C_0 Q_{11} + C_1 Q_{10} + C_2 Q_{20}$$

with Q_{21} : discharge at the downstream station at time 1

Q_{11} : discharge at the upstream station at time 1

Q_{10} : discharge at the upstream station at time 0

Q_{20} : discharge at the downstream station at time 0

C_0, C_1, C_2 are coefficients to be fitted and which take into account the characteristics of flow.

$$C_0 = - \frac{K/t\ x - 0,5}{K/t\ (1-x) + 0,5} \ ; \quad C_1 = \frac{K/t\ x + 0,5}{K/t\ (1-x) + 0,5} \ ; \quad C_2 = \frac{K/t\ (1-x) - 0,5}{K/t\ (1-x) + 0,5}$$

K is the travel time

t is the interval during which discharge Q_{10} becomes Q_{11} and discharge Q_{20} becomes Q_{21}, that is to say the time-interval separating moment 0 from moment 1.

x is a fitting parameter varying from 0 to 1/2 $\frac{t}{k}$-

In a first phase, an attempt was made at fitting the equation parameters through the hydrographs observed at GODE and BURKUR. The parameters used are as follows :

K = 12 days   t = 5 days   x = 0,2

which gives the following coefficients :

C_0 = 0,0082 C_2 = 0,4050 C_3= 0,5868

The hydrograph computed at BURKUR is greater than the observation hydrograph since the MUSKINGUM equations which take into account the assumption of the conservation of flow volumes do not take into consideration losses in the flood plains. Nonetheless, the connection between the two hydrographs is relatively good as may be seen on graph IX.8.

The relation between discharges at BURKUR for time intervals computed and observed for five day periods has already been examined. An average linear equation link : Q computed = 1,25 Q observed may be used.

This form of relation is plausible since it signifies that during a flood period the average loss corresponds to 25 per cent between GODE and BURKUR whereas on the annual gauge it is 20 per cent (par.5.5.)

In a second phase, the flood hydrographs, from the downstream part to the upstream part, was reconstituted from the 19 years of BURKUR (obtained through BELET-UEN) using the inverse equation of MUSKINGUM. The discharges of BURKUR were converted beforehand using the equation linking computed and observed discharges.

This enabled reconstituting the flood hydrographs at GODE for 14 years (from 1951 to 1966 except 1953 and 1960). The time interval of these hydrographs is 5 days. In order to pass on from the discharges per five days to maximal instantaneous discharges, the relation between the peak flood discharges and the average discharges for 5 days was studied. The relation between these discharges is shown on graph IX.9. The relation between the peak discharge and the five days discharge decreases together with the importance of the flood. For floods greater than 500 m3/s, the peak discharge is on the average 20 per cent greater than the discharge for five days.

Finally, the sample maximal annual discharges for 19 years (14 years reconstituted and 5 observation years from 1967 to 1971) were obtained. Of course the reconstitution method used for peak discharges does not allow expecting a very accurate estimate of floods presenting an unusual frequency.

The values vary from 240 to 1 130 m3/s, the average being approximately 530 m3/s.

The estimates given below are derived from the statistical study of the sample and are only valid at ± 20 per cent for floods of 10 or 20-year occurrence. Accuracy is slightly greater for the bi-annual flood.

- Bi-annual frequency flood : 525 m3/s or 4,2 l/s.km2
- 10-year frequency flood : 750 m3/s or 5,9 l/s.km2
- 20-year frequency flood : 900 m3/s or 7 l/s.km2

9.6.3. Estimate of floods with an unusual frequency at the other WABI SHEBELLE stations

An idea of the value of floods for a given frequency may be obtained for the other stations of the WABI SHEBELLE through the flood estimates of GODE and through the relations existing between the flood peaks at the other stations from LEGE-HIDA to KELAFO (taken two by two for neighbouring stations).

The estimates are given below :

Peak discharges in m3/s	LEGE-HIDA	HAMERO-HEDAD	IMI	KELAFO
20-year flood	1 350	1 550	1 050	420
10-year flood	1 100	1 250	950	380
Bi-annual flood	640	720	580	300

The specific peak discharges for the 10-year occurrence flood regularly decrease from the upstream part to the downstream part : 50 l/s.km2 for LEGE-HIDA 20 l/s.km2 for HAMERO-HEDAD and 10 l/s.km2 for IMI.

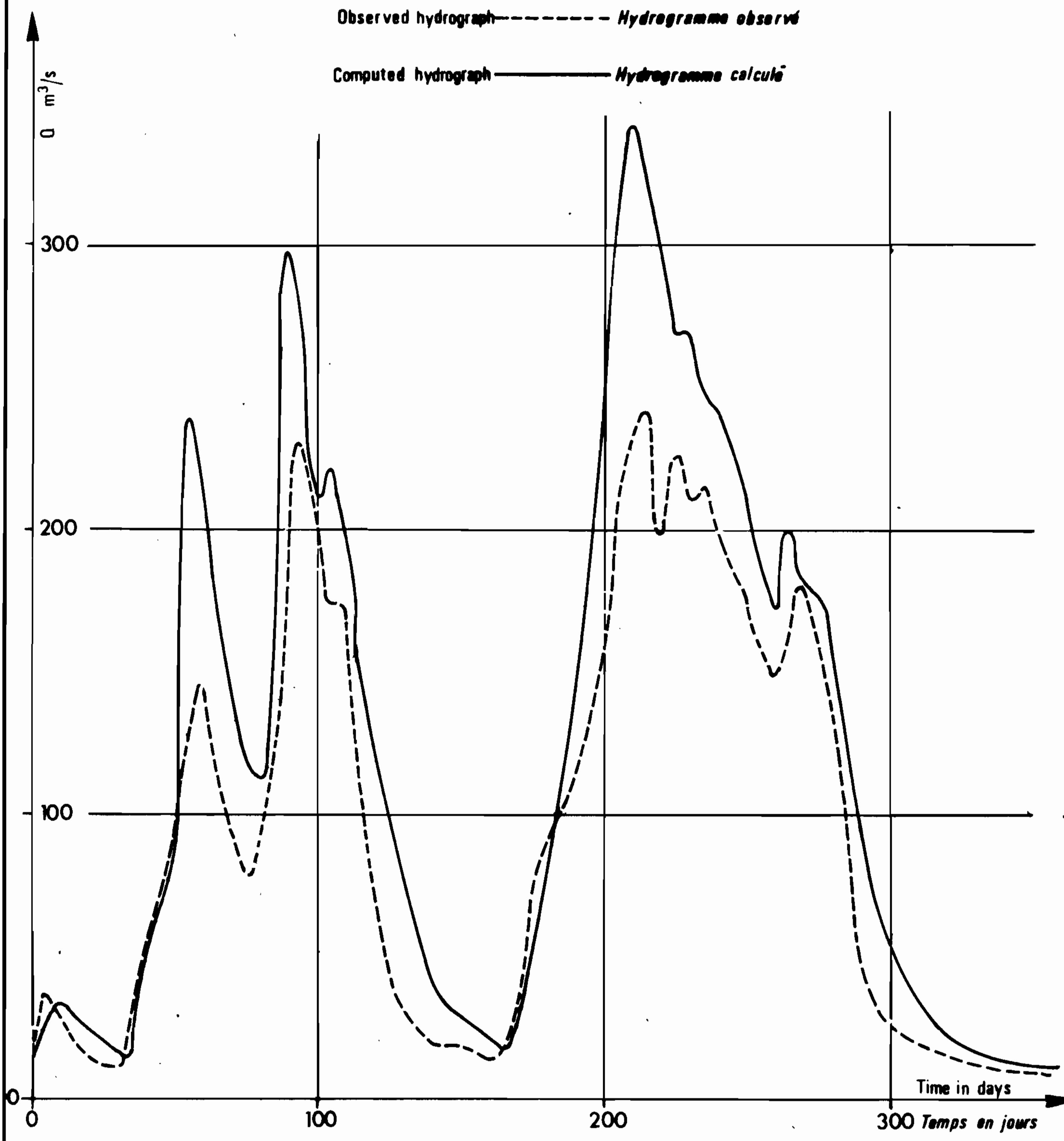
9.7. FLOODS OF THE FAFEN BASIN

Intermittent runoff in this basin is already described in chapter 5.6. The number and duration of runoff periods resulting from the floods are studied in this same chapter.

FLOOD HYDROGRAPHS OF WABI SHEBELLE AT BURKUR (Year 1970-71)

HYDROGRAMMES DE CRUE DU WABI SHEBELLE A BURKUR (Année 1970-71)

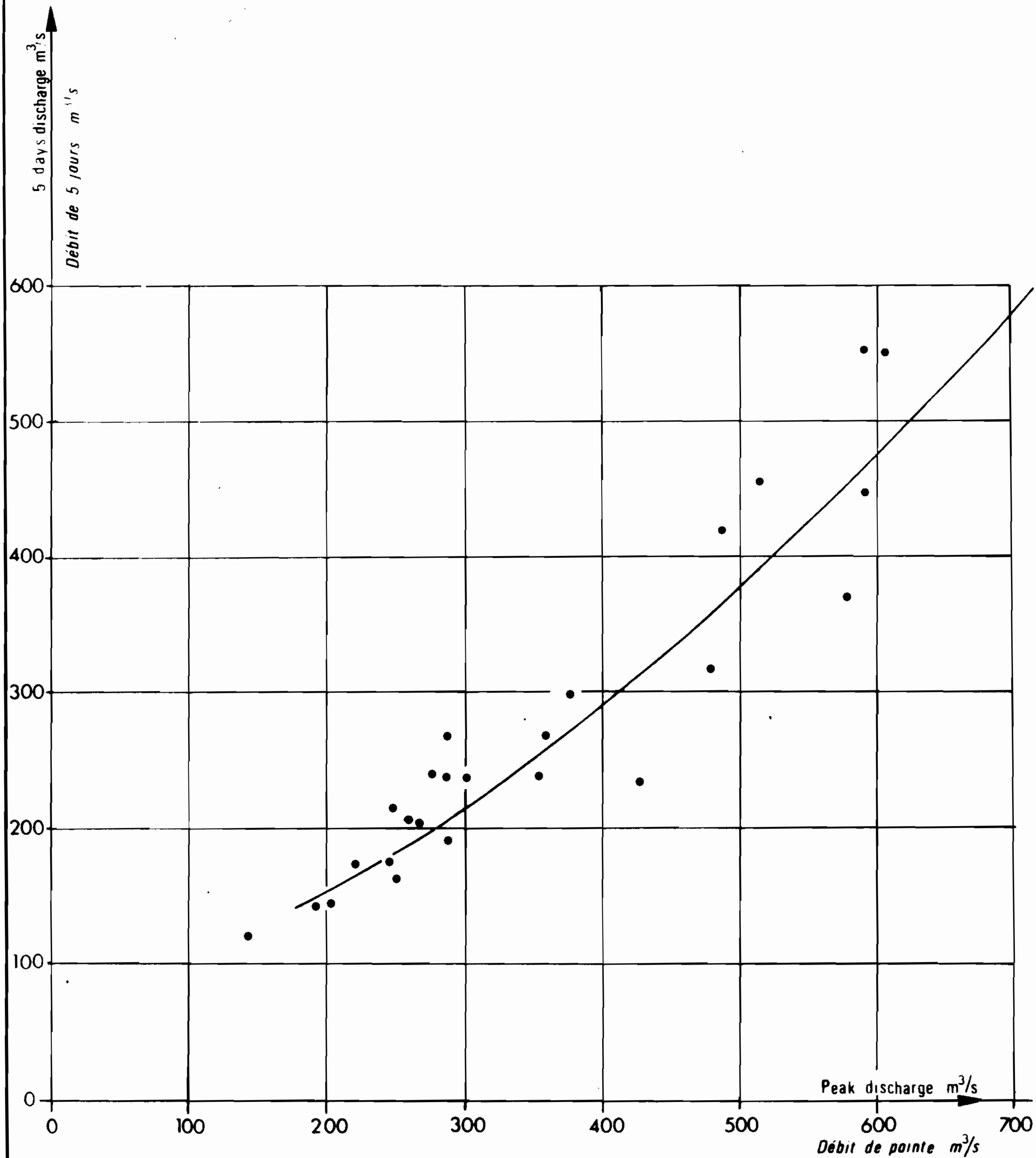
NB The influence of the floodable areas is not taken in account
L'influence des plaines d'inondation n'est pas prise en compte



Gr-IX-9

RELATION BETWEEN PEAK DISCHARGES AND 5 DAYS MAXIMUM FLOOD DISCHARGES AT GODE

CORRELATION ENTRE LES DEBITS DE POINTE ET LES DEBITS MAXIMAUX DE 5 JOURS A GODE



9.7.1.1. Origin and shape of floods

The JERER floods belong to the same type as the floods of the ERRER and of the DAKETA and result from a very short localized rainy phase (maximum : three days). The flood hydrographs are not so sharp owing to the flood plains delaying runoff.

The flood hydrograph is characterized as follows :

- rising-time : from 2 to 3 hours
- base-time : from 12 to 24 hours
- subsurface runoff : discharge less than 1 m3/s for several days (approximately 3 or 7)

Floods occur between March and May for the first rainy season and in October and November for the second rainy season. They are twice more numerous during the first season; there should exist an average of 9 runoff periods for a year, each corresponding to at least one flood.

9.7.1.2. Floods observed during the survey period

The following table sums up the floods observed exceeding or equal to 30 m3/s. When possible, this table presents for each flood the average rainfall (P_m) to which it is due and which corresponds to the arithmetic mean of the three rain-gauging stations of JIJIGA, KEBRI-BEYAH and DEGAHBOUR as well as the reduction coefficient or ratio of the mean height to the maximum height observed at one of these three stations.

The other symbols have already been used in this chapter (see. 9.1.3.)

Year	Date of the flood	Flood characteristics					Rainfall		K_r per cent
		Vr 103 m3	Hr mm	Q max m3/s	Q sp l/s km2	Max Q / aver. Q	Pm mm	Reduc. coeff.	
1968-1969	February 17	780	0.12	45.9	7.1	5.1			
	April 3	537	0.08	48.8	7.5	7.8			
	May 30	2 833	0.44	185	28.6	5.6			
	October 26	864	0.13	132	20.4	13.2			
1969-1970	February 23	861	0.13	91.8	14.2	9.2	32.4	0.47	0.40
	November 1st	372	0.06	32.9	5.1	7.6			
1970-1971	March 2	858	0.13	37.8	5.8	3.8	20.5	0.68	0.63
	March 15	854	0.13	39.6	6.1	4.0	36.4	0.75	0.36
	April 12	299	0.05	32.9	5.1	9.5	14.3	0.83	0.35
	April 18	2 312	0.36	33.7	5.2	1.3			
	April 30	821	0.13	60.2	9.3	6.3			
	May 2	617	0.10	31.3	4.8	4.4			
1971-1972	April 11	378	0.06	34.3	5.3	7.8	25.2	0.56	0.24
	May 4	3 467	0.54	86.5	13.3	8.1	31.3	0.50	1.73
	May 12	540	0.08	57.2	8.8	9.1	9.9	0.54	0.81
	June 16	320	0.05	31.7	4.9	8.6	19.4	0.53	0.26
	October 3	128	0.02	33.8	5.2	22.8	18.2	0.59	0.11

The comparison of these data with those of the DAKETA (see : 9.4.2) shows that the specific flood discharges are far less important. This is also true for the runoff coefficients presenting far lower values than those of the DAKETA. This is due to a less abundant rainfall and especially to the alluvial plains which hold back a large quantity of water from the tributaries. The basin of the FAFEN distinctly shows arid features and a local endhoreism.

9.7.1.3. Flood estimate

The estimates obtained through observations of daily rainfall at JIJIGA station allows roughly evaluating the characteristics of bi-annual and 10-year occurence floods. The values resulting from the statistical survey of daily rainfall at JIJIGA must be recalled :

Bi-annual rainfall 51,2 mm

10-year rainfall : 84,5 mm

The preceding observations allow estimating the characteristic parameters of bi-annual and 10-year floods, i.e :

Flood	Flood characteristics					Rainfall		Kr per cent
	Vr 10^3 m3	Hr mm	Q max m3/s	Q sp l/s.km2	Q max / aver Q	Pm mm	Reduction coeff.	
bi-annual	1 450	0.23	85	13	10	28.2	0.55	0.80
decennial	2 970	0.46	222	34	13	46.5	0.55	1.0

9.7.2. The FAFEN floods at KEBRI-DAHAR

9.7.2.1. Origin and shape of floods.

After the confluence with the JERER in the BIRCOT region, the alluvial plain of the FAFEN spreads out considerably. Floods are reduced in the channel and the floods of the tributaries do not directly meet the FAFEN but flow in the alluvial plain. The flood hydrographs of the FAFEN at KEBRI-DAHAR therefore present relatively weak shapes and are separated by periods of uninterrupted runoff with a weak or inexistent discharge. Consequently, the number of runoff periods is smaller than at DEGAHBOUR (averaging 6 instead of nine yearly) but these periods are longer (an average of 10 to 20 days). They seem to be equally distributed in the two rainy seasons.

9.7.2.2. Floods observed during the survey period

The maximum instantaneous discharge observed during the two rainy seasons is presented in the table below.This maximum discharge is slightly less than the effective instantaneous discharge (since the station is only equipped with a flood gauge for observations twice a day) but considering the relatively weak shapes of the hydrographs, the underrating does probably not exceed 20 per cent.

Year	1st rainy season			Second rainy season		
	Date	max m3/s	Q sp 1/s km2	Date	Q max m3/s	Q sp 1/s km2
1968-1969				30-10	10.0	0.39
1969-1970	8-5	64.5	2.52	3-11	28.3	1.11
1970-1971	12-5	37.3	1.46	28-10	17.5	0.68
1971-1972	8-5	32.3	1.26	15-10	15.2	0.59

The specific flood discharges are very weak and for a same drainage area are far smaller than those of the most arid type of tributaries of the WABI SHEBELLE.

9.7.2.3. Flood estimate

An examination of the daily rainfall observations at DEGAHOUR and KEBRI-DAHAR shows that the floods of the FAFEN at KEBRI-DAHAR cannot be linked to the rainfall recorded at both these stations. The floods are due to local rainstorms occurring between the two stations.

As no informations on rainfall are available for this sector, it is therefore difficult to estimate floods with a bi-annual or 10-year frequency.

Upon presentation of the results achieved for the three and a half observation years, the following figures may be put forth, i.e :

For the bi-annual flood : 40 m3/s or 1,6 1/s.km2

For the 10-year flood : 80 m3/s or 3,1 1/s.km2

These figures must be used carefully since they may be considerably underrated. As a matter of fact, the rainy phases occurring near KEBRI-DAHAR are likely to produce flash floods which, for want of time, cannot be reduced and may present peak discharges similar to those of the JERER. A few other observation years are necessary to invalidate or confirm this assumption.

FOURTH PART

SEDIMENT TRANSPORTATION

and

CHEMICAL ANALYSIS OF WATER

CHAPTER X

SURVEY OF SEDIMENT TRANSPORTATION

The sediment transportation of a river is either a suspended load or a bed load, depending on how sediments are transported. The suspended load presents finer particles such as fine sand, silt and clay, whereas the bed load presents coarser particles such as coarse sand, gravel and pebbles. Both types of material contribute to sedimentation of reservoirs. The total sediment transportation is mainly represented by suspended load.

The erosion factors of the basin conditionning the amount of material transported by rivers are the rainfall conditions, the climate, the physical features of the basin (geology, pedology, relief) and the density of the vegetative cover.

10.1. MEASUREMENT CONTRIVANCE

Water was sampled at various stations on the WABI-SHEBELLE and on the FAFEN in order to determine the turbidity of water. These stations were selected mainly with respect to the development project of the basin. In this end, measurements were made at the following stations :

- WABI SHEBELLE at MALKA-WAKANA -

This station controls the inflows at the site of the electric dam project -

- WABI-SHEBELLE and DAKETA at HAMERO-HEDAD -

These two stations control most of the project site at the entrance of the lower valley -

- WABI-SHEBELLE at GODE -

This station controls the sediment discharge in the lower valley. The results are useful for irrigation development plans -

- WABI SHEBELLE at BURKUR -

This station enables determining the sediment discharge at the border after the decantation of the WABI SHEBELLE water in the flood plains located between KELAFO and MUSTAHIL -

- FAFEN at KEBRI-DAHAR -

This station controls the sediment transportation of the FAFEN before it flows into the water-spreading plains.

In order to be accurate turbidity measurements must be made in the stream-flow from the surface to the bottom. But this requires heavy equipment which may not be easily used especially in rivers presenting a swift current. Turbidity may be estimated approximately, though easily, by sampling at the surface. This has been done for the WABI SHEBELLE and FAFEN.

Some complete measurements were carried out at the beginning in order to know the distribution of suspended load in the reach, then measurements were made at reference points near the surface (generally from 1 to 3 samples for each measurement). The 10 litres samples were flocculated with hydrochloric acid then decanted. The resulting solution was then analysed by the Project Laboratory at ADDIS-ABABA.

10.2. RESULTS OF MEASUREMENTS AND INTERPRETATION

Annexe III presents in tables 10. 1 to 10. 6 all the results of the measurements made at the six stations of the WABI SHEBELLE and of the FAFEN.

The data for water discharges given in these tables correspond to the depth of flow at the time of sampling but are not alway equal to the mean daily discharges.

When several samples are used for a same measurement, the turbidity in g/m3 is the arithmetic mean of the turbidities of each sample. The sediment discharge in kg/s is obtained by multiplying the mean turbidity by the discharge.

10.2.1. Turbidity of the WABI SHEBELLE at MALKA-WAKANA

Sixty-one measurements of sediment transportation were made from the 27th of September 1968 to the 28th of September 1969 for discharges ranging from 5,9 to 130 m3/s. The results of these measurements are presented in table 10.1 of the annexe.It may be noted that turbidity varies from 20 to 305 g/m3.

Graph X. 1 gives the values of sediment transportation in kg/s related to the water discharge in m3/s. The relation between water discharge and sediment transportation is suitable. This relation is due to the fact that the floods issuing from the high volcanic mountains are considerably reduced in the GUEDEB plain.

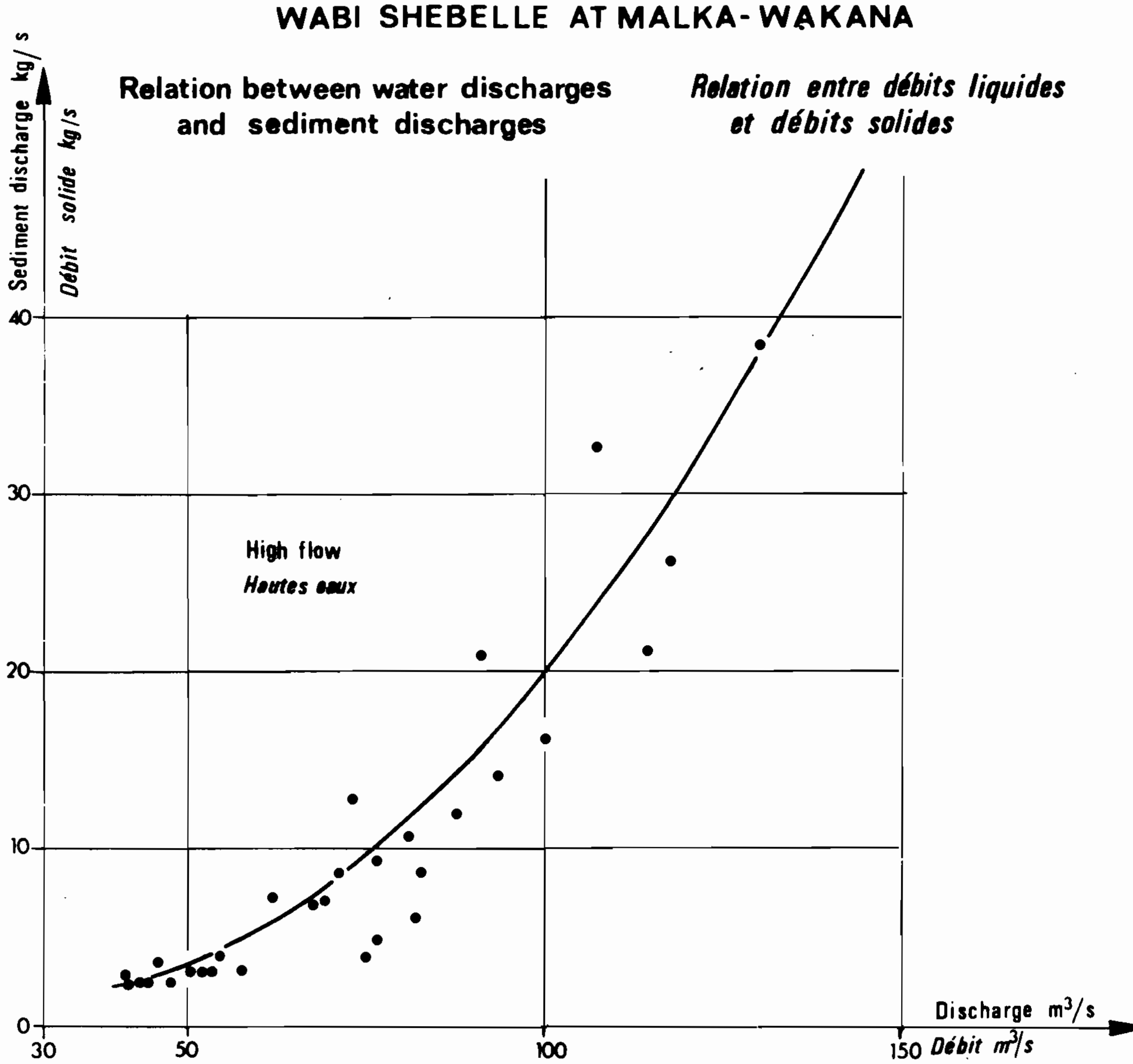
The load of transported sediments has been computed for each month of the observation period using the curve of the graph.

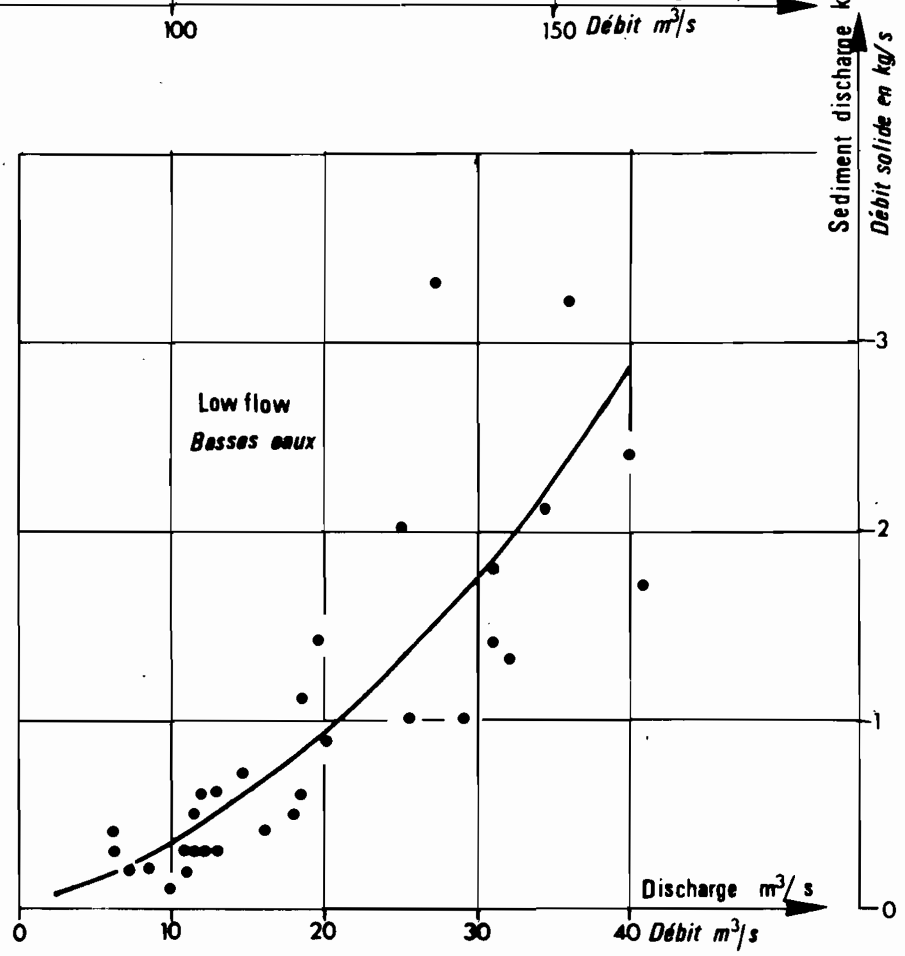
WABI SHEBELLE AT MALKA-WAKANA

Gr-X-1

Relation between water discharges and sediment discharges

Relation entre débits liquides et débits solides





The results are as follows, i.e :

Suspended load (tons)													
Year	F	M	A	M	J	J	A	S	O	N	D	J	yearly Total.
1968-1969	2 050	3 530	34 830	7 700	2 950	11 550	32 300	8 950	3 840	1 030	550	980	110 000
1969-1970	2 530	8 170	2 580	3 750	920	16 000	50 300	15 940	1 690	590	440	820	104 000
1970-1971	400	6 190	5 140	2 090	550	4 580	68 900	29 200	5 880	1 160	380	450	125 000
1971-1972	370	450	1 610	3 630	4 150	1 720	53 900	16 180	20100	1 400	690	400	105 000

The suspended load scarcely varies from one year to the next. The mean annual load computed for four years is 110 000 tons. This will be considered as valid for an average year, hence, the mean annual erosion corresponds to 21 tons per km2.

Considering that the mean density of earth is 1,6 tons/m3, the annual volume of transported sediment is 68 800 m3.

10.2.2. Turbidity of the WABI SHEBELLE at HAMERO-HEDAD

One hundred and seventeen measurements of sediment transportation were made from the 20th of July 1968 to the 28th of September 1971 for discharges (water) ranging from 19,8 to 606 m3/s. Most of these measurements were carried out during the high-flow gauging campaigns. The results of these measurements are presented in table 10.2 (annex). It may be noted that turbidities vary considerably : the minimum being 14,3 g/m3 and the maximum 38 kg/m3.

These results show that there is no well determined relation between sediment transportation and water discharge. For a same discharge the amount of sediments is usually greater during the flood rising than during the recession period. Besides, the amount of sediments also depends on the period of the year and on the origin of floods. The floods of the first rainy season are generally more turbid than the floods of the second season. The floods coming from the high basalt plateaus transport a smaller amount of sediment than floods formed on limestone series.

From these measurements different series of stage discharge relations were established according to the period of the year, to the origin of the floods and to the moment of sampling (flood-rising or recession). These relations allowed estimating the suspended load transported during the months for which measurements are available. The results are given below :

Suspended load in thousands of tons												
Year	F	M	A	M	J	J	A	S	O	N	D	J
1969-1970						175	750	285	37			
1970-1971	(200)	4 400	2 000	540	50	250	3 200	1 200	370	(100)		
1971-1972							1 260	930				

Graph X. 2 gives the values of monthly suspended load related to the mean monthly discharge. Two different relations are observed : a relation corresponding to the months of the first rainy season which produces the most turbid floods, and another for the second season.

These relations are relatively loose but allow estimating the suspended load for the months lacking measurements of sediment transportation but with a known average rate of flow.

The values of annual suspended load obtained through these relations are as follows :

Year 1968 - 1969 : 20 600 000 tons or 320 tons/year/km2

Year 1969 - 1970 : 12 600 000 tons or 196 tons/year/km2

Year 1970 - 1971 : 12 600 000 tons or 196 tons/year/km2

Year 1971 - 1972 : 5 900 000 tons or 92 tons/year/km2

If these values are related to the mean annual discharge, a linear relation may be observed.

The mean annual discharge being 86 m3/s, the mean annual suspended load is then approximately 8 million tons or 124 tons per km2. Supposing the density is 1,6 ton per m3, the annual volume of sediment discharge corresponds to 5 million m3.

10.2.3. Turbidity of the DAKETA at HAMERO-HEDAD

Thirty one measurements of sediment transportation were carried out from the 25th of September 1971 to the 11th of May 1971 for rates of flow ranging from 0,5 to 430 m3/s. The results of these measurements are given in table 10.3 in the annexe and show that turbidity is always considerable except for very low rates of flow (less than 1 m3/s) which usually correspond to the subsurface flow resulting from the drying-up of soils after flooding. The maximum turbidity observed is 61,3 kg/m3 for an instantaneous discharge of 210 m3/s. When flash floods occur, turbidity certainly exceeds 100 kg/m3.

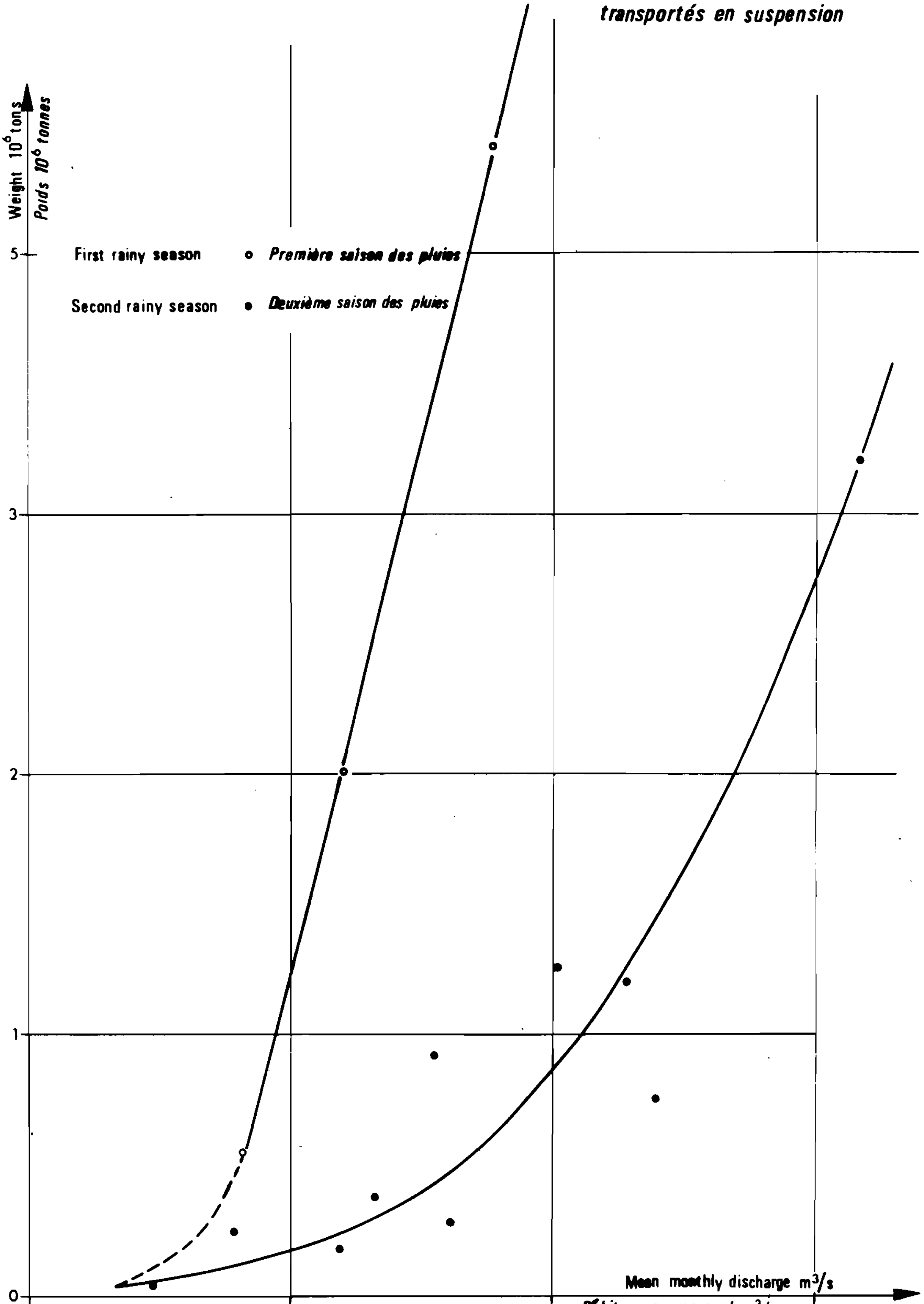
The too small number of measurements does not allow estimating with enough accuracy the annual suspended load since the relations between sediment transportation and water discharge vary and depend on the shape and origin of floods. For three flood periods the average relations between sediment transportation and water discharge were calculated from the results of measurements, and thus the load of transported sediments during these floods were obtained. The results achieved for these three floods are as follows, i. e :

WABI SHEBELLE AT HAMERO-HEDAD

Gr-X-2

Relations between mean monthly discharges and suspended load

Relations entre débits moyens mensuels et poids de sédiments transportés en suspension



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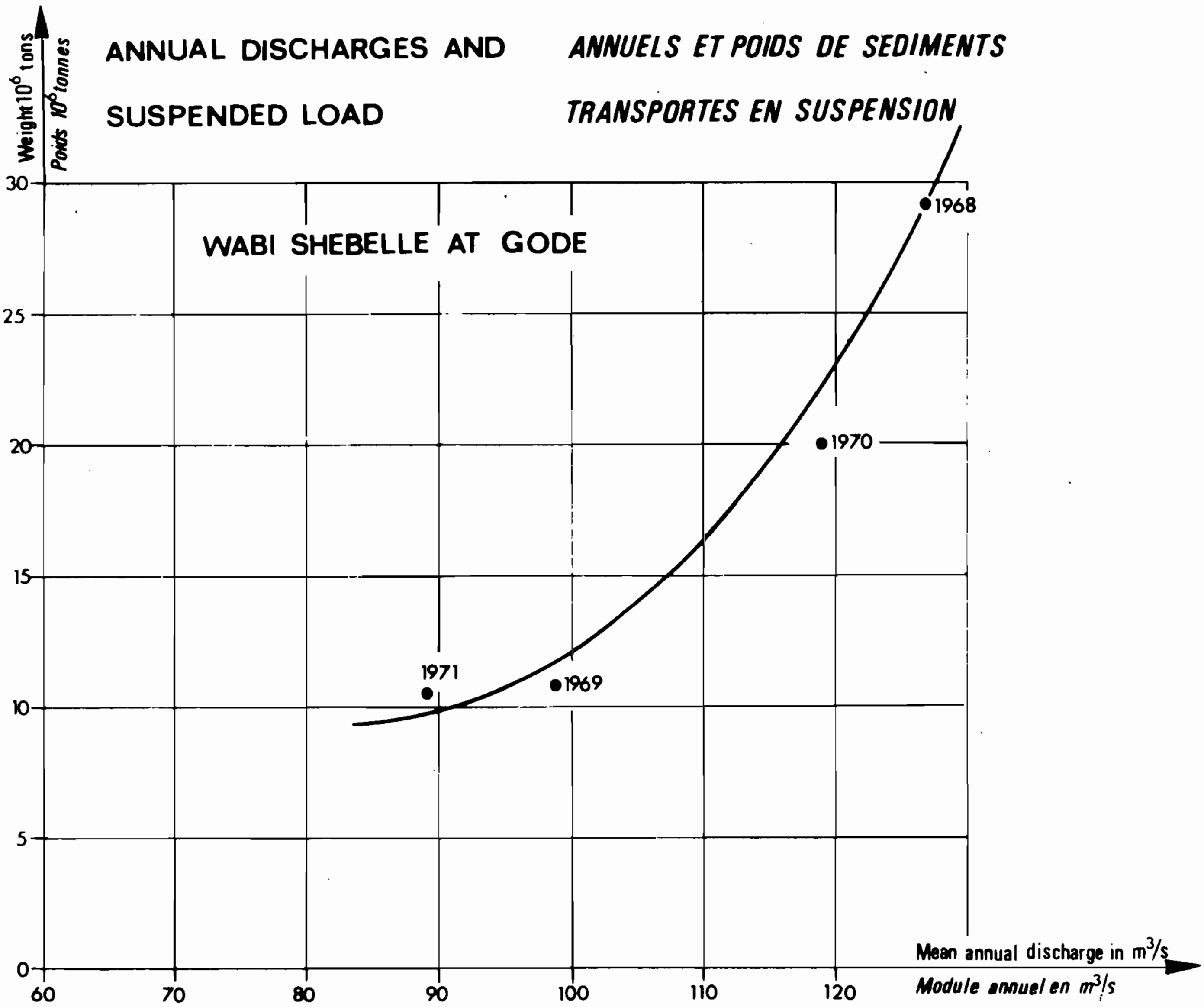
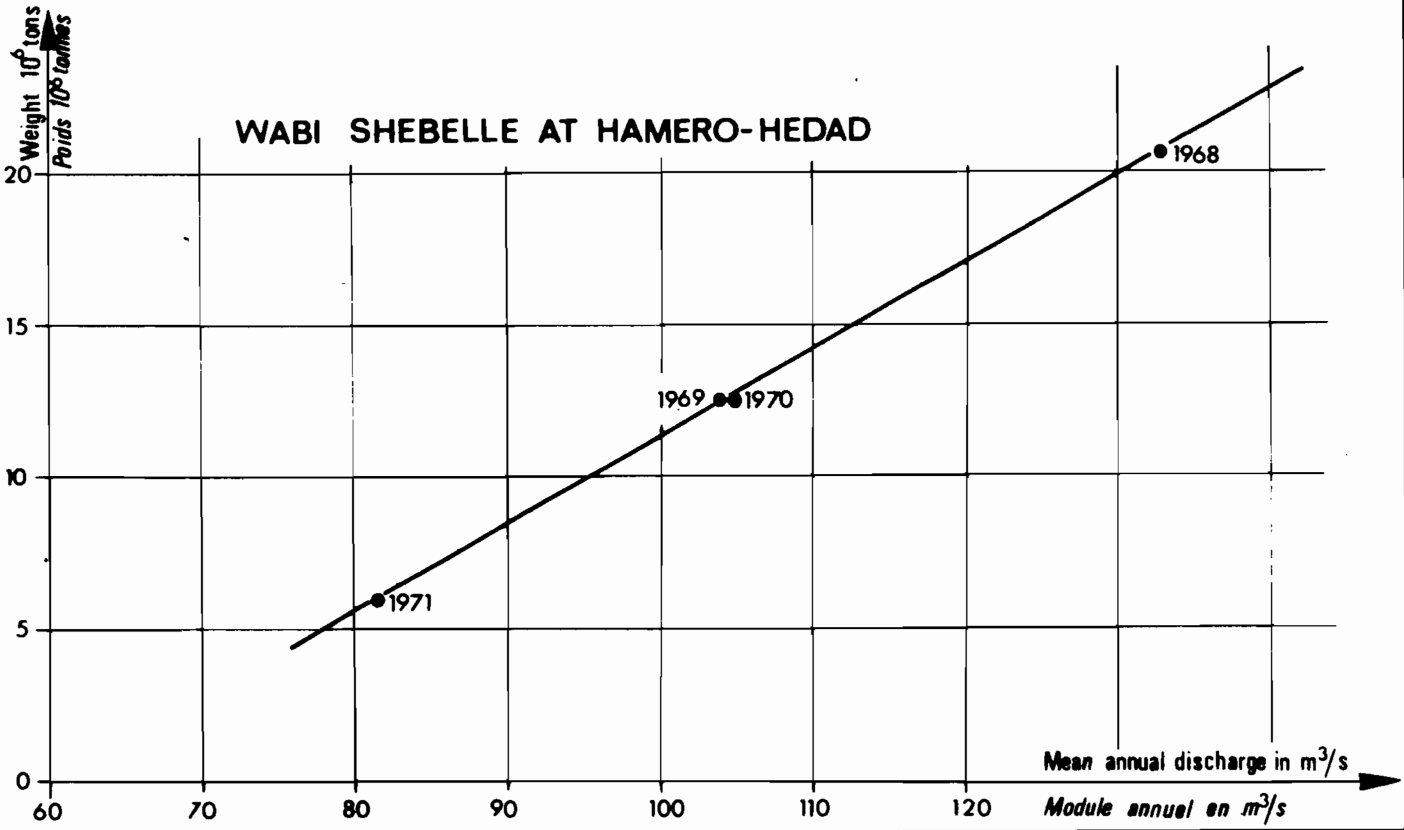
Gr-X-3

RELATION BETWEEN MEAN ANNUAL DISCHARGES AND SUSPENDED LOAD

RELATION ENTRE MODULES ANNUELS ET POIDS DE SEDIMENTS TRANSPORTES EN SUSPENSION





- Flood of 25th to 27th of September 1970 (simple flood)
  Volume of runoff : 11 millions m3
  Suspended load : 375 000 tons
- Flood of 17th to 23rd of October 1970 (compound flood)
  Volume of runoff : 33 millions m3
  Suspended load : 1 600 000 tons
- Flood of 3rd to 8th of May 1971 (compound flood)
  Volume of runoff : 33 millions m3
  Suspended load : 1 600 000 tons
- Flood of 3rd to 8th of Mai 1971 (compound flood)
  Volume of runoff : 45 millions m3
  Suspended load : 1 000 000 tons

The amount of transported sediments largely varies for a same volume of runoff. The average relation corresponds to a suspended load of 35 000 tons per million m3 of runoff. This relation applied to the annual runoff volume gives the following results.

Year 1970 - 1971 : 6,7 million tons or 472 ton/km2

Year 1971 - 1972 : 3,4 million tons or 239 ton/km2

These figures are relative and only give an approximate value of the amount of sediments transported by the DAKETA.

The mean annual suspended load should be approximately 5 million tons or 350 ton/km2, that is to say practically the same as the suspended load of the WABI SHEBELLE upstream from HAMERO-HEDAD.

10.2.4. Turbidity of the WABI SHEBELLE at GODE

Two hundred and twenty one measurements of sediment transportation were made from the 6th of September 1968 to the 4th of June 1971 for discharges ranging from 4 to 598 m3/s. The results of these measurements are given in table 10.4. (annexe). The minimum turbidity measured is 10 mg/1 and the maximum turbidity is 71 kg/m3.

For the same reasons as at the HAMERO-HEDAD station, turbidity is very variable and no relation exists between sediment transportation and water discharge

The measurements allowed establishing a whole series of sediment transportation / water-discharge relations depending on the periods. These relations enabled (as for HAMERO-HEDAD) evaluating the suspended load during the months when these measurements were carried out. The results are given below :

Year	Suspended load (in thousands of tons)												
	F	M	A	M	J	J	A	S	O	N	D	J	An.Tot.
1968-1969								541	373				
1969-1970	282	1 925	430	4 950	52	222	1 050	582	240	960	7	234	10 700
1970-1971	510	4 980	3 950	2 830	162	67	2 750	1 600	2 500	304	2	1	19 900
1971-1972	2	31	1 700	3 440									

On graph X. 4 the data for monthly suspended load are given in relation to the mean monthly water discharge.The points represent two relations , the first corresponding to the months of the first rainy season (from February to June) and to the late floods of OGADEN (October and November). These months produce the most turbid floods. The second relation corresponds to the months of the second rainy season on the high plateaus (July, August and September). During these three months, the amount of suspended load is far less for equal discharges.

These two curves allow estimating the suspended load for all the monthly discharges observed. The values in annual weights of transported sediments are as follows, i.e :

1968 - 1969 : 29 000 000 tons or 228 ton/km2.

1969 - 1970 : 10 700 000 tons or 84 ton/km2.

1970 - 1971 : 19 900 000 tons or 156 ton/km2.

1971 - 1972 : 10 500 000 tons or 82 ton/km2.

If these values are related to the mean annual discharge, a certain link may be observed (graph X. 3), but unlike HAMERO-HEDAD, the link is not linear. The gradient of sediment transportation increases together with the mean annual discharge. This is due to the very considerable sediment transportation observed in the intermediate basin between HAMERO-HEDAD and GODE and especially for the DAKETA. Consequently, the mean suspended load is certainly greater than the suspended load corresponding to the mean annual discharge; the latter being approximately 10 million tons, an average load of 15 million tons or 118 ton/km2 is very likely and the annual volume of transported soil is probably about 9,4 million m3.

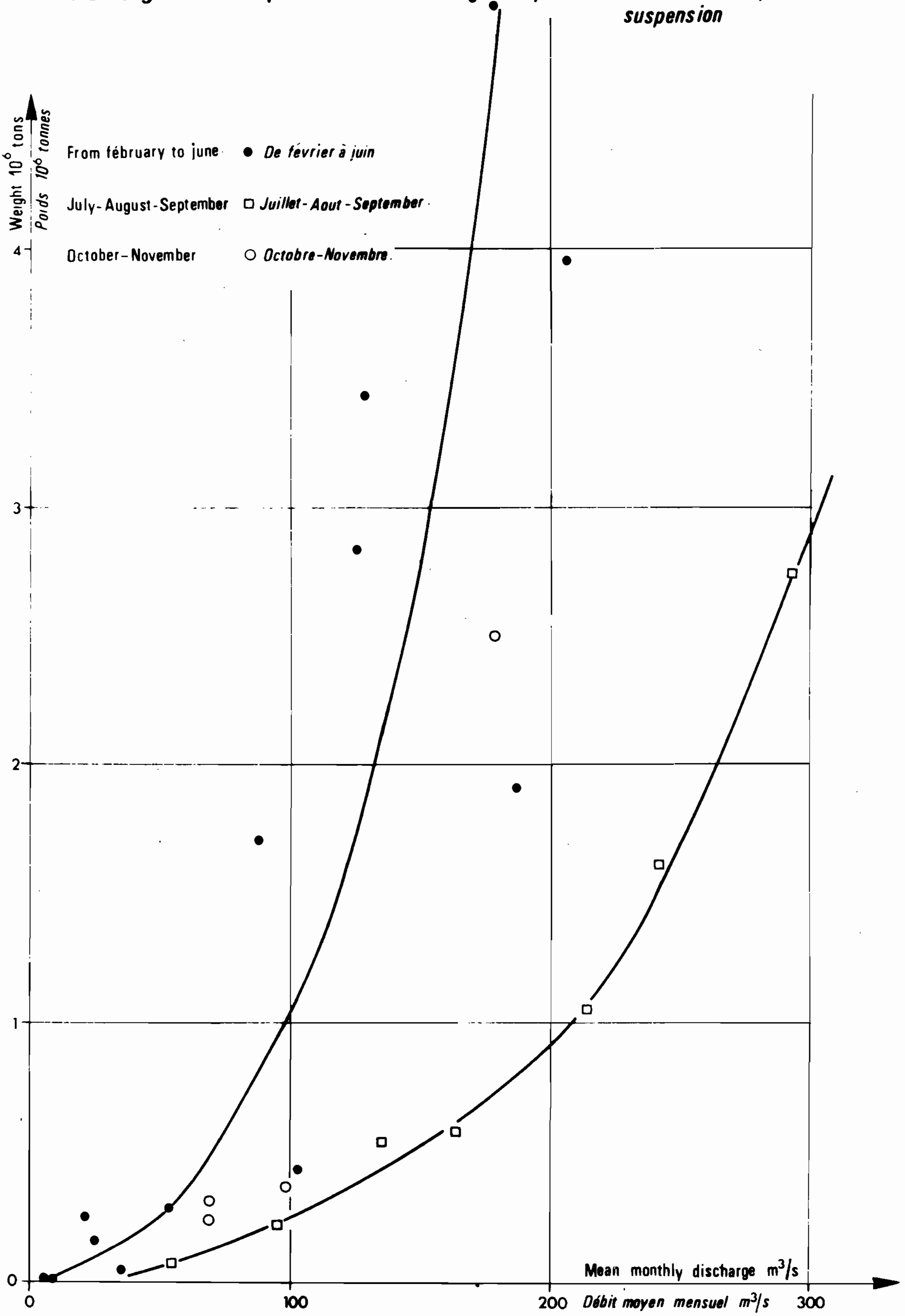
10.2.5. Turbidity of the WABI SHEBELLE at BURKUR

Eight measurements of sediment discharges were made during the rising of the flood of August-September 1970 for discharges ranging from 18,6 to 243 m3/s.

WABI SHEBELLE AT GODE

Relations between mean monthly discharges and suspended load

Relations entre débits moyens mensuels et poids de sédiments transportés en suspension



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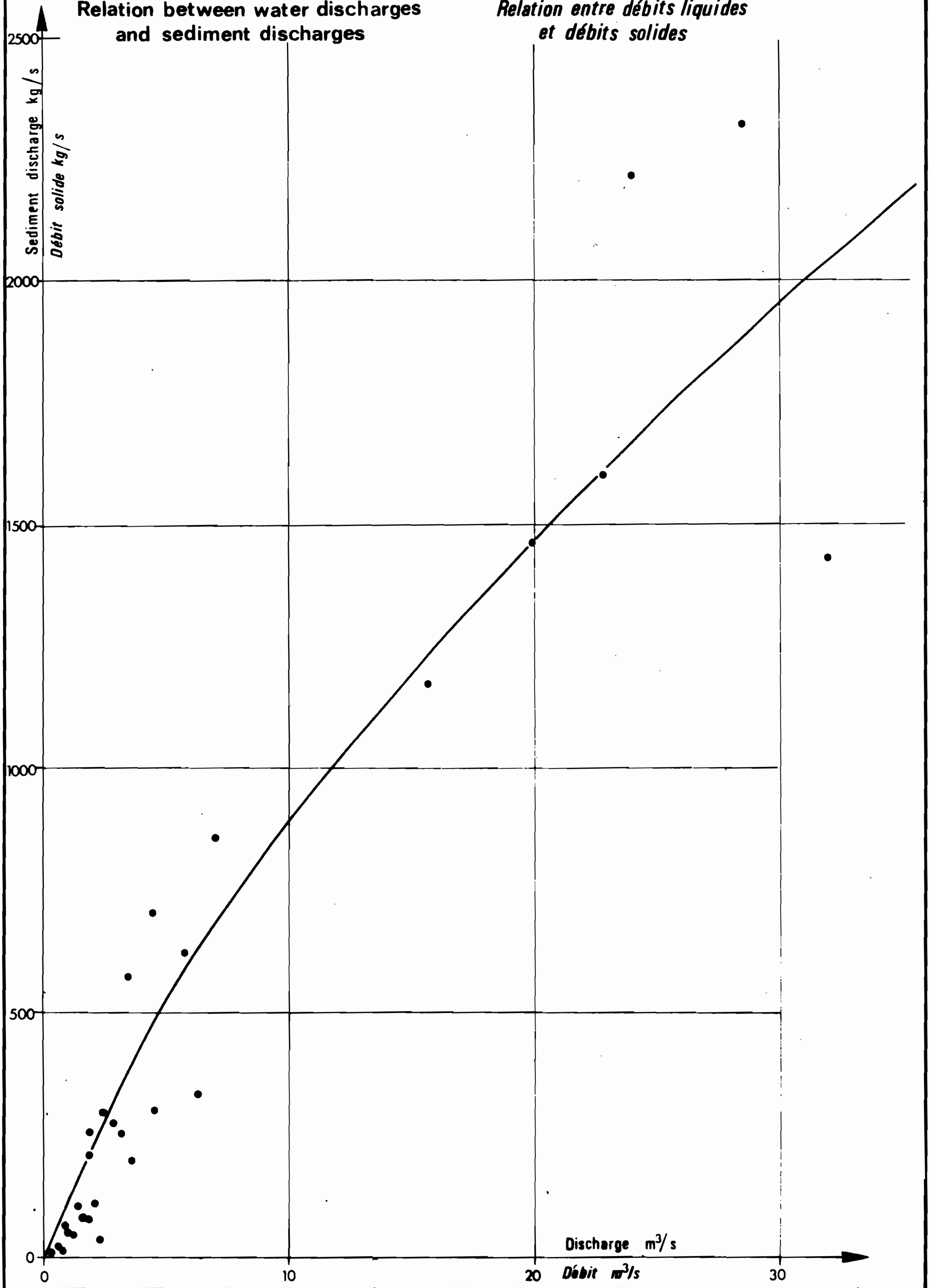
FAFEN AT KEBRI-DAHAR

Gr-X-5



The results of these measurements are given in table 10.5 (annexe). Though these measurements do not allow estimating the mean annual sediment transportation, they give an idea of the role played by the flood plains located between KELAFO and MUSTAHIL as regards the decantation of water. The maximum measured turbidity is 400 g/m3 at the beginning of the flood rising. It then falls very quickly and is only 40 g/m3 for the flood maximum.

During the same period at GODE, turbidity is 3 to 5 kg/m3. It is therefore obvious that over 95 per cent of the sediments transported by the WABI SHEBELLE at GODE are deposited in the flood plains. The travel-time of runoff between GODE and BURKUR during the flood period averages 13 days which represents a very small velocity of 18 cm/s; the velocity in the flood plains from KELAFO to MUSTAHIL is still less.

Only the local floods formed between MUSTAHIL and BURKUR bring a considerable amount of turbidities but, owing to the weakness of inflows, they contribute in a small proportion only to the total annual quantity of sediment transportation.

These observations being taken into account, the suspended load should not exceed 750 000 tons for an average year.

10.2.6. Turbidity of the FAFEN at KEBRI-DAHAR

Thirty-two turbidity measurements were carried out in October 1970 and May 1971. The results are given in table 10.6 (annex). Turbidity is always considerable and exceeds 40 kg/m3 for discharges greater than 1 m3/s and the maximum measured turbidity is 170 kg/m3.

Graph X. 5 gives the values of sediment transportation in kg/s in relation to the water discharge in m3/s, and a curve has been plotted.

This graph enabled computing the suspended load for each month of the observation period. The results are given below :

Year	Suspended load (in thousands of tons)											
	F	M	A	M	J	J	A	S	O	N	D	J	n. tot.
1969-1970	0	28	1 224	0	0	0	0	0	56	284	0	0	1 592
1970-1971	0	474	1 240	1067	10	0	0	76	516	9	0	0	3 340
1971-1972	0	0	280	998	168	9	0	62	496	31	0	0	2 040

Taking these results into account, the mean annual sediment load is approximately 2 500 000 tons which corresponds to a mean annual erosion of 98 ton/km2. The annual volume of transported sediments is 1 600 000 m3.

10.3 ESTIMATE OF SEDIMENT DISCHARGE AT THE ENTRANCE OF THE LOWER VALLEY.

10.3.1. Suspended load for an average year

The sediments transported to the dam site at the entrance of the lower valley may be estimated from the results achieved for the WABI SHEBELLE and for the DAKETA at HAMERO - HEDAD.

We have already seen that the suspended load of the WABI SHEBELLE and of the DAKETA is respectively 8 million tons yearly and 5 million tons yearly

The intermediate basin of 2 600 km2 is not controlled by these two stations since the dam is to be located downstream from the DAKETA tributary, in the hemmed-in area above IMI. This basin belongs to te same type as the basin of the DAKETA and presents a similar annual erosion of 350 ton/km2. This figure represents an annual suspended load of 900 000 tons for this basin.

Finally, the suspended load at the dam-site for an average year is probably approximately 14 million tons yearly or about 9 million m3/yearly, if we consider that the sediment density is 1,6.

10.3.2. Estimate of total sediment transportation at the dam-site

To the suspended load must also be added the bed-load which increases upstream from the dam and will largely contribute to the silting-up of the reservoir.

No well-defined methodology exists for a direct measuring of this type of sediment supply to large basins. Only a subsequent study of the filling in of reservoirs located at the outlet of drainage basins presenting similar relief, geological and climatic conditions, allow estimating the bed-load transport.

In his work "Silting up of reservoirs" published in 1953, KHOSLA studies the sediment supply measured in 146 dams throughout the world. This study shows that the quantity of material deposited in the reservoirs largely varies according to the types of basins but that for arid basins it is always approximately the same and averages 360 m3/km2 yearly. This figure was determined through the survey of 10 basins of variable sizes and generally located in the U.S.A. or Africa.

This figure applied to the basin of the WABI SHEBELLE leads to a total annual sediment transportation at the dam site of 29 million m3. This value seems very high if one considers that the high volcanic plateaus of the upper basin which cover approximately 20 per cent of the basin upstream from this site do not present a torrential flow of subarid type. In fact, it has already been seen that the suspended load at MALKA-WAKANA is very moderate. This value nevertheless gives an idea of the total annual volume of sediment transportation (suspended load and bed load).

A sediment volume of approximately 20 million m3 yearly is a very likely figure.

CHAPTER XI

CHEMICAL ANALYSIS OF THE WABI SHEBELLE WATER

Water samples analysed at the Project laboratory at ADDIS-ABABA and at O.R.S.T.O.M. in PARIS enabled determining the chemical composition of the WABI SHEBELLE water for several stations of the basin.

The results of these analyses are given in table 11.1 (annexe). The largest number of samples were made at the stations of MALKA-WAKANA, HAMERO-HEDAD GODE and KELAFO. Some samples were taken during the low flow period at the IMI and BURKUR stations.

A first examination of this table shows an essential difference in the chemical composition between water at MALKA-WAKANA and water in the middle and lower valley from HAMERO to BURKUR, since water flowing over volcanic soils is far less saline than water flowing on limestone and gypsum soils.

11.1 CHEMICAL ANALYSIS OF THE WABI SHEBELLE WATER AT MALKA-WAKANA

The ten samples taken for discharges ranging from 123 to 4,62 m3/s show the evolution of the chemical composition of water with the flow period.

a) Global salinity

The global salinity is termed in conductivity in millimhos/cm -1.

During the rainy season the water of the WABI SHEBELLE mostly consists of overland flow. Conductivity is then very low and regular and corresponds approximately to 0,075 millimhos/cm -1 or an average salinity of water of 50 mg/1.

During the minimum flow period for discharges less than 20 m3/s, the water of the WABI SHEBELLE is mainly due to the emptying of ground water tables, and since the contact of water with the soil of the basin lasts longer, this water is more mineralized. The conductivity increases in proportion as the discharge decreases. The maximum conductivity observed for a discharge of 4,6 m3/s is approximately 0,23 mmhos/cm -1 which corresponds to a global salinity of 170 mg/1.

b) Ionic content

Water presents a calcic bicarbonated chemical facies. The content of Cl and SO4 is less than 0,1 milliequivalent/1, hence it is very weak. The relative contents of cations are distributed as follows :

Ca > Na > Mg > K with Ca + Mg > Na + K.

11.2 CHEMICAL ANALYSIS OF THE WABI SHEBELLE WATER IN THE MIDDLE VALLEY AND IN THE LOWER VALLEY

The samples taken at the stations of HAMERO-HEDAD, IMI, GODE, KELAFO and BURKUR show the evolution of the salt content and distribution in the middle and lower valley. Chemical analysis reveals the preponderating influence on the ionic composition of water of the very soluble limestone and gypsum soils.

a) Global salinity

The conductivities observed are far greater than the conductivities of the MALKA-WAKANA water and increase noticeably from the upstream part to the downstream part.

During the high flow period the mean conductivities are as follows, i, e :

at HAMERO-HEDAD : 0,38 mmhos/cm -1 or a salinity of 280 mg/1.

at GODE : 0,45 mmhos/cm -1 or a salinity of 320 mg/1.

at KELAFO : 0,45 mmhos/cm -1 or a salinity of 320 mg/1.

Downstream from IMI, local floods spreading on gypsum soils may produce far greater conductivities. The duration of these floods is usually short but must nevertheless be taken into account for irrigation plans. The maximum conductivity observed at GODE at the end of October 1970 is 1,98 mmhos/cm -1 or an average salinity of 1 420 mg/1, which signifies that the salt load of the local flood water is far greater than this global figure.

For minimum flow periods and for discharges less than 30 m3/s, the salinity progressively increases together with the decreasing discharge.

The maximum conductivities observed at the stations during the same period are as follows, i. e :

at IMI : 0,72 mmhos/cm -1 or a salinity of 520 mg/1.

at GODE : 0,78 mmhos/cm -1 or a salinity of 560 mg/1.

at KELAFO : 0,78 mmhos/cm -1 or a salinity of 560 mg/1.

at BURKUR : 0,91 mmhos/cm -1 or a salinity of 650 mg/1.

It may be noted that during the minimum flow period salinity increases very noticeably from the upstream part to the downstream part. This may be linked to the reduction of the low water discharge through evapotranspiration. The interactions with the alluvial water table also play a role*. The latter presents a global salinity varying from 1,5 to 3,8 g/1 between GODE and MUSTAHIL, which is three to six times more than the salinity of the river.

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* Information provided by another Project report : "Hydrogeological survey of OGADEN".

b) Ionic contents

Water presents different chemical facies in relation to the period of the year.

During the months of high flow when runoff mainly occurs on the upper basin, water is calcic bicarbonated. The sulphate and chlorine contents are nevertheless relatively high (approximately 2 meq/l for SO_4^{--} and 0,40 meq/l for Cl^-). The relative contents in anions and cations are distributed as follows:

$CO_3 > SO_4 > Cl$ and $Ca > Mg > Na > K$.

During the flood periods in OGADEN and the minimum flow periods (for discharges less than 30 m3/s), water becomes calcic sulphated. The sulphate and chlorine contents are far greater (from 3 to 5 meq/l for SO_4^- and from 0,70 to 1,65 meq/l for Cl^-). The relative contents in anions and cations are distributed as follows :

$SO_4 > CO_3 > Cl$ and $Ca > Mg > Na > K$. The Na and Mg contents also increase (from 1 to 2 meq/l for Na and from 2 to 3 meq/l for Mg).

These considerably high contents of sulphate and chlorine reveal the influence of gypsum soils on the chemical quality of water.

The water of the alluvial ground water table of the lower valley is also a sodic sulphated water with the following distribution : $SO_4 > Cl > CO_3 >$ and $Na > Ca \geqslant Mg$. The influence of the local ground water table is therefore apparent in the process of the rising of contents mainly for sulphates and chlorides. One must remind that the alluvial water table is contaminated by the water table of the subjacent main gypsum formation (salinity : 40 g/l at the GODE well).**

** The content in milliequivalent/litre : meq/l - is equal to the content in milligrams per litre divided by the quotient of the atomic mass of the element by its valency.

ANNEXE I

AVERAGE DAILY DISCHARGES

STATION : ETHIOPIA WABI SHEBELLE WABI SHEBELLE BRIDGE ROAD OF DODOLA

NUMBER : 13280108

AVERAGE DAILY DISCHARGES 1967-1968 (M3/S)

	FEBR	MARC	APRI	MAY	JUNE	JULY	AUGU	SEPT	OCTO	NOVE	DECE	JANU
1	1.24	1.10	1.81	1.52	1.52	4.51	4.47	25.9	15.6	2.26	5.61	1.52
2	1.24	1.10	1.88	1.45	1.31	6.27	4.38	20.5	22.6	3.00	4.77	1.52
3	1.24	1.24	1.59	2.50	1.24	5.50	9.32	28.2	41.0	3.63	4.09	1.52
4	1.24	1.24	1.38	2.67	1.24	4.78	9.51	27.5	77.2	2.83	3.71	1.52
5	1.38	1.24	1.31	4.09	1.52	5.08	6.61	32.4	73.6	2.59	3.35	1.52
6	1.52	1.24	1.38	5.09	1.88	5.08	5.49	26.2	66.5	2.26	3.09	1.38
7	1.66	1.24	1.31	2.84	1.66	10.0	7.10	26.2	81.9	2.03	2.83	1.38
8	1.66	1.24	1.17	2.50	1.66	9.01	17.6	26.2	75.3	1.96	2.58	1.38
9	1.96	1.24	1.10	2.19	1.81	14.7	10.3	34.4	34.7	2.34	2.42	1.38
10	1.81	1.10	2.30	2.03	2.04	18.7	24.0	24.0	23.5	4.38	2.26	1.38
11	1.81	1.10	2.92	2.34	1.45	30.0	16.6	16.4	17.7	6.16	2.19	1.38
12	1.81	1.10	2.35	4.47	1.38	9.13	17.2	26.6	27.0	7.19	2.60	1.38
13	1.24	1.10	3.53	3.01	1.66	8.26	36.3	22.0	12.3	12.3	2.11	1.38
14	1.24	1.24	2.75	2.19	2.27	13.4	10.0	30.2	8.63	16.3	1.96	1.38
15	1.24	1.24	3.54	1.88	1.59	11.9	18.3	12.9	7.31	26.8	1.96	1.38
16	1.24	1.24	2.11	2.26	1.38	7.90	25.0	37.2	7.31	44.7	1.96	1.38
17	1.24	1.38	1.73	2.34	1.52	6.38	21.1	24.5	6.96	32.2	1.81	1.38
18	1.24	1.38	1.52	2.43	1.45	6.84	23.3	17.7	6.73	19.8	1.81	1.38
19	1.24	1.24	1.52	2.42	1.45	20.7	24.1	17.7	5.08	26.5	1.81	1.38
20	1.10	1.24	1.45	2.51	1.52	20.1	33.0	23.3	4.57	32.5	1.66	1.38
21	1.10	1.10	1.45	1.96	1.59	26.5	26.6	18.5	3.99	22.0	1.66	1.38
22	1.24	1.10	1.88	1.59	2.67	19.5	30.9	20.6	3.27	45.5	1.66	1.38
23	1.24	1.10	2.92	1.45	2.03	15.2	23.0	21.3	2.83	25.8	1.66	1.38
24	1.10	1.10	2.03	1.45	1.96	7.43	29.1	28.8	2.58	16.1	1.66	1.38
25	1.10	1.10	2.03	1.38	2.34	5.39	18.2	20.1	2.67	38.2	1.66	1.38
26	1.10	1.10	1.96	1.31	1.96	4.38	23.0	22.5	3.00	21.5	1.66	1.38
27	1.10	1.24	2.03	1.38	2.04	3.90	17.0	18.9	4.60	29.4	1.66	1.38
28	1.10	1.24	1.59	1.81	3.91	3.53	22.3	14.4	4.39	16.8	1.66	1.24
29		1.38	1.38	4.35	4.19	3.35	22.7	46.1	2.67	8.26	1.66	1.24
30		1.66	1.31	4.89	3.00	4.09	18.1	26.6	2.42	7.07	1.66	1.38
31		1.81		1.96		4.87	15.3		2.42		1.52	1.38
AVE	1.34	1.23	1.91	2.46	1.91	10.2	18.4	24.6	21.0	16.1	2.34	1.39

MEAN ANNUAL DISCHARGE 8.60 M3/S

STATION : ETHIOPIA WABI SHEBELLE WABI SHEBELLE BRIDGE ROAD OF DODOLA

NUMBER : 13280108

AVERAGE DAILY DISCHARGES 1968-1969 (M3/S)

	FEBR	MARC	APRI	MAY	JUNE	JULY	AUGU	SEPT	OCTO	NOVE	DECE	JANU
1	1.66	6.24	1.38	31.3	28.0	5.39	4.98	8.32	21.1	1.96	1.52	3.00
2	1.81	7.08	2.42	11.5	7.07	7.08	4.09	17.0	25.5	1.81	1.66	3.71
3	1.73	3.90	1.96	15.9	9.00	6.61	4.70	13.9	15.4	1.81	1.52	2.84
4	1.74	2.83	3.09	27.8	28.0	6.72	8.14	5.97	17.5	1.81	1.52	1.96
5	1.96	1.95	5.49	9.50	29.2	6.96	13.5	4.68	18.5	1.66	2.26	3.29
6	2.04	2.75	6.27	6.84	22.0	9.25	11.6	4.38	19.3	1.66	2.26	3.44
7	2.50	2.58	9.38	6.04	9.26	12.7	15.9	8.26	15.6	1.66	1.66	2.50
8	3.71	2.34	22.6	5.82	6.50	13.0	11.5	10.8	11.6	1.66	1.52	2.92
9	3.00	1.96	17.9	5.60	4.87	7.54	11.7	7.32	7.79	1.66	1.52	1.96
10	3.92	26.8	16.0	5.08	5.93	5.72	12.1	8.15	6.38	1.66	1.52	1.96
11	3.36	7.46	21.4	5.40	5.60	4.87	23.1	5.95	5.39	1.66	1.52	3.05
12	2.26	4.87	8.77	29.0	4.68	4.88	20.5	7.31	4.47	1.66	1.96	3.44
13	2.03	3.72	25.8	8.88	3.81	4.09	17.9	23.7	4.18	1.52	1.66	3.27
14	2.50	2.92	40.0	14.7	3.53	3.90	18.8	48.7	4.28	1.52	1.66	3.63
15	1.88	2.19	27.3	14.5	3.91	4.68	15.0	32.3	3.62	1.52	1.66	3.76
16	1.73	1.96	27.0	22.3	3.53	8.02	10.6	26.0	3.18	1.66	1.52	5.36
17	1.66	1.81	26.8	8.51	3.54	7.42	10.6	29.3	2.92	1.66	1.52	4.59
18	1.81	1.66	15.8	6.50	3.81	10.3	14.0	27.1	2.75	1.81	1.38	3.18
19	2.26	1.59	20.1	6.38	4.28	5.49	12.0	27.2	2.67	1.81	1.38	3.46
20	2.75	1.52	50.9	5.93	5.32	4.77	17.0	18.9	2.58	1.96	1.38	2.26
21	2.26	1.52	29.5	5.39	6.05	4.79	13.7	14.1	2.58	2.11	1.38	2.11
22	2.50	1.52	21.2	3.90	5.82	7.19	10.9	13.1	3.19	3.09	1.38	1.96
23	3.95	2.05	10.1	3.62	6.27	9.63	7.42	11.3	2.67	3.48	1.38	2.11
24	4.57	2.42	15.3	3.26	5.18	11.4	5.93	11.1	2.50	3.83	1.38	1.81
25	4.47	2.27	18.9	3.44	4.28	4.87	6.16	11.7	2.26	2.19	1.38	1.81
26	3.44	1.81	15.4	3.99	12.1	4.09	15.4	25.0	2.26	1.96	1.38	2.26
27	2.83	1.66	19.0	3.90	9.25	23.2	18.2	20.1	2.26	1.81	1.38	4.15
28	2.75	1.66	24.5	3.00	6.85	11.1	12.6	26.8	2.11	1.73	1.52	8.63
29	3.63	1.73	24.3	2.58	5.08	9.63	7.79	29.5	2.67	1.66	2.11	5.93
30		1.66	13.8	2.50	4.87	8.75	5.72	21.4	2.84	1.52	2.11	5.95
31		1.59		7.19		9.25	5.29		2.19		2.92	3.35
AVE	2.65	3.49	18.1	9.36	8.59	7.85	11.8	17.3	7.17	1.92	1.64	3.34

MEAN ANNUAL DISCHARGE 7.75 M3/S

STATION : ETHIOPIA WABI SHEBELLE WABI SHEBELLE BRIDGE ROAD OF DODOLA

NUMBER : 13280108

AVERAGE DAILY DISCHARGES 1969-1970 (M3/S)

	FEBR	MARC	APRI	MAY	JUNE	JULY	AUGU	SEPT	OCTO	NOVE	DECE	JANU
1	2.83	8.75	3.26	11.5	3.44	5.18	15.9	12.5	7.79	1.88	1.66	1.38
2	2.50	5.84	3.45	8.63	3.27	6.06	35.3	11.9	5.60	3.65	1.66	1.38
3	2.75	3.90	2.50	11.2	4.09	6.05	37.0	8.88	4.77	2.26	1.66	1.38
4	2.03	4.18	3.35	7.08	4.77	4.77	31.0	13.3	4.57	2.11	1.66	1.38
5	1.88	3.81	4.40	4.88	4.87	5.82	24.6	14.8	5.29	1.81	1.52	1.38
6	1.81	4.48	8.56	3.62	4.88	12.0	28.6	10.3	5.61	1.81	1.52	1.38
7	1.66	4.68	8.63	3.35	3.99	9.76	21.8	16.7	5.49	1.66	1.52	1.38
8	1.52	6.61	9.50	3.27	7.71	9.63	22.2	16.8	4.87	1.66	1.38	1.38
9	1.52	6.73	6.16	5.60	7.45	11.5	23.7	34.0	4.88	1.66	1.52	1.38
10	1.52	10.7	4.99	16.1	3.90	8.15	30.6	27.3	4.77	1.59	1.52	1.38
11	1.52	8.76	3.26	14.9	4.09	16.7	24.2	38.7	4.00	1.52	1.38	1.38
12	1.66	9.63	3.18	5.95	3.27	9.54	31.1	30.8	3.09	1.52	1.38	1.38
13	1.59	8.39	2.50	3.81	2.59	5.93	22.9	24.6	2.92	1.52	1.38	1.66
14	1.66	6.27	2.19	3.09	2.26	7.92	22.9	39.6	3.26	1.52	1.38	2.75
15	2.42	5.82	1.96	2.58	2.19	23.6	13.4	22.9	2.92	1.52	1.38	2.93
16	2.76	8.28	1.96	2.42	2.11	17.9	14.8	14.2	2.34	1.52	1.38	1.88
17	10.3	4.88	1.81	2.26	3.02	20.1	16.7	12.8	2.76	1.52	1.38	2.42
18	6.64	4.18	1.66	2.11	2.92	13.7	33.3	16.1	2.83	1.52	1.38	3.44
19	3.81	4.09	1.66	1.96	2.67	10.9	30.6	15.2	2.92	1.52	1.38	3.72
20	3.18	5.49	2.42	1.81	2.67	16.1	39.7	9.88	2.92	1.38	1.38	2.92
21	2.50	10.3	2.26	2.50	4.81	16.7	59.0	15.2	5.18	1.38	1.38	2.83
22	2.76	8.26	2.03	2.11	5.51	14.1	55.2	11.7	3.92	1.38	1.38	2.92
23	4.88	9.50	1.81	1.66	3.90	12.7	58.5	15.3	2.42	1.74	1.96	5.49
24	11.2	8.16	1.96	2.92	3.26	13.0	52.9	11.5	2.26	3.00	1.81	4.57
25	13.4	10.8	2.03	5.32	3.44	9.64	48.2	8.14	2.11	3.63	1.66	4.57
26	9.76	10.8	2.67	2.92	4.38	13.1	25.5	8.54	1.96	2.75	1.52	3.99
27	8.26	6.38	2.27	2.67	4.19	45.3	18.0	6.61	1.81	2.19	1.52	3.01
28	14.7	4.67	3.26	2.83	6.41	37.2	16.3	8.26	1.66	2.03	1.52	2.11
29		4.87	2.67	2.58	4.57	22.1	25.7	7.90	1.81	2.34	1.52	1.96
30		5.19	4.67	2.50	5.28	18.8	19.9	7.36	1.96	1.96	1.52	3.90
31		4.88		3.00		19.4	19.6		1.81		1.52	2.83
AVE	4.39	6.75	3.43	4.75	4.06	14.3	29.7	16.4	3.56	1.92	1.50	2.47

MEAN ANNUAL DISCHARGE 7.81 M3/S

STATION : ETHIOPIA WABI SHEBELLE WABI SHEBELLE BRIDGE ROAD OF DODOLA

NUMBER : 13280108

AVERAGE DAILY DISCHARGES 1970-1971 (M3/S)

	FEBR	MARC	APRI	MAY	JUNE	JULY	AUGU	SEPT	OCTO	NOVE	DECE	JANU
1	2.92	1.66	5.28	6.29	2.26	5.72	19.8	19.9	8.63	4.47	1.52	1.66
2	2.11	1.66	4.77	6.16	2.19	3.36	25.7	13.5	8.02	4.09	1.52	1.81
3	1.88	1.96	6.18	6.50	2.11	5.64	16.4	23.8	5.24	3.81	1.52	1.96
4	1.66	3.85	4.28	5.71	2.11	7.42	12.1	14.8	3.81	4.18	1.52	1.81
5	1.52	5.18	6.96	8.03	2.51	10.7	9.25	23.1	28.1	3.81	1.52	1.81
6	1.52	7.54	6.16	8.88	2.75	11.3	8.39	17.2	23.3	2.92	1.52	1.52
7	1.38	10.8	5.71	10.5	2.50	5.82	8.40	35.9	15.2	2.67	1.52	1.52
8	1.38	6.04	5.49	7.42	2.51	6.73	25.3	26.4	10.9	2.42	1.52	1.52
9	1.52	5.71	6.50	3.99	4.30	5.93	21.3	24.4	8.26	2.34	1.38	1.52
10	1.38	5.18	6.61	3.35	4.70	4.97	23.7	29.5	10.3	2.26	1.38	1.38
11	1.38	6.27	7.78	2.83	2.51	5.08	36.2	23.2	10.7	2.11	1.38	1.38
12	1.38	8.33	6.61	10.7	2.19	7.44	37.8	37.2	11.3	1.96	1.38	1.38
13	1.38	8.14	14.4	12.7	1.96	4.57	33.6	35.4	7.66	1.96	1.38	1.38
14	1.38	9.88	9.50	6.61	1.81	11.1	37.6	27.5	6.16	1.88	1.38	1.38
15	1.38	11.3	8.51	4.28	2.11	10.3	24.1	22.9	5.39	1.81	1.38	1.38
16	1.24	11.1	7.54	3.62	2.27	8.14	23.1	19.8	4.77	1.81	1.38	1.38
17	1.24	10.9	9.15	10.3	2.42	11.9	22.2	20.5	4.38	1.81	1.38	1.38
18	1.38	11.5	6.16	6.85	2.11	11.2	20.7	33.7	3.99	1.66	1.38	1.52
19	1.52	7.91	11.1	5.08	2.75	10.3	17.2	41.1	3.81	1.66	1.38	1.52
20	1.96	6.27	10.0	4.38	2.75	7.55	46.8	34.9	3.62	1.66	1.38	1.52
21	2.83	6.27	10.8	3.35	2.92	5.08	30.1	18.1	3.71	1.66	1.38	1.38
22	3.01	5.28	10.7	4.22	3.09	4.77	25.1	13.5	6.28	1.66	1.38	1.38
23	2.76	5.18	8.02	3.00	3.09	11.6	16.8	14.4	6.61	1.66	1.38	2.75
24	3.81	6.96	6.39	4.19	3.00	7.66	16.7	10.8	5.93	1.66	1.38	1.81
25	2.42	9.13	12.0	4.78	3.27	5.49	31.6	11.2	5.49	1.66	1.38	2.58
26	1.88	8.75	10.9	3.90	3.10	4.87	23.3	18.8	6.73	1.52	1.38	1.96
27	1.66	10.9	10.3	3.44	2.26	4.57	34.6	13.9	9.13	1.52	1.38	1.66
28	1.66	8.66	7.90	5.84	2.75	4.48	74.7	23.8	10.1	1.52	1.38	1.81
29		6.16	5.39	4.20	2.58	6.96	34.7	13.1	5.82	1.52	1.38	1.81
30		7.19	4.87	2.92	4.95	12.6	29.7	9.76	9.01	1.52	1.52	1.52
31		7.66		2.58		14.1	23.5		5.94		1.81	1.52
AVE	1.84	7.21	7.87	5.70	2.73	7.65	26.1	22.4	8.34	2.24	1.43	1.64

MEAN ANNUAL DISCHARGE 7.97 M3/S

STATION : ETHIOPIA WABI SHEBELLE WABI SHEBELLE BRIDGE ROAD OF DODOLA

NUMBER : 13280108

AVERAGE DAILY DISCHARGES 1971-1972 (M3/S)

	FEBR	MARC	APRI	MAY	JUNE	JULY	AUGU	SEPT	OCTO	NOVE	DECE	JANU
1	2.11	1.10	1.88	1.52	4.77	12.3	22.9	17.2	23.1	2.59	6.96	2.26
2	1.66	1.10	2.11	2.13	6.62	23.4	17.9	32.6	15.1	2.67	4.10	3.83
3	1.66	1.10	1.81	2.42	5.39	27.0	17.1	34.4	16.9	2.58	2.67	4.09
4	1.81	1.10	2.26	4.48	4.28	15.7	23.6	35.1	24.6	2.58	2.50	2.84
5	1.52	1.10	2.03	4.99	7.46	12.8	45.7	20.7	49.7	3.18	2.19	2.67
6	1.38	1.10	3.18	3.44	6.27	11.7	38.7	19.6	30.6	2.92	2.11	2.67
7	1.38	1.10	5.81	13.4	5.18	11.9	66.0	19.6	19.7	2.92	1.96	2.11
8	1.38	1.10	7.67	8.40	10.3	17.3	33.5	14.1	14.1	2.83	1.96	2.11
9	1.38	1.10	6.61	6.04	12.7	20.6	27.7	19.7	6.38	3.36	1.88	2.11
10	1.38	1.10	5.50	5.72	7.31	24.6	25.0	13.1	17.3	2.75	1.81	2.03
11	1.24	1.24	4.87	5.98	9.07	15.7	23.1	9.63	11.2	2.58	1.81	1.88
12	1.24	1.45	5.29	14.2	7.31	13.5	19.9	9.00	9.50	4.18	1.81	1.81
13	1.24	1.81	4.38	10.5	5.82	39.2	24.8	15.7	8.38	5.39	1.66	1.88
14	1.24	1.81	5.08	7.42	7.55	20.9	28.6	12.8	8.26	11.3	1.66	1.96
15	1.52	1.81	4.67	6.28	11.2	22.5	32.6	8.26	7.90	8.27	1.66	1.88
16	1.52	2.92	4.09	3.90	12.8	17.0	46.5	6.78	7.54	5.65	1.66	1.81
17	1.38	2.76	3.44	8.17	10.9	16.8	34.3	6.34	6.61	3.53	1.66	1.66
18	1.24	1.81	2.92	7.81	8.88	29.7	32.8	6.16	4.97	3.35	1.66	1.66
19	1.24	1.45	2.92	4.77	9.25	33.7	33.8	6.28	4.98	3.26	1.66	1.66
20	1.24	1.38	2.11	6.50	7.90	21.1	38.3	6.39	9.89	2.83	1.66	1.66
21	1.24	1.38	1.96	5.71	6.96	14.4	27.5	8.51	7.54	2.58	1.73	2.58
22	1.24	1.38	1.66	5.72	16.3	27.3	28.1	12.3	5.71	2.50	1.81	2.26
23	1.24	1.59	1.52	11.9	17.3	13.0	26.4	5.82	6.96	2.42	1.96	2.11
24	1.24	2.67	1.38	12.0	14.7	24.2	35.9	16.8	6.27	2.26	1.96	1.81
25	1.24	1.81	1.38	8.75	14.7	17.0	24.7	14.4	5.08	2.19	1.88	1.66
26	1.10	2.76	1.38	8.63	8.76	12.7	21.1	17.3	5.61	2.11	3.09	1.66
27	1.10	2.58	1.81	13.1	6.73	11.5	17.7	13.8	4.67	2.11	2.83	1.96
28	1.24	2.27	1.52	9.63	8.14	22.7	35.2	11.6	4.18	3.42	6.73	1.66
29		1.96	1.38	13.4	8.77	27.3	17.7	10.8	3.71	2.75	4.68	1.66
30		2.27	1.38	7.19	9.02	20.7	32.6	15.0	3.18	4.54	3.62	1.66
31		2.76		6.38		31.2	15.6		2.92		2.67	1.66
AVE	1.37	1.71	3.13	7.44	9.08	20.3	29.5	14.7	11.4	3.52	2.52	2.10

MEAN ANNUAL DISCHARGE 8.97 M3/S

STATION : ETHIOPIA WABI SHEBELLE WABI SHEBELLE MALKA-WAKANA

NUMBER : 13280127

AVERAGE DAILY DISCHARGES 1967-1968 (M3/S)

	FEBR	MARC	APRI	MAY	JUNE	JULY	AUGU	SEPT	OCTO	NOVE	DECE	JANU
1							42.6	104.	54.2	8.15	25.8	4.37
2								95.2	47.9	8.46	22.3	4.37
3								110.	60.9	9.56	19.2	4.37
4								112.	137.	9.08	16.5	4.37
5								93.0	169.	8.15	14.6	4.37
6							80.7	93.0	187.	7.40	13.0	4.37
7							94.1	97.2	225.	7.40	11.5	4.37
8							111.	109.	205.	9.24	11.0	4.37
9							101.	103.	215.	9.88	10.0	4.37
10							78.7	85.5	199.	16.1	9.40	4.37
11							67.6	78.7	157.	24.7	8.62	4.37
12							70.2	62.6	95.0	31.3	8.31	4.37
13							69.4	51.4	56.8	35.9	7.70	4.37
14							52.5	48.2	39.4	49.6	7.10	4.37
15							47.9	44.4	32.5	86.2	6.52	4.37
16							54.2	38.0	27.4	97.2	6.23	4.37
17							58.7	42.2	25.6	83.6	6.09	4.37
18							73.8	48.6	22.8	65.1	5.67	4.37
19							80.7	51.0	21.8	53.9	5.39	4.13
20							80.7	61.1	18.1	51.4	5.26	4.13
21							84.2	68.4	16.1	81.7	5.12	4.13
22						84.2	102.	57.6	14.8	140.	5.12	4.13
23						68.5	84.5	72.4	11.9	87.6	4.87	4.13
24						57.3	84.0	82.5	11.4	61.8	4.62	4.13
25						45.8	91.5	84.5	10.5	50.7	4.62	3.90
26						81.5	109.	71.2	10.0	43.4	4.62	3.90
27						33.4	95.6	61.4	10.9	46.5	4.62	3.90
28						28.8	87.1	54.8	12.3	41.7	4.62	3.90
29						26.3	97.2	49.7	11.7	35.5	4.50	3.90
30						26.9	98.8	51.1	9.40	30.2	4.37	3.90
31						33.4	95.7		8.62		4.37	3.90
AVE							78.7	72.8	68.4	43.0	8.77	4.22

STATICN : ETHIOFIA WABI SHEBELLE WABI SHEBELLE MALKA-WAKANA

NUMBER : 13280127

AVERAGE DAILY DISCHARGES 1968-1969 (M3/S)

	FEBR	MARC	APRI	MAY	JUNE	JULY	AUGU	SEPT	OCTO	NOVE	DECE	JANU
1	4.25	38.9	7.40	81.1	18.3	26.2	88.9	32.3	43.6	8.36	7.65	6.77
2	5.28	47.6	7.40	74.6	24.3	27.1	80.6	30.0	52.1	7.60	7.05	7.90
3	6.52	57.7	9.60	70.2	19.7	26.0	91.1	38.0	50.8	7.20	6.81	9.35
4	6.76	32.2	13.0	65.1	22.3	23.2	78.4	50.2	42.7	6.86	7.01	9.46
5	6.23	25.8	16.1	59.5	27.1	27.2	78.2	39.2	45.2	6.91	7.35	9.10
6	7.25	21.8	23.5	53.9	33.4	35.6	70.9	34.5	49.0	6.52	7.45	9.40
7	7.40	17.4	25.8	47.6	37.4	40.2	83.4	32.1	49.7	6.19	7.15	9.88
8	9.09	14.6	37.4	41.7	24.0	45.1	86.3	37.8	39.9	5.90	6.52	9.67
9	9.99	13.2	89.8	35.5	19.3	46.1	69.9	43.1	32.0	5.95	6.14	9.67
10	10.7	27.1	88.0	33.4	15.5	39.7	79.7	42.4	24.9	5.95	6.06	8.93
11	11.6	52.4	69.3	26.4	15.5	32.2	81.9	40.8	20.5	6.19	5.95	8.26
12	12.6	45.5	64.3	37.7	13.8	31.1	88.7	35.6	18.2	6.14	5.95	8.41
13	10.1	32.6	65.5	38.7	11.4	30.2	84.2	37.7	17.2	5.76	6.71	10.5
14	9.19	24.0	83.2	38.4	11.4	27.7	79.6	68.7	15.6	5.58	5.95	11.2
15	8.93	19.2	106.	37.4	11.7	35.7	85.8	68.1	14.3	5.39	5.67	10.5
16	9.09	16.5	88.8	32.8	12.6	46.2	75.1	61.0	12.6	6.31	5.86	9.09
17	10.5	13.2	86.5	35.2	10.8	48.2	79.0	52.0	11.7	12.6	5.54	10.2
18	11.4	11.2	79.1	25.8	10.2	38.4	72.4	54.8	11.6	13.5	5.12	10.4
19	13.4	9.24	71.8	20.6	12.7	37.3	90.6	57.0	12.9	10.9	5.12	8.72
20	16.5	8.31	101.	16.9	12.0	31.4	102.	54.5	13.5	10.2	4.87	9.09
21	22.8	7.70	124.	15.2	11.9	32.0	92.9	48.4	14.9	14.3	4.87	7.20
22	24.4	6.81	91.4	16.1	13.3	40.0	73.6	39.8	19.2	19.8	4.87	6.52
23	40.0	7.70	76.5	13.6	15.0	54.2	58.8	32.0	18.6	20.0	4.87	6.00
24	26.9	14.0	80.2	11.9	16.8	49.2	46.8	29.9	14.7	18.2	4.62	6.47
25	41.4	16.7	88.1	10.7	16.1	67.0	46.0	28.1	12.5	15.8	4.62	6.00
26	30.8	15.2	88.4	15.8	20.3	48.2	56.4	30.4	11.1	12.4	4.62	5.95
27	24.3	13.0	86.9	16.5	41.2	57.0	67.2	39.6	10.4	11.2	4.62	7.59
28	26.4	12.6	92.5	14.0	43.5	68.0	68.6	34.4	9.78	10.1	5.40	10.7
29	27.7	11.0	104.	10.7	38.3	72.9	61.3	48.0	9.72	9.03	5.81	16.3
30		10.0	88.5	9.56	30.2	75.8	47.2	49.9	9.45	8.26	6.09	15.8
31		9.08		9.90		102.	37.3		9.72		6.38	19.2
AVE	15.6	21.1	68.5	32.8	20.3	43.9	74.3	43.0	23.2	9.64	5.89	9.49

MEAN ANNUAL DISCHARGE 30.7 M3/S

STATION : ETHIOPIA WABI SHEBELLE WABI SHEBELLE MALKA-WAKANA

NUMBER : 13280127

AVERAGE DAILY DISCHARGES 1969 1970 (M3/S)

	FEBR	MARC	APRI	MAY	JUNE	JULY	AUGU	SEPT	OCTO	NOVE	DECE	JANU
1	13.2	41.9	32.1	41.8	8.56	12.9	101.	67.8	20.9	6.47	6.42	4.87
2	11.0	34.8	25.1	49.5	8.77	13.1	94.9	55.1	23.0	7.16	6.14	4.87
3	11.6	28.0	21.0	57.6	8.51	14.3	103.	48.7	19.7	8.31	5.95	4.87
4	9.09	24.3	17.2	53.4	8.88	15.0	104.	42.9	18.4	9.83	5.90	4.78
5	7.75	23.1	17.9	39.1	9.62	13.5	92.2	43.4	21.0	7.65	5.44	4.62
6	7.01	21.3	22.0	35.9	9.40	15.8	83.7	47.3	21.7	7.01	5.39	4.62
7	6.38	26.6	25.1	31.0	9.78	21.3	79.9	59.6	24.6	7.05	5.39	4.62
8	5.90	38.2	26.3	29.0	8.93	20.0	75.2	65.0	21.7	6.57	5.39	5.21
9	5.49	46.2	32.5	29.8	10.9	18.8	85.5	66.0	19.3	6.23	5.39	5.12
10	5.39	55.3	28.0	35.5	12.0	19.8	95.0	96.9	18.3	5.76	5.39	5.17
11	5.53	50.3	23.3	43.2	9.46	22.4	90.3	92.7	17.0	5.62	5.39	5.21
12	6.06	46.5	19.0	37.1	8.67	28.7	80.5	100.	15.1	5.39	5.08	5.12
13	7.15	42.2	16.1	25.3	7.65	22.4	83.8	85.3	14.1	5.39	4.87	5.26
14	8.60	35.9	13.9	19.3	6.81	20.1	72.3	79.0	13.0	5.39	4.62	6.33
15	11.5	34.6	11.9	15.6	6.33	25.4	60.3	75.7	12.3	5.39	4.62	8.46
16	13.5	34.9	10.7	13.1	6.09	43.0	63.1	56.1	10.1	5.35	4.62	8.72
17	13.3	31.8	10.7	11.9	6.14	43.0	72.1	44.2	9.88	5.12	4.62	7.35
18	25.6	27.3	10.5	10.4	6.00	39.8	82.0	39.0	9.88	5.12	4.62	7.66
19	26.6	26.7	12.4	9.45	6.57	33.8	88.5	39.4	10.0	5.12	4.62	9.77
20	21.8	25.9	12.1	8.62	6.67	39.3	80.1	35.2	11.7	5.12	4.62	13.4
21	17.5	31.8	13.6	8.32	6.76	50.8	85.5	33.0	12.9	5.12	4.54	13.2
22	15.6	44.1	15.2	6.81	8.85	58.5	114.	36.0	13.8	6.06	4.37	13.6
23	20.5	48.9	17.6	7.00	11.1	56.4	124.	29.5	11.9	7.26	4.37	16.9
24	27.2	50.2	17.0	6.86	10.0	66.7	128.	30.0	10.1	8.93	4.37	20.2
25	50.2	54.4	15.4	7.53	8.72	72.6	128.	30.1	8.88	8.77	4.37	16.6
26	55.8	67.8	17.2	11.7	10.2	58.5	107.	24.9	8.10	8.87	4.37	14.3
27	45.4	63.5	21.1	10.2	15.1	81.9	74.2	23.3	7.80	8.01	4.45	11.6
28	39.8	55.8	21.7	9.67	15.5	119.	74.3	19.5	7.30	7.60	4.62	8.67
29		54.5	22.2	9.45	16.5	106.	79.7	20.4	7.10	6.57	4.62	7.55
30		48.5	26.4	8.67	13.1	87.4	86.4	19.4	6.96	6.47	4.62	6.81
31		39.9		8.26		98.5	79.4		6.76		4.82	8.01
AVE	17.7	40.5	19.2	22.3	9.39	43.2	89.3	50.2	14.0	6.62	4.97	8.50

MEAN ANNUAL DISCHARGE 27.3 M3/S

STATION : ETHIOPIA WABI SHEBELLE WABI SHEBELLE MALKA-WAKANA

NUMBER : 13280127

AVERAGE DAILY DISCHARGES 1970-1971 (M3/S)

	FEBR	MARC	APRI	MAY	JUNE	JULY	AUGU	SEPT	OCTO	NOVE	DECE	JANU
1	7.70	7.05	19.1	14.1	6.33	8.31	53.8	91.8	52.2	35.5	5.12	4.37
2	7.40	10.6	14.9	16.2	6.09	11.3	71.5	97.0	44.2	27.3	5.12	6.23
3	6.05	10.1	14.6	18.1	5.76	9.51	64.0	88.4	36.2	23.8	5.12	5.67
4	5.30	9.67	22.2	23.0	5.67	10.6	48.8	83.7	29.2	20.5	5.12	5.95
5	4.95	18.3	21.7	30.6	5.62	16.0	49.9	75.5	26.4	18.2	5.12	5.95
6	4.66	19.4	21.1	35.8	5.58	20.2	41.8	71.6	49.3	16.0	5.12	5.67
7	4.87	21.8	17.9	35.2	5.95	22.7	38.8	74.5	54.3	13.6	5.12	5.39
8	4.87	27.6	15.8	31.6	6.33	16.3	51.1	94.2	51.6	11.8	4.87	5.12
9	4.87	22.6	21.0	21.6	6.00	14.9	74.5	82.9	51.2	11.1	4.87	4.62
10	4.62	20.0	20.0	16.4	7.56	15.4	86.0	84.3	48.7	10.2	4.62	4.37
11	4.62	19.9	19.3	13.3	8.78	15.2	98.8	77.6	48.2	9.30	4.62	4.62
12	4.62	21.1	22.0	12.9	6.62	17.3	124.	98.7	39.3	8.82	4.62	4.37
13	4.62	24.7	24.1	26.5	5.90	22.3	122.	106.	34.6	8.61	4.62	4.37
14	4.62	26.9	36.6	28.4	6.09	29.3	121.	94.3	29.2	8.31	4.62	4.37
15	4.54	37.7	33.2	21.0	5.76	38.3	110.	77.5	23.5	7.75	4.62	4.13
16	4.17	71.6	48.6	14.3	6.09	31.0	111.	66.9	19.6	7.40	4.62	4.13
17	4.13	85.8	60.4	12.4	6.33	35.7	122.	56.3	18.9	7.10	4.62	4.13
18	4.02	73.3	49.1	15.9	6.81	48.3	123.	63.4	22.6	6.81	4.62	4.13
19	3.90	56.2	40.0	14.3	7.10	46.0	137.	80.4	19.6	6.81	4.62	4.37
20	3.90	38.7	39.4	12.0	8.00	41.3	147.	87.7	20.7	6.81	4.37	4.13
21	3.90	28.4	44.5	10.4	7.45	32.1	144.	83.8	23.2	6.23	4.37	4.37
22	4.69	24.0	54.9	8.72	6.62	34.4	127.	59.2	24.8	6.23	4.37	4.37
23	6.43	20.9	42.1	9.36	6.86	39.1	126.	51.4	22.5	5.95	4.37	4.37
24	5.91	20.1	32.3	7.50	7.00	42.2	98.3	49.2	21.6	5.95	4.13	4.62
25	6.59	23.5	48.0	7.50	6.81	36.9	101.	41.4	22.2	5.67	4.13	4.13
26	6.87	28.1	53.7	8.98	6.91	37.1	113.	45.4	24.0	5.39	4.13	4.13
27	5.67	30.4	34.5	8.26	7.35	37.3	127.	58.3	30.2	5.39	4.13	3.90
28	5.90	37.0	24.5	7.70	6.86	37.0	146.	60.6	39.8	5.39	4.13	4.37
29		29.3	19.6	9.21	7.15	38.2	154.	69.5	46.6	5.39	4.13	4.62
30		23.3	15.3	9.09	7.40	40.5	90.3	53.2	48.6	5.39	4.37	4.62
31		20.6		7.25		45.2	70.3		46.4		4.37	4.37
AVE	5.16	29.3	31.0	16.4	6.63	28.7	99.8	74.2	34.5	10.8	4.61	4.65

MEAN ANNUAL DISCHARGE 29.0 M3/S

STATION : ETHIOPIA WABI SHEBELLE WABI SHEBELLE MALKA-WAKANA

NUMBER : 13280127

AVERAGE DAILY DISCHARGES 1971-1972 (M3/S)

	FEBR	MARC	APRI	MAY	JUNE	JULY	AUGU	SEPT	OCTO	NOVE	DECE	JANU
1	4.37	3.01	7.00	5.12	15.2	32.0	65.6	64.7	65.4	12.5	12.9	7.70
2	5.67	3.23	6.05	5.12	14.4	35.6	56.1	72.5	70.8	11.8	13.6	6.81
3	7.10	3.23	5.86	5.17	15.4	39.1	46.7	95.7	75.3	11.6	9.46	7.40
4	6.52	3.23	6.38	7.82	12.5	46.4	50.2	95.6	79.3	11.6	8.21	8.00
5	5.95	3.23	6.14	13.2	11.2	40.9	76.0	97.9	105.	13.5	7.62	7.70
6	5.12	3.01	6.97	22.8	12.3	43.7	105.	72.5	140.	14.1	7.25	6.81
7	4.62	3.23	10.0	34.3	13.6	42.7	97.3	71.2	114.	10.8	6.81	7.10
8	4.37	3.23	12.8	45.5	17.6	48.4	101.	73.2	93.9	9.24	6.52	6.23
9	4.13	3.23	16.7	46.0	24.2	55.7	81.9	63.9	79.5	10.1	6.23	5.67
10	3.90	3.23	16.8	34.7	28.3	59.9	77.3	60.7	64.9	9.67	5.95	5.39
11	3.90	3.23	18.4	28.2	22.2	59.9	70.8	47.2	52.0	8.72	5.67	5.39
12	3.90	3.45	17.7	30.9	19.2	58.3	65.5	45.7	41.7	8.36	5.67	5.12
13	3.67	3.45	20.8	33.9	15.3	65.7	84.3	47.0	34.6	9.67	5.67	5.12
14	3.67	3.67	21.0	26.1	15.6	68.5	104.	52.2	31.5	12.3	5.67	4.87
15	3.67	4.13	23.3	20.0	19.5	60.1	106.	43.2	31.2	25.1	5.39	4.62
16	3.45	4.62	24.1	17.7	23.0	58.0	101.	35.2	31.5	27.4	5.12	4.62
17	3.45	5.82	31.1	14.8	26.2	42.7	98.3	32.2	27.9	21.2	5.12	4.62
18	3.45	6.29	21.4	21.1	28.6	55.7	95.7	28.7	23.5	15.5	4.87	4.62
19	3.45	5.05	18.9	21.4	33.1	95.8	104.	28.1	20.0	12.6	5.39	4.62
20	3.45	4.22	16.7	17.5	36.5	92.5	103.	28.7	23.1	11.8	5.39	4.62
21	3.23	3.67	15.0	17.0	37.7	64.5	101.	29.7	26.9	10.5	5.39	4.62
22	3.23	3.56	11.5	16.2	40.5	57.3	100.	32.2	27.2	11.4	5.67	4.62
23	3.23	3.90	9.30	16.4	39.9	62.3	103.	37.3	25.4	11.5	6.67	5.12
24	3.23	4.62	7.80	24.7	44.6	64.5	99.2	44.9	27.7	11.0	7.10	5.12
25	3.23	5.53	6.76	27.2	44.6	62.7	102.	42.0	27.0	10.6	6.52	5.12
26	3.23	6.00	6.09	24.5	39.7	51.2	98.9	36.7	26.3	9.78	9.00	5.12
27	3.23	7.45	5.95	28.5	32.7	48.3	101.	40.5	26.8	9.03	9.35	4.87
28	3.01	6.38	6.09	27.9	32.3	54.7	96.4	45.4	23.4	8.61	8.46	4.87
29		7.60	5.81	25.5	30.4	71.1	113.	49.4	19.4	10.0	10.1	4.62
30		7.40	5.40	26.0	30.4	74.3	107.	55.9	16.2	10.8	9.94	4.37
31		9.10		19.8		69.2	84.2		13.8		8.51	4.37
AVE	4.05	4.55	12.9	22.7	25.9	57.5	90.2	52.3	47.3	12.4	7.27	5.48

MEAN ANNUAL DISCHARGE 28.8 M3/S

STATION : ETHIOPIA WABI SHEBELLE WABI SHEBELLE MALKA-WAKANA

NUMBER : 13280127

AVERAGE DAILY DISCHARGES 1972-1973 (M3/S)

	FEBR	MARC	APRI	MAY	JUNE	JULY	AUGU	SEPT	OCTO	NOVE	DECE	JANU
1	4.37	21.7	7.30	39.7	14.0	16.1	43.1	31.1	12.5	12.8	5.39	4.50
2	4.62	18.3	6.71	29.1	13.1	20.4	42.7	40.7	12.1	9.72	5.12	4.37
3	5.82	13.9	6.42	24.5	8.77	23.5	52.1	64.1	11.2	8.77	5.12	4.37
4	7.11	11.9	7.59	52.3	7.55	27.2	55.3	71.0	13.0	9.10	5.12	4.62
5	7.55	10.1	11.7	59.9	7.25	41.0	63.5	66.6	12.6	8.77	5.12	4.87
6	8.51	9.04	18.4	36.3	6.81	36.2	72.6	65.0	13.8	8.15	4.87	4.62
7	8.26	7.35	19.4	26.1	6.52	30.8	87.1	68.6	13.6	8.15	4.87	4.62
8	10.3	6.52	24.8	20.2	6.24	29.3	87.3	61.1	11.9	8.00	4.87	4.74
9	15.8	6.33	35.3	16.1	7.28	29.6	66.8	58.6	10.5	7.55	4.87	4.62
10	23.6	6.05	26.4	13.4	8.93	38.7	68.3	54.6	10.4	6.96	4.87	5.01
11	22.7	5.86	21.8	11.0	9.40	42.8	55.7	56.0	10.2	6.81	4.87	4.38
12	24.2	6.82	37.7	9.56	8.31	44.4	46.9	49.5	9.09	6.52	4.62	4.25
13	38.8	10.4	80.6	8.62	6.96	49.3	37.1	50.1	8.46	6.52	4.62	4.37
14	26.2	10.4	102.	8.00	6.09	48.6	31.6	45.1	8.15	6.52	4.62	4.37
15	17.0	9.92	86.3	7.55	5.81	54.2	29.1	47.8	7.70	6.38	4.62	4.37
16	13.6	13.4	66.0	7.10	5.81	56.1	39.2	38.1	7.70	6.23	4.62	4.37
17	9.78	14.2	54.1	6.66	7.55	59.9	62.6	37.6	8.00	6.38	4.62	4.37
18	8.16	20.7	56.8	6.52	7.40	58.3	85.6	35.9	7.70	6.96	4.62	4.37
19	7.05	25.8	66.8	8.62	6.96	55.7	96.9	28.2	7.70	7.25	4.62	4.37
20	6.38	35.8	66.2	14.4	6.66	44.7	72.8	26.3	6.81	7.25	4.62	4.37
21	5.95	27.9	56.0	20.2	7.70	38.0	61.0	32.4	7.25	7.55	4.62	4.37
22	5.86	26.7	43.7	22.1	8.93	37.7	65.9	36.8	7.40	10.7	4.62	4.37
23	7.95	23.4	42.0	27.6	8.31	37.4	63.5	36.0	6.81	11.1	4.62	4.37
24	10.4	18.5	36.5	25.8	9.24	34.3	59.5	38.7	6.81	10.2	4.62	4.37
25	9.45	18.0	40.0	19.5	9.56	35.5	53.9	44.2	6.52	7.55	4.62	4.37
26	12.3	18.5	43.7	13.8	10.0	44.4	49.3	32.5	6.45	6.81	4.62	4.13
27	15.9	16.4	64.6	12.1	11.4	43.7	36.8	23.3	6.23	6.66	4.62	3.90
28	21.9	14.8	75.9	10.2	12.6	38.0	32.5	18.6	6.23	6.23	4.62	3.90
29	26.0	11.6	55.7	9.40	15.5	34.6	29.3	15.4	6.09	5.95	4.62	3.67
30		9.62	50.6	8.61	18.8	31.6	37.1	13.8	9.96	5.67	4.62	3.67
31		8.21		11.6		32.5	36.8		14.3		4.87	3.67
AVE	13.3	14.8	43.7	18.9	8.98	39.2	55.5	42.9	9.27	7.77	4.76	4.35

MEAN ANNUAL DISCHARGE 22.0 M3/S

STATION : ETHIOPIA WABI SHEBELLE WABI SHEBELLE LEGE HIDA

NUMBER : 13280124

AVERAGE DAILY DISCHARGES 1968-1969 (M3/S)

	FEBR	MARC	APRI	MAY	JUNE	JULY	AUGU	SEPT	OCTO	NOVE	DECE	JANU
1												15.9
2												
3			44.8									
4												
5												
6												
7												
8												
9						115.						
10												
11												
12												
13												
14												15.9
15												
16												16.6
17												
18												
19												
20												
21												
22												
23												
24												
25												
26												
27												
28										85.1		
29												
30												
31											15.9	
AVE												

STATION : ETHIOPIA WABI SHEBELLE WABI SHEBELLE LEGE HIDA

NUMBER : 13280124

AVERAGE DAILY DISCHARGES 1969-1970 (M3/S)

	FEBR	MARC	APRI	MAY	JUNE	JULY	AUGU	SEPT	OCTC	NOVE	DECE	JANU
1		275.										8.23
2		149.										
3												
4												
5												
6												
7		276.										
8		143.										
9		201.										7.36
10		175.										
11		141.										
12		205.										
13												
14					12.2							
15												
16												
17	203.											
18	194.											
19	188.											
20												
21												
22												
23												
24												
25	139.											
26	217.	113.										
27	331.	184.										
28	282.	139.										
29												
30												
31											8.23	
AVE												

STATION : ETHIOPIA WABI SHEBELLE WABI SHEBELLE LEGE HIDA

NUMBER : 13280124

AVERAGE DAILY DISCHARGES 1970-1971 (M3/S)

	FEBR	MARC	APRI	MAY	JUNE	JULY	AUGU	SEPT	OCTC	NOVE	DECE	JANU
1			50.3	56.5	21.3	14.0	160.	193.	113.	102.	11.2	8.23
2			48.0	55.8	18.2	14.5	165.	262.	100.	83.9	11.2	8.23
3			40.6	83.8	16.6	15.3	156.	267.	83.7	66.2	11.2	8.69
4			35.5	78.6	15.5	19.3	166.	193.	73.3	50.6	11.2	9.18
5			49.3	104.	15.2	26.8	309.	162.	72.1	47.8	10.7	9.18
6			54.7	146.	14.2	24.3	265.	173.	71.5	41.9	10.7	10.2
7			49.7	131.	14.0	29.8	209.	161.	140.	36.5	10.2	9.18
8			47.6	106.	13.4	31.7	236.	174.	162.	32.5	10.2	9.18
9		275.	57.6	90.5	13.9	33.4	224.	190.	143.	29.7	9.68	8.23
10		173.	56.7	71.0	20.3	34.9	249.	172.	129.	27.0	9.68	8.23
11		131.	59.2	56.7	17.6	32.8	295.	166.	122.	24.9	9.68	7.79
12			61.8	50.1	17.5	31.2	330.	154.	103.	23.3	9.68	7.79
13			69.9	49.3	18.8	32.8	328.	205.	90.6	22.5	9.68	7.79
14		50.5	99.0	63.4	16.6	35.2	372.	194.	78.1	20.7	9.68	7.36
15		458.	134.	68.1	15.9	49.4	334.	195.	70.0	19.9	9.18	7.36
16		559.	267.	57.0	16.7	99.9	347.	173.	58.2	18.8	9.18	7.36
17		572.	204.	43.7	14.8	91.9	527.	128.	60.4	17.3	8.69	6.95
18		430.	184.	37.4	21.0	102.	429.	112.	59.7	16.6	8.69	6.95
19		227.	153.	35.8	17.8	160.	348.	162.	59.0	15.9	8.69	6.95
20		132.	122.	36.3	17.3	149.	375.	158.	64.0	15.3	8.23	7.79
21			113.	32.3	15.9	125.	425.	147.	58.3	15.3	8.23	7.79
22		103.	122.	29.3	15.9	105.	427.	132.	56.2	14.6	8.23	7.36
23		86.4	102.	27.0	15.4	103.	328.	170.	54.9	14.0	8.23	7.36
24		76.2	90.0	24.3	14.1	113.	274.	133.	54.2	13.4	8.23	7.36
25		64.7	80.8	24.0	13.7	129.	204.	111.	50.6	13.4	8.23	7.36
26		59.4	82.6	21.1	13.4	189.	203.	114.	91.7	12.8	7.79	7.36
27		73.1	108.	20.8	13.7	174.	242.	146.	111.	12.2	7.79	7.79
28		86.6	98.1	22.4	14.0	147.	279.	195.	103.	12.2	7.79	8.23
29		79.2	82.0	22.5	15.7	138.	265.	173.	98.5	11.7	7.79	8.69
30		71.3	68.1	21.3	14.3	154.	245.	132.	125.	11.7	7.79	8.23
31		59.9		22.5		165.	169.		112.		7.79	7.79
AVE			93.0	54.5	16.1	82.9	287.	168.	89.5	28.1	9.20	8.00

STATION : ETHIOPIA WABI SHEBELLE WABI SHEBELLE LEGE HIDA

NUMBER : 13280124

AVERAGE DAILY DISCHARGES 1971-1972 (M3/S)

	FEBR	MARC	APRI	MAY	JUNE	JULY	AUGU	SEPT	OCTO	NOVE	DECE	JANU
1	7.79	5.21	14.7	20.0	34.5	67.7	128.	135.	71.5	34.9	23.3	15.0
2	7.36	5.21	15.1	18.2	48.1	65.4	111.	133.	80.6	30.6	23.3	13.6
3	7.36	5.21	24.7	16.0	27.4	118.	96.3	132.	85.8	27.0	24.9	12.6
4	7.36	5.21	15.5	20.6	25.7	116.	81.3	171.	98.9	26.5	24.9	11.2
5	9.18	5.21	26.3	36.6	25.3	121.	142.	172.	139.	24.9	20.7	10.9
6	10.2	5.21	18.5	62.2	24.9	116.	161.	173.	201.	22.5	17.7	11.7
7	9.68	5.21	74.6	76.5	26.0	97.0	211.	127.	212.	24.1	16.6	11.4
8	9.18	5.21	48.8	103.	24.5	95.5	150.	132.	175.	22.1	15.9	10.2
9	8.23	5.21	38.1	127.	30.1	94.1	145.	132.	141.	21.8	14.3	10.2
10	7.79	5.21	75.0	125.	36.0	138.	128.	130.	123.	22.5	13.4	9.60
11	7.36	5.21	86.3	113.	37.0	124.	122.	119.	105.	22.5	13.4	9.20
12	6.57	5.21	92.3	82.4	35.5	120.	135.	104.	86.5	27.8	12.8	8.70
13	6.57	5.21	173.	64.4	30.6	105.	119.	99.2	72.1	29.6	12.2	8.20
14	6.57	5.21	109.	63.7	26.1	108.	148.	92.7	63.2	71.5	11.4	8.20
15	6.57	5.21	96.9	53.8	48.7	130.	183.	89.2	58.9	159.	11.2	8.00
16	6.20	5.52	71.5	42.8	62.4	112.	195.	81.9	60.3	239.	11.2	7.80
17	6.20	5.94	64.3	42.0	76.9	98.5	176.	74.4	60.3	186.	10.7	7.80
18	5.85	6.57	67.0	55.8	133.	105.	208.	67.7	52.9	109.	10.2	7.80
19	5.85	7.28	52.6	47.5	88.0	123.	224.	64.7	49.0	90.6	10.2	8.20
20	5.85	9.31	46.0	48.1	76.3	175.	202.	61.1	41.9	84.5	9.94	7.60
21	5.85	8.70	40.5	40.8	76.2	144.	170.	60.3	43.0	52.2	9.68	7.40
22	5.85	7.48	34.7	34.8	81.3	113.	221.	61.1	46.6	39.1	9.68	7.00
23	5.85	9.32	28.7	37.3	83.3	101.	195.	61.1	47.2	38.1	9.43	7.00
24	5.85	12.0	24.3	46.6	84.5	102.	170.	63.2	44.2	37.0	9.18	7.00
25	5.85	82.8	20.8	56.9	97.8	98.5	125.	67.7	48.4	33.0	9.43	7.20
26	5.85	23.8	17.9	57.6	97.0	104.	155.	69.2	69.2	30.1	10.4	7.40
27	5.52	48.8	16.5	60.8	96.3	95.6	181.	69.2	69.2	27.4	12.0	7.40
28	5.52	24.7	14.2	51.9	72.1	89.9	179.	64.7	66.9	27.4	14.0	6.80
29		17.9	12.7	48.4	79.3	135.	178.	59.0	64.7	21.8	17.0	6.30
30		18.6	12.7	43.1	70.7	183.	161.	68.5	50.3	21.8	14.6	7.00
31		17.2		42.1		143.	155.		39.2		15.3	7.40
AVE	6.92	12.4	47.8	56.1	58.5	114.	160.	97.8	82.8	53.5	14.2	8.90

MEAN ANNUAL DISCHARGE 59.8 M3/S

STATION : ETHIOPIA   WABI SHEBELLE WABI SHEBELLE   HAMERO HEDAD

NUMBER : 13280115

AVERAGE DAILY DISCHARGES   1968-1969 (M3/S)

	FEBR	MARC	APRI	MAY	JUNE	JULY	AUGU	SEPT	OCTO	NOVE	DECE	JANU
1		149.	34.9	404.	96.5	124.	250.	166.	136.	42.3	74.9	31.6
2		205.	30.8	509.	98.4	115.	249.	150.	177.	39.5	65.3	31.0
3		198.	32.8	430.	122.	110.	235.	136.	162.	37.5	58.8	29.8
4		171.	34.9	343.	118.	103.	214.	126.	147.	35.5	53.3	29.2
5		147.	44.9	293.	200.	101.	234.	120.	148.	33.5	50.3	28.6
6		128.	117.	267.	175.	104.	199.	136.	140.	32.0	48.5	28.0
7		110.	164.	249.	178.	108.	196.	137.	161.	30.7	53.3	30.4
8		95.3	196.	216.	166.	150.	192.	135.	183.	29.2	50.7	32.3
9		83.9	255.	190.	151.	149.	202.	151.	177.	28.6	47.3	34.8
10		79.1	334.	175.	146.	148.	211.	170.	155.	28.0	45.1	34.2
11	32.9	82.4	521.	181.	136.	158.	225.	184.	130.	27.1	41.6	32.9
12	30.7	117.	503.	158.	123.	157.	240.	175.	111.	26.0	38.8	31.6
13	32.0	144.	490.	146.	112.	142.	242.	170.	96.5	25.7	36.5	31.6
14	30.7	130.	479.	141.	112.	126.	266.	175.	84.8	25.7	34.8	29.2
15	29.8	104.	374.	143.	112.	122.	287.	193.	77.1	25.4	33.2	28.0
16	31.7	82.3	416.	150.	121.	118.	297.	230.	69.9	27.1	32.0	26.8
17	31.0	68.1	472.	158.	105.	120.	314.	241.	65.1	39.3	30.7	27.1
18	29.3	58.1	418.	161.	100.	148.	320.	212.	62.3	33.3	30.1	28.0
19	29.7	50.5	422.	150.	96.3	150.	281.	205.	62.3	52.6	28.6	26.8
20	29.7	44.2	524.	137.	94.2	132.	284.	206.	68.0	59.3	27.1	26.0
21	33.7	39.3	765.	144.	96.8	127.	296.	213.	73.6	61.8	26.6	25.4
22	38.9	35.4	686.	141.	99.3	118.	312.	181.	79.0	217.	25.7	25.7
23	53.8	35.3	508.	127.	97.5	123.	301.	166.	69.5	193.	25.4	25.7
24	58.7	32.9	494.	124.	91.8	117.	243.	153.	64.5	168.	24.8	24.8
25	53.7	32.5	457.	144.	88.1	139.	212.	137.	63.0	141.	24.5	24.5
26	101.	32.6	547.	135.	85.0	137.	193.	127.	69.5	119.	24.3	24.5
27	129.	40.4	513.	123.	96.5	153.	208.	118.	70.7	102.	23.4	24.3
28	133.	45.5	479.	118.	110.	149.	205.	136.	59.9	107.	23.7	27.7
29	155.	47.5	405.	112.	108.	169.	217.	131.	54.6	104.	24.3	34.5
30		45.3	409.	108.	121.	189.	200.	128.	49.8	91.2	28.4	31.2
31		39.0		102.		202.	184.		46.0		31.4	34.4
AVE	47.1	86.2	371.	193.	119.	136.	242.	164.	100.	66.1	37.5	29.1

MEAN ANNUAL DISCHARGE   133.   M3/S

STATION : ETHIOPIA WABI SHEBELLE WABI SHEBELLE HAMERO HEDAD

NUMBER : 13280115

AVERAGE DAILY DISCHARGES 1969 1970 (M3/S)

	FEBR	MARC	APRI	MAY	JUNE	JULY	AUGU	SEPT	OCTO	NOVE	DECE	JANU
1	36.4	359.	166.	258.	48.8	87.7	196.	219.	76.7	76.4	20.6	11.5
2	41.0	368.	141.	431.	48.8	79.9	220.	209.	64.1	123.	20.0	11.5
3	40.9	243.	117.	540.	48.1	73.1	311.	174.	64.2	44.6	19.5	11.5
4	40.8	167.	99.0	327.	47.3	68.2	279.	145.	61.8	38.0	17.9	11.5
5	35.6	132.	82.5	257.	46.6	67.7	263.	141.	66.3	34.5	17.3	11.5
6	31.8	114.	72.7	233.	46.6	71.0	269.	133.	63.8	33.2	17.3	11.5
7	30.1	111.	70.9	254.	45.9	126.	262.	142.	62.2	32.0	16.8	11.5
8	28.0	134.	88.4	206.	45.1	115.	250.	162.	68.1	30.7	16.3	11.1
9	25.8	221.	109.	171.	44.4	104.	231.	210.	71.4	30.4	15.7	11.1
10	24.1	267.	239.	188.	43.7	93.0	236.	208.	70.3	29.8	15.7	11.1
11	22.8	267.	179.	189.	43.0	86.5	264.	212.	63.7	29.2	15.2	11.1
12	21.7	242.	157.	223.	41.6	79.9	279.	267.	57.6	28.6	14.6	11.1
13	20.7	300.	141.	225.	41.6	75.4	248.	241.	53.3	28.3	14.6	11.1
14	20.0	201.	121.	162.	40.9	71.0	238.	208.	48.5	28.0	14.1	13.5
15	19.5	165.	110.	134.	40.2	75.9	197.	226.	45.1	27.4	13.5	25.4
16	20.9	139.	93.3	132.	38.8	79.2	184.	264.	42.6	26.8	13.5	19.7
17	60.0	123.	78.9	118.	37.1	92.1	168.	205.	40.9	26.8	13.5	20.1
18	212.	123.	69.0	106.	36.5	86.8	216.	173.	38.1	26.3	13.0	19.5
19	275.	109.	62.0	89.0	35.5	97.6	250.	174.	36.8	26.3	13.0	20.0
20	283.	94.3	59.7	80.0	34.8	92.0	250.	147.	36.8	25.7	13.0	21.2
21	182.	82.2	55.4	71.6	33.2	93.4	232.	126.	35.5	25.1	12.5	26.2
22	159.	81.9	55.3	64.7	32.3	104.	201.	115.	33.5	25.1	12.5	23.8
23	139.	120.	63.1	61.0	31.6	130.	167.	105.	32.9	24.5	12.5	53.8
24	128.	137.	73.0	58.8	31.6	155.	226.	99.8	32.9	24.0	12.5	55.0
25	118.	154.	81.7	57.2	33.5	240.	280.	95.3	32.3	23.4	12.0	57.0
26	178.	161.	93.0	55.6	56.4	214.	273.	85.5	32.9	22.8	12.0	55.6
27	286.	216.	107.	54.7	64.9	210.	269.	83.6	30.4	22.3	12.0	57.9
28	386.	301.	105.	53.3	77.5	193.	274.	78.3	28.0	21.7	12.0	56.1
29		257.	179.	51.8	83.5	188.	237.	70.3	27.4	21.7	11.5	50.1
30		217.	185.	50.5	88.4	222.	262.	67.2	26.3	21.2	11.5	43.7
31		194.		49.8		206.	210.		25.7		11.5	37.8
AVE	102.	187.	108.	160.	46.3	119.	240.	160.	47.4	32.6	14.5	25.9

MEAN ANNUAL DISCHARGE 104. M3/S

STATION : ETHIOPIA WABI SHEBELLE WABI SHEBELLE HAMERO HEDAD

NUMBER : 13280115

AVERAGE DAILY DISCHARGES 1970-1971 (M3/S)

	FEBR	MARC	APRI	MAY	JUNE	JULY	AUGU	SEPT	OCTO	NOVE	DECE	JANU
1	32.8	37.4	83.4	91.9		17.6	167.	213.	218.	142.	21.2	13.5
2	29.7	33.5	72.9	109.		18.6	168.	219.	181.	128.	20.6	13.5
3	27.7	61.3	64.8	79.7		17.5	172.	282.	161.	109.	20.6	13.0
4	27.4	46.2	62.6	127.		18.0	167.	301.	147.	92.2	20.0	13.0
5	26.9	37.1	59.0	125.		18.7	169.	235.	127.	79.7	20.0	13.5
6	24.9	64.8	56.7	150.	21.2	20.1	298.	206.	110.	71.7	19.5	13.5
7	23.8	113.	62.7	192.	20.0	26.8	285.	212.	102.	65.1	19.5	14.6
8	21.8	98.1	63.3	164.		27.6	252.	209.	146.	59.2	19.5	14.6
9	20.4	82.6	58.2	143.		29.6	248.	220.	187.	54.0	19.0	15.2
10	19.3	139.	58.6	121.		32.9	250.	251.	178.	49.8	18.4	14.6
11	18.5	130.	74.1	95.1		36.5	280.	270.	164.	45.9	18.4	14.1
12	17.4	101.	71.3	77.6		37.5	318.	281.	180.	42.4	18.4	13.5
13	16.5	100.	80.2	77.4		36.9	358.	284.	147.	39.3	17.9	13.0
14	16.0	102.	87.5	72.4	24.0	34.2	350.	288.	126.	37.2	17.9	12.5
15	15.7	278.	111.	68.6	24.5	37.6	396.	276.	106.	36.0	17.3	12.5
16	15.2	488.	186.	79.3	26.0	40.8	343.	258.	95.1	34.5	17.3	12.5
17	14.9	677.	330.	75.7	23.2	68.7	354.	249.	119.	33.1	16.8	12.5
18	14.6	647.	248.	63.7	22.2	101.	535.	193.	99.2	31.9	16.8	12.5
19	14.6	551.	206.	57.6	22.0	92.0	447.	165.	99.7	30.8	16.8	12.5
20	13.8	360.	179.	50.5	22.6	139.	366.	193.	110.	29.6	16.3	12.5
21	13.5	246.	168.	51.5	24.4	151.	462.	222.	94.3	28.9	16.3	12.5
22	13.5	185.	142.	64.5	22.9	132.	550.	208.	96.3	28.1	15.7	12.0
23	13.5	147.	144.	51.2	21.7	115.	503.	192.	87.3	27.4	15.7	12.0
24	13.5	122.	132.		20.8	107.	388.	212.	85.6	26.5	15.2	12.0
25	13.5	105.	181.		20.6	110.	324.	218.	85.3	25.7	15.2	12.0
26	13.5	93.9	136.		20.0	127.	260.	177.	99.5	24.9	15.2	12.0
27	13.5	88.6	117.		18.5	194.	247.	164.	129.	23.9	14.6	12.0
28	14.5	90.2	125.		17.9	178.	278.	168.	176.	23.0	14.6	12.0
29		106.	124.		17.3	160.	315.	228.	137.	22.2	14.1	12.0
30		101.	108.		17.3	143.	305.	246.	127.	21.6	14.1	12.5
31		95.4				169.	279.		157.		13.5	12.5
AVE	18.6	178.	120.	81.3	22.6	78.7	317.	228.	132.	48.8	17.3	12.9

MEAN ANNUAL DISCHARGE 105. M3/S

STATION : ETHIOPIA WABI SHEBELLE WABI SHEBELLE HAMERO HEDAD

NUMBER : 13280115

AVERAGE DAILY DISCHARGES 1971-1972 (M3/S)

	FEBR	MARC	APRI	MAY	JUNE	JULY	AUGU	SEPT	OCTO	NOVE	DECE	JANU
1	12.0	8.62	24.5			77.4	169.	226.	83.7	56.6	33.2	22.3
2	12.0	8.62	29.2			68.8	145.	186.	89.9	49.8	32.0	22.3
3	12.0	8.26	31.8			66.8	131.	174.	96.6	44.8	31.6	22.3
4	12.0	8.26	27.8			68.3	115.	195.	107.	41.0	31.6	22.3
5	11.5	8.26	33.3			73.7	102.	227.	113.	37.5	31.6	21.7
6	11.5	8.26	27.4			81.4	111.	231.	159.	35.1	31.6	21.7
7	11.5	8.26	39.9			116.	219.	237.	219.	34.5	30.4	21.2
8	12.5	7.92	47.9			145.	252.	225.	219.	33.6	26.0	21.2
9	13.0	7.92	98.4			120.	203.	198.	76.5	32.9	22.6	20.6
10	12.5	7.92	85.0			100.	180.	215.	163.	31.9	22.3	20.0
11	12.0	7.92	89.7			110.	178.	227.	148.	36.4	22.3	19.5
12	11.5	7.92	114.			144.	172.	215.	135.	42.8	22.3	19.5
13	11.1	7.59	128.		42.3	137.	179.	190.	117.	39.6	22.6	19.5
14	11.1	7.59	193.		42.3	132.	169.	163.	99.3	43.1	22.6	19.5
15	10.6	7.59	137.		45.4	127.	165.	154.	92.1	67.0	22.3	19.5
16	10.6	7.59	114.		54.3	154.	209.	145.	76.3	274.	22.3	19.0
17	10.2	7.59	105.		82.3	133.	216.	144.	70.9	338.	22.3	19.0
18	10.2	7.92	83.5		108.	114.	203.	129.	74.5	204.	22.3	19.0
19	10.2	8.26	86.3		89.8	106.	249.	114.	80.5	142.	22.8	19.0
20	9.78	8.26	78.0		144.	133.	276.	108.	69.6	110.	22.8	19.0
21	9.78	8.62	64.6		139.	174.	270.	103.	59.9	88.7	22.8	19.0
22	9.78	8.99	64.4		100.	164.	242.	97.4	54.1	73.5	22.8	19.0
23	9.38	9.82	58.1		85.0	130.	300.	93.7	59.5	63.1	22.8	19.0
24	9.38	10.4	55.3		85.4	114.	266.	95.6	78.5	55.0	22.8	19.0
25	9.38	15.7	53.1		95.0	113.	230.	94.4	67.9	49.0	22.8	19.0
26	8.99	53.2	49.7		111.	107.	203.	95.6	61.7	46.6	22.8	19.0
27	8.99	75.8	46.6		115.	116.	209.	99.7	85.4	42.4	22.8	19.0
28	8.62	37.4			118.	109.	258.	93.4	79.7	39.8	22.8	19.0
29		61.2			96.9	99.5	239.	81.9	79.1	37.5	22.8	19.0
30		35.5			102.	147.	210.	80.3	75.2	35.7	22.8	19.0
31		27.3				182.	206.		64.5		22.8	19.0
AVE	10.8	16.3	70.1			118.	202.	155.	98.5	74.2	24.8	19.9

STATION : ETHIOPIA WABI SHEBELLE WABI SHEBELLE IMI

NUMBER : 13280118

AVERAGE DAILY DISCHARGES 1969-1970 (M3/S)

	FEBR	MARC	APRI	MAY	JUNE	JULY	AUGU	SEPT	OCTO	NOVE	DECE	JANU
1		251.	179.	172.	38.6	83.1	185.	199.	65.7	18.3	21.0	12.8
2		275.	154.	312.	38.6	81.3	183.	197.	71.3	150.	19.9	12.6
3		242.	135.	360.	38.6	72.5	220.	186.	62.1	130.	19.7	12.6
4		195.	113.	261.	38.6	64.6	282.	160.	60.2	68.4	18.7	12.6
5		153.	102.	203.	38.6	59.3	239.	137.	60.4	42.2	18.3	12.6
6		126.	92.5	219.	38.6	58.8	240.	131.	67.9	32.0	17.4	12.6
7		118.	83.6	203.	37.2	69.5	249.	123.	76.7	27.6	17.0	12.6
8		122.	78.3	222.	35.4	128.	236.	136.	67.3	26.0	16.7	12.6
9		172.	82.0	175.	34.1	106.	225.	150.	63.0	25.3	16.5	12.4
10		219.	115.	158.	35.0	97.3	225.	195.	71.1	25.8	16.3	12.4
11		257.	200.	219.	33.2	86.5	226.	186.	106.	24.0	16.0	12.4
12		248.	157.	198.	33.4	80.0	250.	194.	73.6	22.7	15.7	12.4
13		267.	145.	216.	33.1	73.0	247.	244.	57.1	21.9	15.5	12.4
14		235.	134.	204.	31.1	68.2	232.	201.	50.8	21.3	15.4	12.4
15		189.	116.	156.	34.0	63.9	215.	188.	46.4	20.3	15.1	12.6
16		163.	108.	150.	31.2	70.2	188.	229.	42.3	19.7	14.9	14.2
17		140.	95.3	192.	28.6	75.2	172.	218.	48.3	19.0	14.8	18.6
18		129.	80.9	182.	26.6	88.7	169.	180.	78.2	18.5	14.6	15.5
19		132.	73.1	108.	24.2	82.7	218.	161.	79.2	18.5	14.6	15.8
20		114.	66.1	91.4	22.7	95.5	225.	159.	38.9	18.1	14.6	17.6
21		103.	61.2	76.7	22.8	87.4	223.	135.	31.8	19.1	14.4	16.9
22		94.1	58.6	70.4	22.8	92.4	207.	121.	28.4	19.8	14.2	19.5
23		95.3	56.6	61.8	21.4	101.	177.	111.	26.6	18.4	14.2	23.8
24		160.	57.1	53.5	21.0	133.	174.	103.	24.8	17.8	14.0	78.1
25		169.	66.1	48.0	20.6	165.	227.	98.3	24.7	17.6	14.0	64.8
26		192.	78.3	43.7	21.1	225.	254.	93.2	25.9	19.3	14.0	54.4
27		157.	91.9	41.8	61.9	194.	241.	84.3	24.5	20.1	13.8	55.4
28	314.	187.	106.	40.4	72.3	191.	255.	82.2	22.3	22.1	13.4	54.5
29		260.	104.	40.0	72.5	165.	228.	78.3	20.7	21.8	13.0	55.5
30		220.	188.	39.5	78.1	181.	240.	70.2	22.7	21.8	12.8	47.6
31		192.		38.6		205.	219.		18.7		12.8	41.5
AVE		180.	106.	147.	36.2	108.	222.	152.	50.2	31.6	15.6	25.2

STATION : ETHIOPIA WABI SHEBELLE WABI SHEBELLE IMI

NUMBER : 13280118

AVERAGE DAILY DISCHARGES 1970-1971 (M3/S)

	FEBR	MARC	APRI	MAY	JUNE	JULY	AUGU	SEPT	OCTO	NOVE	DECE	JANU
1	35.5	113.	87.3	105.	28.8	15.3	171.	259.	235.	155.	15.3	12.6
2	29.7	160.	75.1	111.	28.9	15.2	180.	198.	210.	135.	15.0	12.6
3	25.8	69.3	64.6	137.	26.2	15.5	166.	290.	171.	128.	15.0	12.4
4	23.3	77.3	116.	130.	28.7	16.0	180.	394.	160.	110.	14.8	12.4
5	22.4	56.8	95.5	216.	25.7	15.6	164.	297.	138.	94.0	14.8	12.4
6	21.8	37.3	73.2	167.	21.1	15.5	214.	229.	122.	80.9	14.6	12.4
7	20.7	66.1	58.5	231.	19.8	15.8	395.	201.	109.	71.4	14.4	12.4
8	19.4	154.	56.3	225.	18.3	18.0	289.	224.	99.7	62.5	14.4	12.4
9	18.4	118.	56.6	235.	17.6	24.1	257.	201.	153.	54.7	14.4	12.8
10	17.0	88.0	52.2	155.	16.9	22.6	303.	264.	178.	48.0	14.2	13.0
11	16.3	168.	60.7	171.	16.5	27.3	407.	312.	167.	42.5	14.2	13.0
12	15.4	122.	73.6	117.	16.2	31.4	363.	272.	158.	37.5	14.0	12.6
13	15.0	100.	80.9	134.	15.9	35.3	422.	380.	171.	34.3	13.8	12.4
14	14.5	98.5	92.7	146.	19.8	35.3	391.	290.	139.	31.2	13.8	12.4
15	14.3	121.	246.	102.	18.8	31.8	394.	359.	122.	28.7	13.6	12.3
16	14.2	271.	247.	78.6	20.3	31.9	430.	287.	113.	26.6	13.4	12.1
17	13.7	466.	276.	85.1	21.3	36.2	386.	311.	105.	24.8	13.4	12.1
18	13.4	627.	311.	84.9	21.5	58.0	491.	226.	303.	23.2	13.0	11.9
19	13.3	594.	263.	76.4	19.1	101.	465.	177.	184.	21.9	13.0	11.9
20	12.8	444.	258.	67.3	19.0	91.8	333.	152.	197.	20.9	13.0	11.9
21	12.8	295.	356.	67.7	18.4	150.	308.	235.	188.	19.9	13.0	11.7
22	12.6	231.	194.	77.6	20.2	147.	385.	207.	152.	18.8	13.0	11.7
23	12.6	170.	144.	85.1	19.8	134.	450.	198.	116.	18.5	12.8	11.7
24	12.4	135.	147.	62.2	18.8	117.	379.	184.	97.2	17.8	12.8	11.7
25	12.3	112.	127.	47.7	17.6	115.	340.	287.	90.2	17.3	12.6	11.7
26	12.4	98.0	241.	39.8	17.1	115.	321.	243.	141.	16.9	12.6	11.9
27	12.4	87.5	207.	33.8	16.7	146.	284.	166.	125.	16.5	12.6	11.7
28	12.4	80.6	120.	40.8	16.2	214.	319.	164.	144.	16.0	12.6	11.9
29		82.3	129.	30.2	15.8	183.	333.	186.	210.	15.7	12.6	11.9
30		99.4	121.	28.6	15.6	156.	369.	267.	143.	15.4	12.6	11.7
31		91.1		28.3		151.	328.		126.		12.6	11.7
AVE	17.0	175.	148.	107.	19.9	73.7	330.	249.	154.	46.8	13.6	12.2

MEAN ANNUAL DISCHARGE 113. M3/S

STATION : ETHIOPIA WABI SHEBELLE WABI SHEBELLE IMI

NUMBER : 13280118

AVERAGE DAILY DISCHARGES 1971-1972 (M3/S)

	FEBR	MARC	APRI	MAY	JUNE	JULY	AUGU	SEPT	OCTO	NOVE	DECE	JANU
1	11.7	10.6	25.9	22.5	65.9	104.	207.	217.	84.0	74.4		
2	11.7	10.4	21.8	28.3	58.9	94.0	181.	208.	85.6	65.4		
3	11.7	10.3	21.9	47.1	58.7	84.2	159.	178.	91.5	57.6		
4	11.6	10.3	29.9	117.	49.2	82.0	149.	177.	97.5	57.1		
5	11.6	10.3	65.9	98.5	57.9	84.5	132.	199.	112.	60.1		
6	11.6	10.3	50.7	513.	38.8	87.2	119.	228.	126.	42.8		
7	11.6	10.3	32.0	168.	32.2	125.	158.	227.	179.	37.7		
8	11.4	10.1	74.7	130.	29.1	140.	250.	230.	227.	35.0		
9	11.6	10.1	56.3	99.0	27.9	117.	238.	213.	262.	32.4		
10	11.9	10.1	120.	159.	27.6	118.	188.	205.	201.	33.2		
11	12.3	9.99	140.	167.	30.9	115.	183.	236.	175.	34.1		
12	12.1	9.99	185.	195.	34.0	138.	182.	229.	162.	30.7		
13	11.9	9.99	303.	151.	41.2	155.	172.	210.	164.	39.1		
14	11.6	9.99	158.	126.	37.4	150.	182.	175.	137.	88.0		
15	11.6	9.99	229.	96.1	38.0	146.	171.	160.	116.	67.9		
16	11.4	9.99	138.	88.4	32.9	140.	177.	155.	107.	75.4		
17	11.2	9.84	139.	106.	82.4	168.	230.	146.	89.3	271.		
18	11.1	9.84	106.	137.	162.	144.	207.	138.	82.9	240.		
19	10.9	9.84	89.6	98.4	111.	128.	220.	123.	90.7	187.		
20	11.1	9.99	90.4	107.	153.	119.	252.	116.	115.	150.		
21	10.9	9.99	81.2	78.3	138.	151.	279.	119.	96.8	122.		
22	10.9	10.1	66.6	80.1	111.	194.	272.	107.	74.9	101.		
23	10.7	10.2	58.0	70.5	96.6	170.	244.	101.	85.6	84.9		
24	10.9	10.7	51.2	69.4	97.8	143.	291.	100.	181.	73.9		
25	10.7	11.0	46.3	73.5	107.	129.	248.	100.	132.	66.1		
26	10.7	68.1	36.7	68.9	107.	129.	209.	97.0	95.8	58.1		
27	10.6	50.8	32.0	82.9	127.	124.	192.	97.0	83.4	54.0		
28	10.6	82.0	27.0	103.	140.	132.	204.	100.	97.7	51.0		
29		37.5	23.4	108.	118.	126.	249.	91.7	90.2	47.1		
30		55.9	21.9	83.7	121.	121.	232.	85.4	89.6	44.2		
31		37.6		72.9		169.	192.		85.1		13.0	
AVE	11.3	18.9	84.1	114.	77.8	130.	205.	159.	123.	79.3		

STATION : ETHIOPIA WABI SHEBELLE WABI SHEBELLE GODE

NUMBER : 13280112

AVERAGE DAILY DISCHARGES 1967-1968 (M3/S)

	FEBR	MARC	APRI	MAY	JUNE	JULY	AUGU	SEPT	OCTO	NOVE	DECE	JANU
1										84.3	222.	42.2
2										79.0	211.	41.3
3										74.4	188.	38.6
4										70.6	171.	37.7
5									337.	68.4	153.	37.7
6									307.	66.3	135.	36.9
7									387.	63.1	121.	36.9
8									441.	61.4	110.	36.0
9									481.	61.4	101.	35.2
10									508.	63.1	93.5	35.2
11									527.	65.2	87.3	34.4
12									597.	95.0	83.7	33.6
13									573.	75.5	104.	33.6
14									551.	210.	78.4	33.6
15									522.	436.	77.8	32.8
16									402.	428.	76.7	32.0
17									319.	407.	75.5	32.0
18									293.	382.	73.9	31.2
19									263.	354.	71.7	30.5
20									237.	335.	68.4	30.5
21									213.	575.	65.3	29.7
22									190.	324.	60.9	29.0
23									172.	266.	56.0	27.5
24									163.	396.	52.8	28.2
25									148.	353.	48.8	27.5
26									139.	370.	46.4	27.5
27									126.	340.	45.4	27.5
28									117.	286.	44.9	27.5
29									107.	278.	44.0	27.5
30									99.4	267.	43.5	26.7
31									90.4		42.6	26.7
AVE									311.	231.	92.1	32.5

STATION : ETHIOPIA WABI SHEBELLE WABI SHEBELLE GODE

NUMBER : 13280112

AVERAGE DAILY DISCHARGES 1968-1969 (M3/S)

	FEBR	MARC	APRI	MAY	JUNE	JULY	AUGU	SEPT	OCTO	NOVE	DECE	JANU
1	25.6	246.		515.	103.	81.0	147.	176.	102.	65.9	87.1	17.6
2	25.2	213.		460.	97.4	90.2	164.	160.	111.	54.8	87.1	17.0
3	24.5	221.		429.	94.8	91.5	208.	146.	105.	46.5	80.5	17.0
4	24.5	204.		460.	115.	102.	215.	131.	107.	42.2	71.1	17.0
5	23.8	247.		467.	149.	92.9	227.	119.	152.	38.6	64.9	17.0
6	23.5	211.	70.0	393.	163.	86.1	194.	105.	136.	35.9	58.0	22.4
7	23.1	191.		291.	152.	83.1	217.	95.0	122.	33.7	52.8	23.5
8	22.4	167.	110.	263.	214.	78.4	190.	90.8	125.	32.3	49.8	22.1
9	21.8	147.	241.	251.	180.	76.5	174.	94.3	122.	31.0	45.6	20.5
10	21.8	125.	300.	211.	163.	80.7	176.	107.	142.	29.6	42.2	19.6
11	22.1	110.	327.	198.	161.	111.	174.	97.4	155.	27.5	40.4	19.3
12	22.1	97.4	338.	249.	161.	126.	179.	114.	146.	25.1	41.6	18.7
13	22.4	88.5	439.	216.	142.	120.	202.	132.	128.	24.2	42.5	19.9
14	22.4	81.3	484.	176.	117.	126.	203.	146.	109.	23.4	40.1	21.8
15	22.8	93.7	494.	165.	106.	132.	217.	139.	106.	23.6	37.2	23.5
16	25.3	180.	513.	162.	95.5	120.	221.	134.	109.	23.5	34.9	23.1
17	33.6	160.	462.	161.	92.3	107.	243.	138.	83.8	30.9	31.6	22.4
18	32.8	130.	474.	160.	92.9	98.9	266.	161.	72.6	43.2	30.1	21.8
19	32.8	114.	549.	158.	101.	96.3	268.	194.	72.4	75.9	28.6	20.8
20	32.0	98.7	509.	158.	93.6	93.7	284.	187.	62.7	72.2	27.1	20.2
21	32.0		476.	156.	83.7	113.	273.	168.	57.2	83.1	24.9	19.0
22	31.2		477.	163.	82.5	124.	247.	171.	57.4	67.4	23.8	17.8
23	31.2		515.	193.	80.1	111.	261.	172.	91.3	89.3	23.1	17.0
24	30.5		546.	172.	74.4	104.	267.	175.	104.	102.	23.1	17.6
25	30.8		582.	160.	77.2	97.6	272.	157.	79.6	175.	23.1	17.8
26	31.2		577.	142.	79.5	97.0	224.	139.	68.1	167.	21.5	16.8
27	354.		549.	165.	79.5	95.0	195.	126.	62.2	183.	20.2	15.7
28	295.		556.	148.	73.3	112.	171.	113.	58.8	130.	19.9	15.7
29	377.		551.	132.	70.0	115.	164.	103.	66.5	102.	19.3	16.0
30			537.	120.	68.4	125.	175.	96.9	92.3	87.5	18.7	16.0
31				111.		125.	175.		61.2		18.1	18.5
AVE	59.2			232.	112.	104.	213.	136.	99.0	65.5	39.6	19.1

STATION : ETHIOPIA WABI SHEBELLE WABI SHEBELLE GODE

NUMBER : 13280112

AVERAGE DAILY DISCHARGES 1969-1970 (M3/S)

	FEBR	MARC	APRI	MAY	JUNE	JULY	AUGU	SEPT	OCTO	NOVE	DECE	JANU
1	19.7	171.	213.	92.9	42.3	71.9	176.	234.	81.5	32.0	16.8	9.66
2	16.9	327.	189.	165.	38.9	70.8	199.	212.	79.0	30.0	18.1	9.66
3	16.3	339.	174.	219.	38.6	73.5	182.	201.	73.0	39.3	19.8	9.66
4	20.6	348.	150.	352.	43.1	77.4	179.	199.	68.8	254.	19.5	9.27
5	21.1	284.	130.	463.	43.8	76.9	228.	187.	71.1	278.	19.1	9.27
6	21.0	207.	111.	386.	42.3	70.6	263.	163.	68.8	109.	18.6	9.27
7	24.8	161.	96.8	289.	40.8	64.7	239.	142.	64.8	70.9	17.7	8.88
8	28.4	135.	85.1	248.	41.1	61.0	231.	131.	105.	56.4	17.3	8.88
9	29.1	124.	75.6	250.	40.4	59.9	241.	128.	154.	45.0	16.5	8.50
10	28.1	112.	69.2	247.	41.3	91.1	231.	129.	128.	36.8	15.7	8.50
11	24.9	180.	65.3	190.	42.0	108.	220.	151.	86.6	32.0	15.2	8.50
12	21.8	235.	117.	183.	41.0	95.5	214.	191.	71.3	28.8	14.8	8.50
13	20.1	265.	185.	275.	40.1	86.9	223.	191.	78.8	27.1	14.3	8.50
14	18.4	257.	150.	241.	39.3	81.7	251.	200.	98.8	26.4	14.0	8.13
15	16.6	280.	139.	231.	38.2	75.7	239.	234.	75.1	25.1	13.6	8.13
16	15.4	223.	125.	199.	37.7	71.3	228.	204.	67.7	23.7	13.2	8.13
17	14.4	181.	109.	169.	37.5	67.7	203.	193.	57.8	22.2	13.1	8.13
18	13.5	153.	100.	244.	36.2	64.4	185.	226.	55.9	21.7	12.7	7.89
19	12.8	131.	89.4	216.	36.7	66.7	170.	217.	52.5	20.6	12.4	7.77
20	12.3	114.	81.7	156.	36.6	73.2	185.	185.	63.2	20.1	12.2	7.77
21	65.4	117.	75.0	115.	34.5	83.1	212.	167.	104.	19.1	11.8	9.34
22	231.	107.	65.5	91.5	32.8	79.7	220.	164.	77.4	18.2	11.7	16.2
23	207.	99.8	59.9	79.9	30.3	88.1	213.	143.	51.5	17.7	11.5	15.7
24	156.	90.2	56.0	72.6	28.5	83.7	200.	126.	44.6	17.0	11.3	15.0
25	139.	82.7	52.7	66.3	27.5	89.5	175.	115.	41.0	16.1	11.2	15.4
26	117.	130.	50.5	59.8	27.5	112.	170.	106.	41.0	16.8	10.8	15.1
27	107.	164.	52.8	54.7	26.4	166.	222.	98.3	39.5	17.8	10.5	25.1
28	97.9	175.	60.5	50.6	24.5	203.	242.	95.7	37.5	16.5	10.5	60.1
29		154.	68.5	48.0	24.4	189.	238.	91.0	38.2	15.5	10.3	53.2
30		234.	84.0	50.8	38.9	182.	250.	83.5	37.7	15.2	10.1	51.8
31		243.		47.7		162.	221.		35.4		9.86	50.3
AVE	54.2	188.	103.	179.	36.4	95.1	215.	164.	69.3	45.6	14.0	16.1

MEAN ANNUAL DISCHARGE 98.8 M3/S

STATION : ETHIOPIA WABI SHEBELLE WABI SHEBELLE GODE

NUMBER : 13280112

AVERAGE DAILY DISCHARGES 1970-1971 (M3/S)

	FEBR	MARC	APRI	MAY	JUNE	JULY	AUGU	SEPT	OCTO	NOVE	DECE	JANU
1	51.3	9.27	89.1	141.	44.0	18.1	152.	311.	188.	163.	26.0	13.1
2	50.8	9.07	99.6	139.	38.6	17.6	141.	282.	237.	138.	24.5	13.1
3	45.7	113.	93.1	119.	36.5	16.2	161.	243.	229.	157.	23.8	13.1
4	40.8	178.	88.9	110.	34.8	15.5	162.	224.	215.	146.	23.1	12.6
5	36.3	96.3	99.3	138.	34.4	15.0	165.	262.	184.	136.	21.8	12.6
6	32.3	67.2	104.	173.	34.8	15.0	169.	309.	171.	121.	21.8	12.2
7	28.6	71.1	106.	229.	32.0	15.0	161.	267.	152.	105.	21.1	12.2
8	25.6	55.6	95.3	231.	32.4	15.2	203.	230.	136.	92.9	20.5	11.7
9	23.9	42.2	80.7	265.	32.4	15.2	289.	216.	123.	84.5	19.9	11.7
10	23.2	96.4	79.9	216.	29.3	14.5	255.	223.	113.	78.2	19.3	11.7
11	22.8	129.	68.5	237.	25.2	15.0	227.	212.	142.	72.0	19.3	11.7
12	21.3	89.5	68.0	180.	23.5	15.5	239.	237.	188.	67.0	19.3	11.7
13	20.0	129.	86.1	174.	21.8	17.3	252.	263.	181.	61.4	19.3	11.7
14	18.5	131.	80.7	130.	20.8	22.5	286.	260.	177.	55.8	18.7	11.7
15	17.1	100.	116.	143.	19.6	24.9	325.	296.	182.	52.7	18.1	11.7
16	16.1	126.	147.	157.	18.4	28.2	324.	273.	157.	49.1	17.6	11.7
17	15.2	128.	321.	127.	17.8	31.5	355.	283.	139.	46.9	17.0	11.7
18	14.3	341.	307.	95.7	16.5	33.6	349.	256.	129.	44.0	16.5	11.7
19	13.6	455.	324.	83.3	20.8	33.9	335.	263.	226.	42.2	16.5	11.7
20	13.1	495.	303.	87.3	20.8	32.0	406.	223.	321.	38.6	16.0	11.3
21	12.4	513.	303.	85.5	21.5	35.4	442.	194.	238.	38.6	15.5	11.3
22	11.9	471.	562.	77.7	22.8	79.2	391.	176.	211.	36.9	15.5	11.3
23	11.3	325.	533.	70.1	22.8	109.	399.	218.	195.	35.2	15.0	11.3
24	11.0	233.	357.	68.3	20.8	140.	464.	218.	178.	33.6	15.0	10.9
25	10.5	183.	480.	74.2	20.5	125.	484.	208.	145.	32.4	14.5	10.5
26	10.5	152.	308.	82.3	19.9	112.	436.	202.	116.	30.8	14.5	10.5
27	9.86	127.	236.	68.3	21.1	102.	368.	279.	122.	29.0	14.0	10.1
28	9.33	110.	298.	57.6	21.1	104.	308.	258.	202.	27.9	14.0	10.1
29		100.	229.	64.1	20.8	123.	266.	193.	177.	26.7	13.6	10.1
30		91.2	155.	53.8	18.4	180.	284.	180.	189.	26.0	13.6	10.1
31		87.3		44.9		169.	310.		203.		13.1	10.1
AVE	22.0	170.	207.	126.	25.5	54.6	294.	242.	180.	68.9	18.0	11.5

MEAN ANNUAL DISCHARGE 119. M3/S

STATION : ETHIOPIA WABI SHEBELLE WABI SHEBELLE GODE

NUMBER : 13280112

AVERAGE DAILY DISCHARGES 1971-1972 (M3/S)

	FEBR	MARC	APRI	MAY	JUNE	JULY	AUGU	SEPT	OCTO	NOVE	DECE	JANU
1	10.1	6.72	50.4	42.2	97.3	124.	108.	231.	98.7	85.5	53.9	14.5
2	9.66	6.39	42.2	150.	81.7	109.	138.	203.	92.1	83.7	50.8	14.3
3	9.66	6.07	51.8	52.3	74.8	112.	180.	220.	86.7	82.5	47.8	14.0
4	9.66	6.07	45.3	46.0	69.3	95.5	169.	209.	86.9	79.0	44.9	14.0
5	9.66	6.07	37.9	106.	65.3	83.1	151.	187.	100.	79.0	42.2	15.2
6	9.27	5.75	30.8	131.	62.5	80.1	139.	187.	108.	74.5	38.6	17.0
7	9.66	5.75	29.1	241.	61.2	79.0	124.	209.	120.	65.3	37.7	19.3
8	9.66	5.75	46.9	400.	61.2	81.3	111.	227.	127.	64.2	36.9	18.4
9	9.66	5.44	77.9	240.	57.3	97.9	125.	231.	177.	54.4	36.9	18.1
10	9.27	5.14	57.3	160.	47.5	154.	222.	229.	227.	47.3	36.0	18.7
11	9.27	5.14	61.5	123.	42.6	127.	223.	212.	249.	44.5	36.0	17.3
12	8.88	4.85	84.3	158.	39.9	112.	186.	211.	203.	43.5	34.4	16.2
13	8.88	4.85	131.	179.	37.7	123.	177.	239.	178.	42.2	30.5	15.2
14	8.50	4.85	195.	198.	38.2	126.	175.	229.	167.	39.9	29.0	14.8
15	8.50	4.85	236.	166.	39.9	163.	168.	211.	166.	40.8	27.5	14.5
16	8.88	4.85	169.	148.	42.6	150.	174.	185.	143.	42.7	25.2	14.5
17	10.1	4.56	191.	112.	47.3	146.	167.	171.	123.	74.4	23.8	14.5
18	9.66	4.28	144.	99.4	46.4	142.	171.	162.	109.	88.3	22.4	14.5
19	8.88	4.28	138.	106.	44.5	152.	215.	150.	98.8	265.	21.1	14.5
20	8.50	4.28	124.	146.	126.	151.	203.	147.	87.3	248.	21.1	13.6
21	8.13	4.28	96.0	109.	132.	127.	211.	132.	87.7	192.	19.9	12.6
22	8.13	4.28	88.5	102.	116.	119.	244.	120.	124.	154.	19.9	12.2
23	7.77	4.15	89.3	99.0	142.	118.	266.	121.	131.	126.	18.7	11.7
24	7.41	4.01	80.4	83.5	115.	171.	266.	116.	121.	107.	18.1	11.7
25	7.41	4.01	71.1	85.5	98.1	162.	253.	105.	157.	91.5	17.6	11.3
26	7.06	4.01	65.5	77.6	98.1	137.	269.	100.	197.	80.1	17.0	10.9
27	6.72	4.01	62.9	75.7	111.	124.	242.	102.	148.	73.3	16.5	10.5
28	6.72	4.01	57.8	79.5	123.	118.	214.	98.1	108.	66.9	16.0	10.5
29		4.01	53.9	76.7	123.	118.	201.	97.0	85.5	60.9	16.0	10.5
30		27.7	48.7	88.2	126.	117.	216.	98.3	96.1	57.0	15.5	10.5
31		63.2		111.		118.	246.		94.2		15.0	10.1
AVE	8.77	7.54	88.6	129.	78.9	124.	192.	171.	132.	88.4	28.6	14.1

MEAN ANNUAL DISCHARGE 89.0 M3/S

STATION : ETHIOPIA WABI SHEBELLE WABI SHEBELLE KELAFO

NUMBER : 13280121

AVERAGE DAILY DISCHARGES 1967-1968 (M3/S)

	FEBR	MARC	APRI	MAY	JUNE	JULY	AUGU	SEPT	OCTO	NOVE	DECE	JANU
1												42.5
2												40.8
3												39.2
4												38.1
5												37.0
6												37.5
7												35.4
8												34.3
9												32.8
10												32.8
11												32.2
12												31.7
13												31.7
14												30.7
15											97.5	29.7
16											90.0	28.7
17											82.6	27.7
18											79.0	27.3
19											75.5	26.8
20											72.0	26.4
21											68.6	26.4
22											65.2	25.9
23											62.0	25.5
24											58.7	25.1
25											55.6	24.7
26											53.7	24.7
27											52.5	24.3
28											49.5	23.8
29											48.3	23.4
30											46.5	22.6
31											43.7	
AVE												30.1

STATION : ETHIOPIA WABI SHEBELLE WABI SHEBELLE KELAFO

NUMBER : 13280121

AVERAGE DAILY DISCHARGES 1968-1969 (M3/S)

	FEBR	MARC	APRI	MAY	JUNE	JULY	AUGU	SEPT	OCTO	NOVE	DECE	JANU
1												16.0
2												15.3
3												15.0
4												14.4
5												14.4
6												14.4
7												14.4
8												20.7
9												20.5
10		162.										20.1
11		139.										18.3
12												16.8
13												16.7
14												16.7
15	18.8											18.4
16												20.9
17	25.5											21.4
18	32.8											21.0
19	32.2											19.5
20	31.2											18.8
21	30.2											18.1
22	29.7											20.7
23	28.7											19.5
24	30.2											18.8
25	30.2											18.4
26	29.7											15.7
27	29.7											15.3
28	162.											14.7
29												14.1
30												13.7
31											19.5	14.1
AVE												17.3

STATION : ETHIOPIA WABI SHEBELLE WABI SHEBELLE KELAFO

NUMBER : 13280121

AVERAGE DAILY DISCHARGES 1969-1970 (M3/S)

	FEBR	MARC	APRI	MAY	JUNE	JULY	AUGU	SEPT	OCTO	NOVE	DECE	JANU
1	14.1	133.	228.	88.4	53.1	17.9	163.	205.	84.1	33.2	16.7	9.46
2	14.5	202.	203.	142.	46.5	69.9	180.	224.	81.3	29.3	17.7	9.46
3	15.8	294.	188.	171.	41.7	72.7	190.	194.	78.0	26.9	17.7	9.23
4	14.7	294.	177.	227.	38.9	74.1	188.	195.	70.6	52.6	18.7	9.00
5	15.7	298.	159.	298.	40.3	75.1	174.	189.	66.3	252.	19.6	9.00
6	17.3	291.	125.	306.	42.0	73.7	179.	177.	67.7	210.	18.9	8.77
7	19.2	198.	123.	295.	42.0	65.9	240.	161.	65.4	127.	18.3	8.55
8	20.1	189.	108.	269.	38.9	61.0	237.	144.	63.6	75.4	17.8	8.55
9	23.4	147.	99.0	248.	37.8	57.2	215.	138.	101.	56.6	17.1	8.55
10	26.0	140.	91.9	254.	37.0	55.9	222.	132.	153.	46.5	16.4	8.32
11	26.6	137.	89.2	234.	36.7	97.5	219.	138.	116.	45.1	15.9	8.10
12	23.8	198.	112.	190.	38.6	107.	203.	158.	83.6	34.5	15.0	8.10
13	20.5	250.	178.	203.	36.7	104.	203.	181.	70.9	30.9	14.1	8.10
14	17.9	258.	160.	264.	37.5	76.9	217.	180.	83.1	28.5	14.0	7.89
15	16.3	253.	155.	241.	35.7	78.3	241.	202.	91.2	27.6	14.0	7.89
16	15.2	286.	154.	223.	34.3	73.0	216.	213.	71.2	26.1	13.5	7.89
17	14.2	206.	133.	190.	32.5	68.2	217.	189.	64.7	25.8	13.2	7.67
18	12.4	180.	130.	192.	32.5	65.2	189.	184.	54.9	24.3	12.7	7.67
19	11.4	161.	109.	236.	31.7	60.3	182.	216.	51.1	23.0	12.4	7.67
20	10.6	144.	97.5	203.	31.5	62.0	166.	192.	48.7	22.3	12.2	7.46
21	13.7	132.	87.0	158.	30.7	69.6	169.	171.	70.0	21.4	11.9	7.46
22	18.8	129.	77.9	133.	28.9	79.0	211.	162.	120.	21.1	11.7	7.26
23	220.	123.	69.9	112.	26.8	87.0	209.	156.	70.5	19.8	11.4	7.26
24	197.	118.	63.3	98.6	24.5	84.4	203.	138.	50.6	19.2	10.9	10.8
25	158.	107.	56.9	87.8	22.4	82.2	189.	123.	42.8	18.3	11.4	15.3
26	150.	99.7	54.4	79.7	21.2	89.2	167.	114.	39.8	18.0	10.9	13.3
27	131.	155.	53.4	69.9	20.7	118.	175.	106.	42.6	17.1	10.7	13.5
28	120.	170.	52.5	63.6	21.2	170.	221.	96.4	43.6	18.3	10.4	15.0
29		175.	59.7	57.8	19.2	181.	227.	96.4	37.2	18.3	10.2	40.5
30		222.	68.9	54.7	18.6	173.	226.	90.5	35.6	16.5	9.94	43.5
31		241.		56.2		171.	236.		34.5		9.70	44.2
AVE	48.5	191.	115.	176.	33.3	87.8	202.	162.	69.5	46.2	14.0	12.4

MEAN ANNUAL DISCHARGE 96.9 M3/S

STATION : ETHIOPIA WABI SHEBELLE WABI SHEBELLE KELAFO

NUMBER : 13280121

AVERAGE DAILY DISCHARGES 1970-1971 (M3/S)

	FEBR	MARC	APRI	MAY	JUNE	JULY	AUGU	SEPT	OCTO	NOVE	DECE	JANU
1	45.0	7.67	89.0	170.	40.9	16.8	153.	281.	165.	163.	21.9	10.6
2	45.5	7.57	90.4	155.	39.3	16.1	134.	281.	178.	141.	21.2	10.6
3	45.5	7.26	97.0	144.	34.5	15.5	132.	268.	206.	122.	20.6	10.3
4	44.7	94.6	93.1	125.	31.4	15.2	140.	231.	196.	141.	19.9	10.1
5	40.5	127.	87.3	118.	30.1	14.4	146.	214.	179.	125.	19.3	9.82
6	32.5	80.6	97.7	223.	28.6	13.9	148.	256.	165.	124.	19.6	9.58
7	28.3	59.4	104.	185.	28.4	13.5	150.	274.	153.	109.	19.0	9.58
8	25.4	61.2	100.	197.	27.3	13.5	142.	237.	138.	96.8	18.3	9.58
9	22.7	48.3	93.6	237.	26.7	13.1	205.	206.	123.	82.4	18.0	9.58
10	21.9	38.2	81.9	227.	27.6	13.5	244.	197.	110.	74.2	17.4	9.34
11	19.6	92.7	83.4	206.	25.4	13.3	222.	199.	104.	68.8	16.8	9.34
12	19.3	101.	68.6	204.	22.7	12.9	208.	191.	144.	62.4	16.2	9.34
13	18.3	74.6	66.2	176.	20.7	13.1	212.	220.	162.	56.6	15.9	9.34
14	16.9	122.	76.7	159.	19.3	13.7	233.	237.	157.	52.7	15.3	9.10
15	16.1	104.	73.3	133.	18.1	16.4	269.	242.	158.	49.0	15.0	9.58
16	14.8	90.2	110.	139.	17.4	19.8	291.	259.	155.	45.5	14.7	9.58
17	13.7	114.	152.	158.	16.4	21.7	295.	257.	138.	41.4	14.4	9.58
18	12.9	145.	292.	115.	15.8	24.5	303.	251.	122.	38.4	13.8	10.1
19	12.3	294.	282.	96.1	15.2	27.5	299.	230.	140.	36.5	13.5	9.58
20	11.5	299.	308.	86.2	15.9	28.6	299.	230.	202.	33.9	13.5	9.58
21	10.1	300.	294.	86.9	18.0	27.8	312.	193.	283.	32.6	13.3	9.34
22	10.3	295.	311.	82.7	18.1	27.5	308.	173.	190.	30.9	12.7	9.10
23	9.94	288.	321.	74.8	19.2	58.0	299.	168.	187.	29.3	12.1	8.63
24	9.35	261.	321.	67.4	19.8	96.3	308.	198.	163.	27.8	12.1	8.63
25	9.00	213.	316.	65.1	18.7	115.	311.	190.	161.	26.7	11.9	8.40
26	8.66	176.	318.	71.4	17.7	110.	312.	182.	123.	25.3	11.9	8.18
27	8.21	152.	290.	74.5	17.4	102.	304.	188.	108.	24.2	11.6	8.18
28	8.00	130.	272.	63.0	17.7	91.6	288.	261.	124.	22.8	11.3	7.95
29		115.	277.	53.8	18.6	90.9	261.	206.	173.	22.5	11.1	7.73
30		103.	212.	58.6	18.0	119.	247.	172.	149.	21.9	10.6	7.73
31		93.9		50.9		155.	264.		180.		10.6	7.73
AVE	20.7	132.	179.	129.	22.8	42.9	240.	223.	159.	64.2	15.3	9.22

MEAN ANNUAL DISCHARGE 104. M3/S

STATION : ETHIOPIA WABI SHEBELLE WABI SHEBELLE KELAFO

NUMBER : 13280121

AVERAGE DAILY DISCHARGES 1971-1972 (M3/S)

	FEBR	MARC	APRI	MAY	JUNE	JULY	AUGU	SEPT	OCTO	NOVE	DECE	JANU
1	7.51	5.31	40.0	41.7	90.0	99.6	97.9	198.	81.7	71.6	45.7	11.6
2	7.51	5.13	46.4	103.	80.2	93.3	91.6	188.	79.8	68.1	43.4	11.4
3	7.51	5.13	37.1	133.	68.2	88.3	124.	176.	73.9	67.3	40.0	11.2
4	7.51	5.13	40.0	57.3	62.4	88.0	152.	179.	70.4	65.9	37.3	10.9
5	7.51	4.95	40.5	46.4	58.6	75.8	144.	172.	71.5	64.8	34.5	11.2
6	7.51	4.60	34.6	106.	54.7	70.7	130.	161.	82.7	65.9	32.2	11.4
7	7.30	4.60	28.1	137.	53.1	65.7	116.	167.	88.0	59.4	30.0	11.6
8	7.30	4.60	25.1	230.	51.3	62.9	106.	179.	97.5	53.6	28.7	13.7
9	7.30	4.60	32.1	283.	49.0	63.2	95.8	186.	105.	50.5	26.7	14.5
10	7.30	4.43	59.2	205.	48.0	78.2	126.	190.	156.	41.5	26.4	13.8
11	7.09	4.26	49.0	149.	37.5	105.	186.	190.	185.	38.7	26.2	13.5
12	7.09	4.26	49.3	119.	34.3	92.7	175.	177.	193.	34.6	25.5	13.2
13	6.88	4.26	76.6	155.	31.8	88.3	155.	181.	166.	32.6	24.9	13.0
14	6.88	4.09	114.	158.	30.6	90.6	152.	198.	150.	32.0	24.0	12.5
15	6.88	4.09	171.	166.	30.6	97.9	149.	186.	144.	31.8	22.1	11.7
16	6.47	3.77	177.	136.	31.1	121.	149.	173.	138.	31.3	20.8	11.6
17	6.27	3.61	156.	122.	32.4	118.	150.	161.	121.	35.1	19.1	11.6
18	6.88	3.53	128.	99.6	36.6	117.	144.	149.	102.	56.8	18.6	11.4
19	7.51	3.46	124.	88.6	35.8	114.	150.	144.	92.0	99.6	18.1	11.2
20	7.30	3.31	103.	99.2	35.0	128.	176.	133.	81.8	205.	17.0	10.9
21	7.30	3.23	86.0	121.	103.	115.	172.	125.	71.5	189.	16.3	10.7
22	6.67	3.16	82.1	92.3	91.1	100.	184.	114.	72.7	159.	15.7	10.3
23	6.27	3.01	79.5	89.6	104.	95.1	206.	109.	107.	131.	15.0	9.94
24	6.07	3.01	77.9	80.8	103.	112.	219.	106.	102.	107.	14.5	9.55
25	5.88	3.01	68.7	72.7	88.3	150.	218.	98.2	157.	91.0	14.2	9.37
26	5.69	3.01	65.7	72.7	75.5	136.	221.	87.3	170.	77.0	13.5	9.18
27	5.50	3.01	57.0	64.8	75.8	116.	217.	84.7	157.	67.6	12.7	9.00
28	5.31	3.01	56.8	64.3	73.6	102.	197.	85.3	130.	60.5	12.5	9.00
29		3.08	50.5	66.8	81.4	101.	179.	81.7	95.2	51.8	12.0	8.82
30		3.22	46.2	63.2	87.7	98.6	174.	82.1	73.6	48.7	11.8	8.65
31		3.92		74.1		100.	189.		68.1		11.8	8.65
AVE	6.87	3.93	73.4	113.	61.1	99.5	160.	149.	112.	73.0	22.9	11.1

MEAN ANNUAL DISCHARGE 74.2 M3/S

STATION : ETHIOPIA WABI SHEBELLE WABI SHEBELLE BURKUR

NUMBER : 13280103

AVERAGE DAILY DISCHARGES 1969-1970 (M3/S)

	FEBR	MARC	APRI	MAY	JUNE	JULY	AUGU	SEPT	OCTO	NOVE	DECE	JANU
1	18.0	82.8	120.	63.6	83.1	25.6	90.6	170.	154.	39.7	17.3	9.98
2	17.8	84.6	120.	70.2	72.0	24.9	93.1	171.	143.	38.0	16.8	9.78
3	18.3	86.3	123.	77.2	62.6	26.7	95.7	171.	133.	36.4	16.4	9.57
4	20.0	88.5	126.	82.8	53.7	51.5	97.8	172.	121.	34.9	16.1	9.38
5	19.7	91.0	131.	88.3	48.4	58.1	100.	173.	110.	37.4	17.1	9.18
6	18.3	94.3	137.	95.6	44.8	62.6	103.	174.	99.3	66.9	18.0	8.98
7	19.2	97.9	145.	98.8	44.5	64.9	106.	176.	89.5	76.8	19.2	8.79
8	21.3	104.	153.	105.	44.1	61.9	110.	179.	85.2	83.5	19.2	8.60
9	21.5	114.	158.	111.	42.7	59.6	116.	181.	82.0	89.0	18.7	8.41
10	23.2	128.	161.	119.	41.0	60.4	121.	182.	82.9	86.9	18.0	8.22
11	24.9	138.	159.	129.	40.3	56.6	128.	182.	86.4	74.7	17.5	8.22
12	26.5	149.	152.	141.	37.7	55.2	135.	181.	89.5	62.6	16.8	8.04
13	26.9	158.	135.	154.	38.4	68.0	143.	177.	91.2	54.8	16.1	7.86
14	25.6	159.	117.	164.	38.4	74.4	152.	172.	88.9	48.8	15.4	7.86
15	23.4	154.	109.	176.	38.0	76.9	160.	166.	85.1	44.5	14.8	7.67
16	21.9	146.	106.	189.	38.0	76.0	166.	116.	85.8	39.0	14.6	7.67
17	20.5	142.	107.	200.	37.4	74.4	173.	156.	84.3	35.5	14.1	7.50
18	19.0	143.	109.	210.	36.8	70.4	177.	153.	78.3	32.5	13.9	7.50
19	17.7	150.	110.	215.	36.1	68.0	181.	150.	71.6	30.2	13.3	7.32
20	17.2	158.	111.	214.	35.5	64.5	184.	150.	64.4	28.2	13.0	7.32
21	17.1	164.	112.	212.	34.9	61.9	186.	151.	58.3	26.4	12.6	7.14
22	17.1	170.	110.	211.	34.3	61.9	187.	153.	55.6	24.6	12.8	7.14
23	17.9	174.	106.	210.	34.6	64.9	188.	156.	70.2	23.2	12.6	6.97
24	51.4	176.	99.3	209.	30.7	68.8	184.	160.	75.2	22.0	12.4	6.97
25	68.2	172.	88.7	204.	31.6	70.4	182.	163.	67.7	21.0	11.8	6.80
26	73.9	164.	78.7	199.	30.2	73.6	180.	166.	58.9	20.0	11.6	12.0
27	77.5	154.	70.2	190.	28.5	74.4	177.	167.	51.1	19.5	11.4	13.7
28	79.7	140.	64.6	175.	27.7	76.4	174.	167.	52.2	18.7	11.2	13.3
29		130.	60.5	155.	28.0	80.6	172.	165.	51.5	18.0	11.0	13.7
30		124.	59.9	124.	26.9	83.9	170.	161.	47.3	17.5	10.6	13.7
31		121.		105.		87.3	170.		41.3		10.4	31.0
AVE	29.4	134.	115.	151.	40.7	64.0	148.	165.	82.4	41.7	14.7	9.68

MEAN ANNUAL DISCHARGE 83.3 M3/S

STATION : ETHIOPIA WABI SHEBELLE WABI SHEBELLE BURKUR

NUMBER : 13280103

AVERAGE DAILY DISCHARGES 1970-1971 (M3/S)

	FEBR	MARC	APRI	MAY	JUNE	JULY	AUGU	SEPT	OCTO	NOVE	DECE	JANU
1	38.0	8.22	151.	209.	58.1	18.5	86.2	228.	200.	175.	25.6	12.2
2	38.4	8.04	138.	220.	51.1	18.2	90.4	232.	195.	172.	24.9	12.0
3	37.1	7.67	122.	228.	42.7	17.3	93.7	236.	191.	168.	24.1	11.8
4	37.1	7.32	115.	234.	40.0	16.4	96.1	239.	189.	165.	23.4	11.6
5	37.1	6.97	113.	237.	35.8	15.9	98.7	241.	187.	162.	22.5	11.4
6	35.2	61.3	106.	237.	32.8	15.2	99.6	242.	186.	159.	21.7	11.2
7	32.5	67.3	101.	234.	31.0	14.6	101.	243.	185.	157.	21.2	11.0
8	29.6	61.3	98.9	229.	30.2	14.1	103.	244.	184.	153.	20.5	10.8
9	26.7	54.6	97.4	221.	29.6	13.7	106.	244.	183.	148.	20.0	10.6
10	24.4	51.1	96.2	210.	28.5	13.3	108.	244.	181.	140.	19.5	10.2
11	22.5	41.7	92.9	196.	27.7	13.0	110.	243.	178.	129.	19.2	9.98
12	21.0	48.3	87.9	183.	28.0	13.0	114.	240.	175.	115.	18.7	9.78
13	19.7	70.7	83.0	174.	26.7	13.3	118.	237.	169.	96.8	18.2	9.57
14	19.0	73.7	75.5	170.	24.1	12.8	121.	234.	164.	91.2	17.8	9.38
15	18.2	73.1	73.8	169.	22.5	12.8	126.	230.	159.	80.2	17.5	9.18
16	17.3	76.6	74.1	170.	21.2	13.0	129.	226.	157.	71.2	17.1	9.18
17	15.9	77.2	77.6	173.	20.0	14.6	133.	222.	154.	64.2	16.6	9.38
18	15.2	80.9	83.6	175.	19.0	17.8	138.	218.	152.	57.4	16.4	9.57
19	16.1	84.4	90.9	176.	18.2	19.2	143.	214.	153.	52.2	15.9	9.78
20	13.3	88.1	98.4	174.	17.3	21.7	150.	210.	149.	47.7	15.4	9.78
21	12.4	91.9	104.	167.	16.8	24.1	157.	208.	147.	44.1	15.2	9.78
22	12.0	96.0	111.	155.	17.1	24.9	164.	207.	146.	40.7	15.0	9.38
23	11.2	100.	119.	134.	18.7	24.9	172.	209.	147.	38.4	14.6	8.98
24	10.8	105.	130.	116.	19.2	26.1	182.	212.	150.	35.8	14.3	8.79
25	9.98	110.	141.	99.1	19.7	59.6	193.	214.	153.	33.7	14.1	8.60
26	9.38	116.	151.	83.1	20.2	69.2	198.	217.	156.	31.9	13.7	8.22
27	8.79	124.	160.	78.0	19.7	74.0	203.	217.	170.	30.5	13.5	7.86
28	8.79	134.	170.	78.2	18.5	77.3	211.	215.	192.	28.8	13.0	8.04
29		141.	182.	75.0	18.0	78.9	217.	211.	191.	27.7	12.8	7.86
30		149.	196.	66.7	18.0	80.6	221.	206.	184.	26.7	12.6	7.67
31		153.		57.7		81.8	225.		179.		12.4	7.50
AVE	21.3	76.4	115.	166.	26.3	30.0	142.	226.	171.	91.4	17.7	9.71

MEAN ANNUAL DISCHARGE 91.4 M3/S

STATION : ETHIOPIA WABI SHEBELLE WABI SHEBELLE BURKUR

NUMBER : 13280103

AVERAGE DAILY DISCHARGES 1971-1972 (M3/S)

	FEBR	MARC	APRI	MAY	JUNE	JULY	AUGU	SEPT	OCTO	NOVE	DECE	JANU
1	7.14	4.90	2.82	47.0	67.3	84.8	98.8	159.	104.	108.	65.7	14.3
2	7.14	4.90	2.82	43.4	77.3	89.5	102.	162.	100.	102.	59.6	13.7
3	6.80	4.62	2.71	41.3	85.2	93.0	100.	165.	98.4	93.4	55.2	13.5
4	7.32	4.62	36.8	79.9	83.5	93.0	98.8	167.	94.8	92.6	50.7	13.0
5	7.14	4.34	32.2	80.6	71.6	92.6	103.	170.	89.1	88.6	47.7	12.6
6	6.97	4.47	33.7	62.2	64.9	88.6	107.	171.	83.9	83.5	45.9	12.4
7	7.14	4.34	34.6	75.3	59.6	81.4	111.	172.	84.8	81.0	39.3	12.2
8	6.97	4.34	30.5	88.1	55.2	74.4	114.	172.	89.9	78.1	37.1	12.2
9	6.97	4.06	25.6	97.0	53.4	70.8	114.	171.	94.3	69.2	34.3	12.4
10	6.80	4.06	22.9	104.	51.1	66.9	112.	170.	97.5	61.9	32.2	14.8
11	6.46	4.20	28.0	110.	50.7	68.8	107.	169.	101.	55.9	30.5	15.7
12	6.46	4.06	53.7	122.	45.9	82.2	107.	168.	108.	48.1	30.2	15.2
13	6.63	4.06	45.5	120.	39.0	87.3	111.	168.	115.	40.7	29.3	15.2
14	6.63	3.80	46.2	122.	34.9	90.8	115.	167.	122.	39.3	28.8	15.0
15	6.46	3.93	71.9	125.	32.8	93.0	119.	168.	128.	37.4	28.0	14.3
16	6.30	3.80	76.2	129.	31.0	95.2	122.	168.	132.	36.1	26.4	13.7
17	6.14	3.67	82.6	133.	30.5	97.0	124.	168.	134.	34.9	25.1	13.0
18	5.97	3.54	89.9	136.	31.0	98.8	125.	168.	134.	34.0	23.6	12.6
19	5.82	3.30	95.3	134.	32.8	101.	127.	168.	132.	46.6	22.5	12.4
20	5.82	3.42	99.4	128.	35.8	102.	127.	168.	129.	63.8	21.5	12.2
21	6.30	3.30	100.	121.	35.8	104.	128.	168.	124.	85.6	21.0	12.0
22	6.63	3.30	101.	116.	49.2	105.	129.	166.	116.	97.5	19.7	11.2
23	6.46	3.17	98.2	115.	80.2	106.	131.	163.	107.	103.	19.2	11.2
24	6.14	3.17	88.4	111.	83.1	104.	134.	159.	106.	112.	18.5	10.2
25	5.97	3.17	81.9	103.	88.2	101.	136.	153.	139.	116.	17.8	9.98
26	5.66	3.06	76.5	92.4	91.2	102.	138.	142.	132.	116.	17.1	9.57
27	5.20	3.06	70.8	83.0	90.4	106.	140.	135.	129.	108.	16.4	8.79
28	5.35	3.06	61.1	79.1	83.1	109.	144.	125.	129.	93.9	15.9	8.60
29		2.94	55.2	69.2	81.0	111.	147.	116.	130.	82.7	15.4	8.22
30		2.94	51.8	68.4	83.1	109.	152.	110.	131.	72.0	15.2	8.04
31		2.94		68.4		106.	156.		127.		14.6	7.86
AVE	6.46	3.76	56.6	96.9	60.0	94.0	122.	160.	114.	76.1	29.8	12.1

MEAN ANNUAL DISCHARGE 69.6 M3/S

STATION : ETHIOPIA WABI SHEBELLE MARIBO BRIDGE ROAD OF DODOLA

NUMBER : 13282201

AVERAGE DAILY DISCHARGES 1967-1968 (M3/S)

	FEBR	MARC	APRI	MAY	JUNE	JULY	AUGU	SEPT	OCTO	NOVE	DECE	JANU
1	.123	.090	2.15	1.85	.756	3.55	14.0	13.2	9.25	.755	3.56	.265
2	.123	.080	1.39	1.70	.597	3.37	15.0	13.0	10.8	.841	2.78	.265
3	.123	.190	1.66	1.95	.573	2.73	15.4	16.0	20.6	.870	2.50	.265
4	.147	.202	2.59	5.52	.480	3.22	15.4	16.7	20.6	.783	2.15	.265
5	.147	.161	1.57	4.75	.553	2.97	15.8	12.8	28.0	.623	1.95	.233
6	.123	.135	1.39	4.05	.550	4.05	16.6	11.9	31.0	.674	1.65	.265
7	.147	.123	1.32	11.1	.458	6.24	17.0	12.0	25.2	.924	1.47	.265
8	.265	.100	1.03	8.17	.415	7.51	20.7	13.6	16.5	1.20	1.31	.233
9	.336	.100	1.06	9.23	.395	7.00	16.6	15.5	12.8	1.30	1.09	.233
10	.233	.100	1.06	7.42	.395	11.7	13.6	13.9	11.2	2.55	.930	.265
11	.202	.112	.812	5.43	.336	11.5	10.6	11.8	8.81	3.21	.811	.233
12	.174	.101	3.56	6.33	.336	11.1	9.02	8.03	6.91	3.02	.811	.233
13	.147	.112	5.57	7.11	.336	7.92	6.80	6.43	5.33	3.21	.728	.202
14	.123	.123	4.05	6.45	.750	7.73	5.42	5.41	4.58	5.89	.674	.174
15	.123	.100	2.97	5.26	.863	6.61	4.91	4.74	3.83	12.4	.623	.202
16	.147	.124	1.95	4.92	.549	6.91	5.59	4.43	3.28	13.6	.573	.174
17	.123	.301	1.36	4.12	.573	9.54	6.41	4.95	2.78	10.6	.549	.147
18	.123	.218	1.06	3.28	.458	7.82	6.25	5.86	2.00	9.25	.415	.174
19	.123	.188	.970	2.67	.553	7.30	9.76	6.23	2.20	7.73	.336	.174
20	.100	.135	.783	1.90	.730	9.03	9.80	5.59	1.95	6.51	.300	.123
21	.123	.123	.783	1.56	2.10	11.7	11.8	5.50	1.65	12.8	.300	.174
22	.100	.112	2.86	1.20	2.00	13.3	9.48	8.27	1.47	12.3	.300	.174
23	.100	.123	1.66	1.06	1.68	11.1	8.57	9.14	1.31	10.7	.265	.174
24	.100	.147	1.39	.962	1.20	8.36	7.87	8.91	1.16	8.37	.233	.147
25	.100	.202	1.20	.783	1.13	8.69	6.51	17.2	1.03	6.90	.375	.147
26	.100	.188	.962	.728	1.03	7.50	6.41	13.3	1.10	6.51	.375	.174
27	.100	.764	.841	.623	1.24	7.10	5.86	11.2	1.13	7.73	.375	.202
28	.080	.356	.728	.549	3.03	6.24	4.99	8.60	.962	6.41	.300	.174
29		1.65	.821	.550	3.30	5.08	8.36	8.14	.841	5.50	.336	.174
30		.903	1.06	1.74	2.30	4.43	9.34	9.48	.783	4.67	.300	.233
31		3.58		.871		4.05	12.0		.841		.300	.300
AVE	.142	.353	1.69	3.67	.989	7.27	10.5	10.1	7.74	5.60	.925	.209

MEAN ANNUAL DISCHARGE 4.13 M3/S

STATION : ETHIOPIA WABI SHEBELLE MARIBO BRIDGE ROAD OF DODOLA

NUMBER : 13282201

AVERAGE DAILY DISCHARGES 1968-1969 (M3/S)

	FEBR	MARC	APRI	MAY	JUNE	JULY	AUGU	SEPT	OCTO	NOVE	DECE	JANU
1	.486	7.13	1.90	11.6	5.24	6.41	12.6	4.91	8.91	1.35	1.13	.573
2	.526	7.51	1.61	8.58	5.59	5.33	13.0	5.78	11.6	1.28	1.06	.573
3	.573	6.23	1.47	10.9	6.13	4.99	12.5	7.00	9.34	1.09	1.06	.756
4	.573	5.24	2.71	10.6	6.90	4.92	12.6	6.51	11.1	1.29	1.43	.812
5	.728	4.35	3.55	9.57	7.40	8.46	10.0	6.91	8.69	1.16	1.06	1.31
6	.674	3.97	3.55	8.15	7.82	7.50	8.69	6.32	10.2	.994	.930	1.28
7	.674	3.35	4.60	6.04	6.64	6.80	8.92	7.34	9.24	.900	.870	1.21
8	.728	2.50	15.3	4.75	4.46	7.30	8.91	8.25	6.91	.932	.811	.900
9	.623	2.84	18.3	4.05	3.28	7.21	8.25	11.4	5.08	.994	.930	1.12
10	.701	5.16	17.9	3.21	2.84	7.30	8.70	10.2	4.28	1.13	.811	1.06
11	.625	7.61	16.5	6.32	2.50	5.97	9.03	9.89	3.21	.962	.755	.995
12	.395	5.86	13.3	6.70	2.10	5.35	17.7	8.36	3.48	.843	.755	1.17
13	.356	4.99	14.5	8.67	1.80	4.05	13.8	7.93	3.48	.701	.648	1.76
14	.300	4.20	18.7	10.5	1.80	15.9	12.4	7.51	3.09	.648	.597	1.43
15	.265	3.69	17.0	8.58	1.47	9.46	10.4	6.13	2.55	.674	.549	1.20
16	.283	2.52	16.5	6.15	1.39	12.0	9.24	6.25	2.25	7.73	.549	.962
17	.811	1.90	18.2	4.35	1.24	9.56	9.44	8.28	2.62	7.26	.502	.932
18	.900	1.47	15.5	3.55	1.28	6.61	8.26	7.93	3.90	3.21	.458	.812
19	1.32	1.35	23.0	2.35	1.47	5.24	7.73	9.35	3.46	2.30	.415	.700
20	3.06	1.09	23.9	1.80	1.27	4.12	10.8	12.2	3.15	3.23	.415	.648
21	4.46	.932	24.1	1.47	1.31	9.46	11.3	12.2	4.28	5.16	.415	.573
22	6.80	.783	18.1	2.31	1.39	10.4	8.92	9.03	7.62	5.08	.375	.549
23	8.80	.811	18.3	7.82	1.47	9.69	7.20	7.10	6.13	3.77	.375	.526
24	8.25	1.06	18.9	6.80	1.62	8.46	6.13	6.24	4.59	2.84	.375	.502
25	6.80	1.16	18.2	5.86	2.69	9.78	9.57	5.68	3.23	2.30	.336	.526
26	5.69	.995	19.7	4.47	8.44	9.86	8.70	7.63	2.72	2.40	.336	.704
27	4.27	.812	19.9	3.28	10.3	9.55	10.1	6.41	2.25	2.10	.458	1.14
28	4.12	1.60	19.2	2.55	10.4	6.64	10.4	10.0	2.49	1.65	.648	1.43
29	4.75	3.15	16.0	2.20	9.14	6.61	9.03	12.4	2.58	1.43	.755	1.66
30		2.84	13.4	2.69	7.30	6.80	6.05	9.79	1.70	1.24	.755	2.67
31		2.35		5.07		12.0	4.91		1.47		.597	1.95
AVE	2.36	3.21	14.5	5.84	4.22	7.86	9.85	8.16	5.02	2.22	.683	1.05

MEAN ANNUAL DISCHARGE 5.41 M3/S

STATION : ETHIOPIA WABI SHEBELLE MARIBO BRIDGE ROAD OF DODOLA

NUMBER : 13282201

AVERAGE DAILY DISCHARGES 1969-1970 (M3/S)

	FEBR	MARC	APRI	MAY	JUNE	JULY	AUGU	SEPT	OCTO	NOVE	DECE	JANU
1	1.47	4.83	7.73	3.41	1.13	1.65	13.2	6.49	6.71	.783	.755	.597
2	1.20	3.76	5.24	3.48	1.13	1.85	11.3	7.10	5.50	1.52	.755	.597
3	.962	3.28	3.98	3.62	.870	1.85	10.9	6.52	5.33	1.35	.811	.597
4	.812	2.55	3.09	8.26	.811	1.90	8.70	8.26	5.33	1.20	.755	.597
5	.728	2.25	3.62	5.99	.870	1.82	6.42	10.9	6.70	.994	.700	.597
6	.649	1.85	6.40	9.45	.700	1.81	6.04	12.8	7.51	1.14	.700	.597
7	.549	4.66	3.90	8.24	.700	1.85	7.01	20.3	6.43	1.06	.700	.597
8	.526	4.84	4.75	6.80	.597	1.65	8.69	16.1	5.33	.900	.700	.648
9	.526	5.03	10.3	6.05	.648	1.85	10.2	15.0	4.67	.870	.700	.700
10	.526	13.9	7.51	6.33	.597	2.10	11.8	13.2	3.83	.811	.700	.755
11	.550	7.73	6.90	6.71	.549	2.10	10.4	10.6	2.96	.811	.700	.755
12	.526	9.01	5.51	5.33	.458	1.85	9.33	9.89	3.17	.755	.700	.700
13	.480	6.33	4.51	4.05	.458	1.60	8.27	9.02	4.20	.783	.648	.811
14	1.57	6.90	3.48	3.02	.415	2.57	6.41	8.50	3.64	.811	.700	.755
15	1.70	8.81	2.78	2.45	.375	1.95	5.60	5.68	2.62	.783	.700	.755
16	2.00	7.38	2.45	2.10	.375	4.52	6.22	5.07	2.10	.783	.648	.811
17	1.86	4.99	3.20	1.75	.375	3.52	6.25	3.83	1.85	.755	.648	.811
18	3.48	5.09	4.35	1.65	.375	2.55	5.89	3.28	2.00	.755	.648	.870
19	3.16	4.12	5.30	1.27	.336	2.30	6.51	2.84	2.40	.700	.648	.783
20	3.09	3.76	5.12	1.13	.395	2.68	5.70	2.35	3.56	.700	.648	.930
21	2.15	5.16	3.62	.962	.684	4.34	7.40	2.78	3.62	.811	.597	.995
22	2.15	7.30	5.21	.870	.789	5.93	7.62	2.72	2.20	.870	.597	1.36
23	5.42	9.86	6.51	.811	.804	6.80	9.25	2.30	1.90	.870	.597	1.47
24	4.66	10.0	11.2	.871	.903	10.4	7.50	5.04	1.65	.811	.597	1.24
25	11.6	11.9	11.8	.994	1.14	7.83	6.23	5.33	1.39	.811	.597	1.06
26	8.03	14.9	10.5	.962	2.42	7.92	5.33	10.9	1.27	.811	.648	.930
27	5.97	13.1	6.30	1.55	3.46	15.3	5.34	3.90	1.24	.811	.648	.900
28	8.02	11.2	4.20	2.05	3.48	12.0	6.61	3.62	1.09	.755	.648	.811
29		14.4	4.59	1.76	2.25	10.2	5.59	3.41	.962	.755	.648	.811
30		15.2	4.76	1.31	1.65	19.5	5.70	4.58	.841	.700	.648	.811
31		10.2		1.16		17.1	5.86		.783		.648	.755
AVE	2.65	7.56	5.63	3.37	.991	5.21	7.65	7.42	3.32	.876	.672	.820

MEAN ANNUAL DISCHARGE 3.86 M3/S

STATION : ETHIOPIA WABI SHEBELLE MARIBO BRIDGE ROAD OF DODOLA

NUMBER : 13282201

AVERAGE DAILY DISCHARGES 1970-1971 (M3/S)

	FEBR	MARC	APRI	MAY	JUNE	JULY	AUGU	SEPT	OCTO	NOVE	DECE	JANU
1	.755	.649	2.40	1.85	.549	.503	7.97	8.17	11.2	10.6	.415	.300
2	.700	1.61	2.10	1.60	.502	.526	8.35	10.5	8.92	7.84	.375	.265
3	.700	.676	3.21	1.49	.458	.573	7.71	14.8	6.71	6.13	.375	.300
4	.700	.700	6.55	13.5	.458	.623	6.52	13.3	6.45	4.92	.375	.300
5	.700	16.1	3.90	12.6	.375	.789	5.77	9.67	10.2	3.62	.375	.300
6	.648	3.55	3.22	14.5	.458	1.37	5.41	8.48	8.69	2.84	.375	.300
7	.648	5.86	2.35	9.34	.375	3.18	5.59	14.1	9.79	2.45	.375	.300
8	.648	3.91	2.86	6.70	.415	2.05	5.59	13.2	13.5	2.20	.336	.300
9	.648	3.59	5.26	5.18	.502	2.00	5.33	12.1	14.2	1.90	.336	.265
10	.597	8.06	3.15	3.55	.458	2.05	6.80	11.8	12.9	1.65	.336	.233
11	.648	7.82	3.09	3.69	.375	2.00	14.7	12.5	11.0	1.47	.300	.202
12	.648	7.73	3.48	2.72	.336	3.23	12.9	13.8	7.97	1.31	.300	.202
13	.597	5.34	6.41	3.28	.458	6.53	13.2	18.8	5.42	1.16	.265	.202
14	.597	5.03	6.91	2.84	.502	5.60	13.4	22.9	4.44	1.03	.300	.174
15	.597	9.12	9.87	2.79	.458	4.83	10.3	12.7	3.28	.930	.300	.202
16	.549	25.5	28.4	2.45	.549	5.24	11.0	10.0	3.35	.841	.300	.202
17	.549	27.5	20.1	2.15	.597	4.36	11.9	11.0	3.42	.811	.300	.375
18	.549	22.1	15.0	1.70	.549	3.91	11.7	12.9	7.11	.755	.300	.336
19	.549	16.2	15.6	1.43	.549	4.35	18.1	10.3	7.30	.755	.300	.265
20	.502	8.18	9.56	1.31	.700	4.20	17.9	13.2	7.92	.700	.300	.233
21	.648	5.34	20.3	1.16	.549	7.80	15.5	11.8	8.91	.648	.265	.233
22	.648	4.05	16.7	1.43	.415	11.3	15.2	10.1	8.04	.597	.265	.265
23	.648	4.83	10.9	1.43	.375	12.2	12.4	9.55	6.23	.597	.265	.415
24	.648	4.68	9.24	.999	.375	10.7	10.4	8.92	4.92	.549	.265	.375
25	.648	6.05	6.43	.783	.336	10.5	9.14	9.25	4.43	.549	.265	.375
26	.648	7.74	5.42	.783	.458	9.70	10.3	13.9	4.12	.502	.265	.233
27	.755	7.40	6.70	.700	.458	9.48	10.0	17.1	11.8	.458	.233	.233
28	.755	7.00	5.51	.674	.458	8.35	10.0	18.6	11.5	.415	.233	.233
29		5.68	3.35	.674	.458	9.33	10.6	15.5	15.2	.458	.233	.202
30		4.37	1.65	.623	.415	8.91	8.38	21.2	19.3	.415	.300	.265
31		3.03		.597		7.41	7.53		14.1		.300	.233
AVE	.640	7.72	7.99	3.37	.464	5.28	10.3	13.0	8.78	1.97	.307	.269

MEAN ANNUAL DISCHARGE 5.03 M3/S

STATION : ETHIOPIA WABI SHEBELLE MARIBO BRIDGE ROAD OF DODOLA

NUMBER : 13282201

AVERAGE DAILY DISCHARGES 1971-1972 (M3/S)

	FEBR	MARC	APRI	MAY	JUNE	JULY	AUGU	SEPT	OCTO	NOVE	DECE	JANU
1	.324	.123	.755	.728	3.15	8.18	8.69	10.1	13.4	2.25	1.51	.674
2	.629	.123	.674	.785	2.92	7.82	7.11	11.6	17.3	1.95	1.27	.573
3	.575	.123	.701	1.13	1.85	6.70	7.62	11.2	17.0	1.65	1.20	.550
4	.437	.123	.841	1.57	1.60	6.32	10.8	13.7	17.1	2.15	1.06	.674
5	.337	.123	.785	3.83	1.56	5.17	10.2	10.8	24.3	2.58	.930	.598
6	.265	.123	2.30	7.84	1.47	5.51	8.25	9.54	27.0	1.75	.870	.502
7	.233	.123	2.76	8.91	1.43	8.25	9.80	10.1	22.9	1.39	.755	.480
8	.202	.123	2.71	7.33	2.20	8.15	9.14	8.35	18.7	1.56	.755	.458
9	.202	.123	2.20	12.5	3.70	9.88	7.51	8.14	11.8	1.35	.700	.458
10	.202	.123	3.62	11.4	2.56	8.25	8.25	8.03	10.1	1.20	.700	.437
11	.202	.123	2.78	7.70	2.00	7.40	7.61	8.14	8.36	1.09	.597	.415
12	.202	.135	3.15	5.59	1.75	13.2	12.6	8.91	6.61	1.32	.549	.375
13	.174	.148	5.68	5.25	1.70	10.4	17.0	8.14	6.43	2.40	.597	.375
14	.161	.161	6.81	3.62	2.50	8.35	14.9	11.4	7.84	2.97	.502	.375
15	.174	.174	7.99	2.78	2.84	7.42	11.9	9.55	7.03	6.09	.458	.375
16	.161	.316	7.72	3.30	3.48	5.59	11.0	7.71	6.80	4.20	.502	.356
17	.174	.700	9.01	7.03	4.05	4.99	8.25	7.11	5.60	3.35	.458	.356
18	.174	.503	8.37	5.97	6.67	6.82	8.37	7.30	4.36	2.61	.437	.318
19	.174	.459	6.13	6.45	8.14	7.85	9.80	7.10	3.48	2.20	.395	.527
20	.174	.266	5.08	4.20	8.25	6.23	8.69	10.2	3.95	2.20	.395	.575
21	.147	.203	4.20	3.69	6.61	5.59	6.80	10.0	4.20	2.78	.459	.301
22	.147	.218	3.76	4.59	5.86	7.20	8.26	12.0	3.91	2.97	.573	.318
23	.123	.266	2.71	4.99	6.45	7.41	25.0	11.4	4.76	2.05	.573	.300
24	.123	.218	1.43	6.32	9.47	5.95	21.5	10.1	5.65	2.05	.597	.265
25	.123	.304	1.16	5.59	8.25	6.13	26.0	8.81	6.90	2.10	1.25	.265
26	.123	.652	1.25	6.32	7.40	5.07	20.3	9.48	7.20	1.75	1.75	.265
27	.123	.674	1.45	6.81	6.91	5.68	17.1	8.80	6.23	1.56	1.39	.300
28	.123	.841	.932	5.68	5.59	7.61	16.4	7.73	5.68	1.51	1.07	.265
29		1.09	.812	4.76	5.78	7.82	20.6	10.5	4.20	1.70	.783	.265
30		.932	.755	3.29	6.61	7.53	18.4	14.0	3.28	2.00	.700	.265
31		.841		2.78		10.0	12.5		2.61		.674	.265
AVE	.222	.337	3.28	5.25	4.42	7.37	12.6	9.67	9.51	2.22	.789	.404

MEAN ANNUAL DISCHARGE 4.71 M3/S

STATION : ETHIOPIA WABI SHEBELLE MARIBO MARIBO CONFLUENCE

NUMBER : 13282202

AVERAGE DAILY DISCHARGES 1968-1969 (M3/S)

	FEBR	MARC	APRI	MAY	JUNE	JULY	AUGU	SEPT	OCTO	NOVE	DECE	JANU
1	1.62	16.0	5.24	41.2	5.83	16.6	51.8	17.7	15.8	3.41	3.12	1.83
2	1.90	17.5	4.64	35.1	7.02	17.8	48.8	13.3	18.3	3.40	2.57	1.76
3	2.06	17.4	5.61	33.6	9.61	16.9	56.9	13.8	20.2	3.02	2.75	2.66
4	2.23	16.1	6.67	30.9	10.9	15.2	46.4	16.0	19.1	2.84	2.40	3.02
5	1.98	14.6	9.88	22.9	12.3	15.4	41.4	15.1	18.3	2.48	2.57	3.31
6	2.32	13.9	13.8	19.2	11.6	17.0	31.3	14.8	15.7	2.40	2.40	3.40
7	2.40	15.8	16.3	17.7	9.73	19.8	31.3	16.7	18.2	2.48	2.23	3.80
8	2.75	18.3	22.1	16.6	8.71	21.1	29.7	17.8	13.6	2.40	2.06	3.70
9	3.03	22.9	30.5	15.1	7.97	19.3	30.0	18.8	10.9	2.48	1.90	3.60
10	3.40	29.0	37.1	17.2	6.90	17.4	28.8	18.0	8.59	2.40	2.23	3.21
11	3.50	28.8	39.6	16.4	5.87	14.1	30.0	14.6	7.14	2.31	2.06	3.60
12	3.21	29.6	42.4	14.8	5.23	14.2	29.6	15.4	5.48	2.23	1.90	4.21
13	2.93	25.1	42.6	13.8	3.90	13.6	32.8	14.9	6.22	2.06	1.90	4.87
14	2.93	14.7	42.8	13.2	3.50	16.7	32.0	13.1	7.37	2.14	1.90	6.56
15	2.75	10.7	42.8	13.6	3.31	22.5	26.0	13.2	6.34	2.14	1.90	6.33
16	2.75	28.2		14.1	3.40	19.3	24.8	12.9	5.24	1.90	1.76	6.45
17	2.75	7.02		13.2	3.40	17.5	25.8	13.4	5.10	2.06	1.76	5.98
18	3.12	6.33		12.6	3.12	16.1	30.4	14.8	5.00	2.24	1.62	4.99
19	4.10	5.87		12.2	3.21	13.8	44.8	15.2	5.24	3.51	1.62	4.53
20	20.2	5.60		11.8	3.60	11.2	60.4	14.9	4.75	7.02	1.76	3.70
21	10.5	6.33	41.2	11.2	3.89	16.8	44.5	17.5	6.57	8.58	1.49	3.02
22	11.9	7.02	41.7	10.9	4.31	23.9	41.0	16.7	7.97	9.34	1.36	2.66
23	12.3	28.0	42.8	10.7	4.41	29.7	33.6	15.4	7.61	8.71	1.24	2.32
24	12.3	10.4	42.8	10.3	4.87	24.6	27.8	14.1	7.73	6.56	1.12	1.69
25	12.9	10.3	42.8	8.11	6.56	33.5	27.8	16.0	6.33	5.48	1.24	1.56
26	12.9	9.99	41.7	6.22	10.9	26.4	25.6	13.6	5.60	5.48	1.36	1.69
27	13.4	7.97	42.1	5.48	12.9	27.6	27.6	12.2	5.35	4.53	1.49	1.98
28	13.5	7.13	42.1	4.41	15.3	26.8	24.6	11.2	4.41	3.70	1.49	2.06
29	14.2	6.56	42.4	3.51	18.3	40.5	24.2	11.6	4.20	3.70	1.49	2.06
30		5.87	42.6	4.10	17.5	39.8	21.2	12.4	3.99	3.12	1.90	2.57
31		5.73		4.10		74.8	20.2		3.60		1.76	4.00
AVE	6.41	14.5	33.1	15.0	7.61	22.6	33.9	14.8	9.03	3.80	1.88	3.46

MEAN ANNUAL DISCHARGE 13.9 M3/S

STATION : ETHIOPIA   WABI SHEBELLE MARIBO   MARIBO CONFLUENCE

NUMBER : 13282202

AVERAGE DAILY DISCHARGES   1969-1970 (M3/S)

	FEBR	MARC	APRI	MAY	JUNE	JULY	AUGU	SEPT	OCTO	NOVE	DECE	JANU
1	6.07	23.6	22.1	21.8	3.12	4.41	45.9	20.7	11.1	2.57	1.49	1.12
2	6.33	18.1	14.8	25.6	2.75	4.64	41.0	20.5	9.21	2.49	1.49	1.07
3	6.00	14.2	11.8	29.6	2.57	4.75	36.5	18.0	8.71	3.50	1.62	1.07
4	5.23	11.6	10.1	23.9	2.23	4.64	28.4	19.7	8.21	2.93	1.49	1.07
5	4.53	10.7	9.21	18.2	2.23	4.87	28.0	19.1	12.2	2.75	1.49	1.07
6	3.80	9.34	10.8	24.6	2.06	4.87	25.2	17.7	10.7	3.14	1.49	1.07
7	2.93	10.0	11.8	17.8	2.06	4.20	27.2	17.7	12.8	2.84	1.49	1.51
8	2.32	15.3	15.1	17.7	1.90	3.80	27.2	27.0	9.47	2.48	1.36	1.49
9	1.90	25.1	18.5	20.7	1.76	3.40	38.4	33.5	8.96	2.40	1.36	1.56
10	2.14	35.8	17.5	22.9	1.76	5.37	40.1	22.1	7.85	2.06	1.36	1.56
11	2.31	34.3	13.8	17.4	1.62	5.16	33.2	23.6	6.57	1.90	1.24	1.56
12	2.66	25.8	10.3	13.9	1.76	6.62	32.8	30.4	6.45	1.90	1.24	1.43
13	3.40	24.8	8.46	10.7	1.62	9.61	30.7	31.1	6.43	1.76	1.24	2.19
14	3.99	23.6	7.85	8.21	1.49	11.1	24.2	26.8	5.98	1.76	1.24	2.85
15	4.87	22.0	7.25	7.37	1.36	10.7	20.5	25.6	5.36	1.76	1.24	3.82
16	6.90	19.1	5.60	6.45	1.49	10.3	21.2	24.0	4.53	1.69	1.12	3.44
17	10.5	18.3	5.61	5.73	1.76	10.7	24.6	18.5	4.31	1.56	1.12	2.66
18	9.77	17.0	6.79	4.52	2.06	9.99	22.7	15.2	4.54	1.49	1.12	3.13
19	10.8	16.1	7.85	4.10	2.23	11.0	21.2	12.8	4.77	1.62	1.12	3.12
20	10.8	16.7	7.37	3.70	2.23	22.5	18.0	10.8	5.49	1.56	1.12	7.37
21	10.3	26.0	6.79	3.50	2.40	21.8	22.0	9.60	5.95	1.49	1.12	6.06
22	11.2	29.6	5.98	3.12	2.40	27.0	20.7	8.71	5.11	2.23	1.12	10.3
23	10.8	30.9	7.61	2.75	2.57	23.1	20.5	8.33	5.60	4.69	1.12	10.0
24	13.9	31.7	7.85	2.57	3.12	32.8	28.0	8.58	3.90	3.13	1.12	11.4
25	22.0	39.1	6.90	2.75	3.50	28.4	22.6	7.13	3.50	2.23	1.12	7.13
26	28.4	42.8	8.60	3.12	3.89	22.7	24.4	7.49	3.21	1.91	1.12	5.48
27	28.6	40.3	12.6	3.31	4.52	44.0	20.5	9.03	3.02	1.90	1.24	4.00
28	25.4	39.1	10.8	3.50	4.75	48.7	22.8	9.34	3.02	1.69	1.24	3.31
29		39.8	11.9	3.89	4.52	39.6	24.4	7.61	2.75	1.56	1.49	2.84
30		33.2	14.9	3.50	4.10	40.2	23.7	7.13	2.57	1.49	1.24	2.66
31		27.6		3.12		52.8	22.5		2.40		1.12	2.40
AVE	9.21	24.9	10.6	11.0	2.53	17.2	27.1	17.3	6.28	2.22	1.28	3.54

MEAN ANNUAL DISCHARGE   11.1   M3/S

STATION : ETHIOPIA WABI SHEBELLE MARIBO MARIBO CONFLUENCE

NUMBER : 13282202

AVERAGE DAILY DISCHARGES 1970-1971 (M3/S)

	FEBR	MARC	APRI	MAY	JUNE	JULY	AUGU	SEPT	OCTO	NOVE	DECE	JANU
1	2.40	3.18	6.68	5.48	1.62	1.49	24.6	46.8	33.3	22.0	1.76	1.49
2	2.23	7.98	5.48	5.35	1.49	1.62	22.4	50.8	20.9	15.2	1.62	1.62
3	1.90	4.44	9.90	8.76	1.49	2.75	19.4	48.8	16.4	11.9	1.62	1.36
4	1.76	4.79	13.2	16.0	1.49	2.57	15.4	36.9	13.5	10.5	1.49	1.36
5	1.62	13.8	11.9	20.7	1.49	2.66	13.5	33.4	13.8	8.59	1.62	1.36
6	1.49	10.0	8.97	21.9	1.49	2.40	13.2	28.6	27.0	7.25	1.62	1.36
7	1.49	9.41	7.49	13.8	1.36	4.33	14.9	29.6	22.9	6.33	1.62	1.24
8	1.36	11.1	6.34	9.09	1.62	4.32	20.2	32.3	26.8	6.45	1.49	1.24
9	1.36	9.74	14.2	8.35	1.49	4.20	21.2	32.5	27.6	6.09	1.49	1.24
10	1.24	7.37	9.74	6.45	1.49	3.50	21.6	33.5	23.6	5.83	1.49	1.24
11	1.24	12.0	9.09	5.87	1.49	4.87	27.0	25.0	23.3	4.64	1.36	1.01
12	1.24	12.4	9.99	4.98	1.36	4.10	37.3	39.3	17.9	3.99	1.36	1.12
13	1.12	14.4	12.5	5.84	1.49	10.8	39.2	37.6	13.2	3.89	1.49	1.12
14	1.01	13.8	16.7	9.37	1.49	10.3	31.7	37.3	10.5	3.60	1.49	1.12
15	1.01	23.3	16.7	6.90	1.49	7.97	33.4	32.8	8.71	3.21	1.36	1.01
16	1.01	51.1	47.0	5.48	2.06	7.85	61.7	24.4	7.85	2.93	1.36	1.01
17	.957	62.7	38.4	4.53	2.06	12.4	61.4	24.1	8.59	2.93	1.24	1.24
18	.957	47.6	33.9	3.80	1.90	10.6	65.7	30.3	14.9	2.75	1.36	1.49
19	.957	32.8	25.6	3.31	1.90	12.4	79.6	24.0	10.1	2.75	1.36	1.49
20	.957	20.2	19.0	3.02	2.06	12.8	79.9	30.5	14.9	2.75	1.24	1.24
21	1.07	14.2	30.0	2.84	2.06	15.2	66.1	27.6	17.8	2.40	1.24	1.01
22	1.07	10.5	29.0	2.66	1.49	20.9	56.3	21.4	17.0	2.23	1.24	1.01
23	1.01	10.7	17.9	2.40	1.36	20.0	77.0	20.4	11.5	2.06	1.12	1.12
24	1.01	10.2	14.2	2.31	1.36	16.4	52.4	17.7	9.47	2.06	1.24	1.76
25	1.31	13.3	17.2	2.14	1.36	21.3	45.0	16.3	10.3	2.06	1.24	1.36
26	1.56	13.2	12.9	2.06	2.06	21.3	36.5	21.8	13.1	2.06	1.12	1.36
27	1.24	15.2	9.75	1.90	1.62	22.1	34.1	30.2	17.0	1.90	1.24	1.24
28	1.62	18.1	7.97	1.83	1.49	22.0	41.2	28.6	27.6	1.90	1.24	1.24
29		12.6	6.34	1.90	1.49	21.6	47.2	34.5	29.9	1.76	1.24	1.12
30		9.61	5.49	1.83	1.49	18.0	31.9	28.0	31.9	1.76	1.24	1.01
31		7.85		1.69		16.4	30.5		28.6		1.36	1.12
AVE	1.33	16.4	15.8	6.21	1.61	10.9	39.4	30.8	18.4	5.13	1.39	1.25

MEAN ANNUAL DISCHARGE 12.5 M3/S

STATION : ETHIOPIA WABI SHEBELLE MARIBO MARIBO CONFLUENCE

NUMBER : 13282202

AVERAGE DAILY DISCHARGES 1971-1972 (M3/S)

	FEBR	MARC	APRI	MAY	JUNE	JULY	AUGU	SEPT	OCTO	NOVE	DECE	JANU
1	1.01	.516	2.31	1.62	4.87	14.1	22.2	28.0			4.10	1.90
2	1.63	.431	1.98	1.90	4.64	12.0	17.8	30.9			3.89	2.06
3	2.21	.431	1.76	1.43	4.64	11.9	15.8	30.3			3.70	2.23
4	2.24	.431	2.48	2.30	3.99	11.8	14.2	33.4			3.89	2.06
5	1.69	.431	2.76	7.54	3.80	10.7	17.9	34.8			3.89	1.90
6	1.13	.431	2.84	16.1	3.40	12.3	22.5	26.2			3.70	1.76
7	.957	.431	4.77	19.0	4.03	12.9	26.7	29.8			3.50	1.49
8	.957	.431	6.20	26.6	5.49	13.4	23.8	25.6			3.50	1.36
9	.957	.431	6.32	34.5	9.60	22.9	20.4	25.0			3.89	1.36
10	.957	.516	10.5	21.3	8.09	20.4	19.2	19.8			4.10	1.49
11	1.07	.516	10.3	18.2	6.06	16.4	21.4	19.9			4.10	1.76
12	.903	.606	8.34	15.7	5.26	22.7	23.3	23.2			4.10	1.24
13	.903	.516	12.2	12.2	4.10	19.5	34.9	27.8			4.31	1.36
14	.851	.606	10.5	9.23		17.4	37.6	22.9			4.10	1.24
15	.851	.606	17.2	7.37		16.1	32.2	19.2			4.10	1.12
16	.851	.700	14.2	6.45		11.2	38.2	15.7			4.31	1.36
17	.799	1.97	11.3	6.55		13.8	28.6	14.1			4.10	1.24
18	.799	1.37	13.2	11.8		16.9	25.4	12.6			3.99	1.12
19	.799	1.25	11.1	8.46		25.8	28.8	14.4			4.31	1.12
20	.799	.957	11.0	9.09	18.5	19.3	28.4	15.5			5.23	1.12
21	.606	.700	7.38	6.22	20.0	17.5	25.0	14.1			5.87	1.36
22	.606	.561	4.99	5.48	16.9	13.8	36.0	16.0			6.33	1.24
23	.606	1.30	4.89	7.37	16.1	22.2	53.6	19.4			6.11	1.12
24	.606	1.70	3.40	10.4	18.6	22.9	50.3	20.6			6.33	1.12
25	.516	2.73	3.12	9.09	18.7	17.4	53.3	14.2			6.79	1.01
26	.516	2.93	2.75	9.21	16.3	14.9	58.5				4.77	1.01
27	.516	2.40	3.02	12.0	14.9	14.6	53.1				3.99	1.01
28	.516	2.17	2.66	12.8	13.6	16.4	52.8				3.50	1.01
29		3.51	2.31	9.09	13.2	18.2	52.1				2.93	1.01
30		3.81	1.91	6.68	13.6	21.2	50.1				2.14	1.01
31		2.93		5.48		20.7	36.9				2.06	1.01
AVE	.959	1.24	6.59	10.7	10.5	16.8	32.9	20.7			4.25	1.36

STATION : ETHIOPIA WABI SHEBELLE ERRER HAMERO-HEDAD

NUMBER : 13281412

AVERAGE DAILY DISCHARGES 1968-1969 (M3/S)

	FEBR	MARC	APRI	MAY	JUNE	JULY	AUGU	SEPT	OCTO	NOVE	DECE	JANU
1					54.5	14.3	10.7	11.9			3.08	2.70
2					74.3	14.3	11.4	11.4		3.08	3.08	2.70
3					48.6	14.3	14.4	11.2		3.08	3.08	2.70
4					35.7	13.9	12.6	10.9		3.08	3.08	2.70
5					115.	13.6	11.6	11.2		3.08	3.08	2.70
6						13.6	12.4	11.5		3.08	3.08	2.70
7						13.6	20.6	11.2		3.08	3.08	2.70
8						13.6	15.6	13.6		3.08	3.08	2.70
9						13.6	13.7	15.3		3.08	3.08	2.70
10						13.6	22.2	18.5		3.08	3.08	2.70
11						13.6	16.2	15.7		3.08	3.08	2.70
12						13.6	16.9	13.6		3.08	3.08	2.70
13						13.6	30.4	12.4		3.08	3.08	2.70
14						13.6	18.7	12.6		3.08	3.08	2.70
15						13.6	21.7	24.4		3.08	2.99	2.70
16						13.6	29.8	25.7		4.34	2.89	2.70
17						13.3	32.9			6.14	2.89	2.70
18						13.0	29.3			3.70	2.89	2.70
19						13.0	26.6			3.18	2.89	2.70
20						13.0	26.7			3.08	2.89	2.70
21						13.0	27.3			3.08	2.89	2.70
22						13.0	24.1			3.08	2.89	2.70
23						13.0	21.1			3.08	2.89	2.70
24				14.5		13.0	19.5			3.08	2.89	2.70
25				13.6		13.0	18.5			3.08	2.89	2.70
26				12.4		13.0	17.6		5.14	3.08	2.89	2.70
27				11.4		13.0	18.5			3.08	2.89	2.70
28				10.5		12.4	21.8			3.08	2.89	2.70
29				9.74		11.4	19.4			3.08	2.89	2.70
30				9.31	14.3	10.9	13.6			3.08	2.89	2.70
31				31.0		10.9	12.7				2.70	2.70
AVE						13.2	19.6				2.97	2.70

STATION : ETHIOPIA WABI SHEBELLE ERRER HAMERO-HEDAD

NUMBER : 13281412

AVERAGE DAILY DISCHARGES 1969-1970 (M3/S)

	FEBR	MARC	APRI	MAY	JUNE	JULY	AUGU	SEPT	OCTO	NOVE	DECE	JANU
1	2.70	4.79			5.60				11.5	62.7		1.70
2	2.79	4.23	3.42	35.2	5.60				7.61	30.3		1.70
3	2.89	3.70	3.01	18.3	5.44				6.52			1.70
4	2.89	3.28	2.73	16.7	5.29				7.93			1.70
5	2.99	2.99	2.56	16.2	5.29				5.23			1.70
6	3.18	2.79	2.22	29.9	5.15				4.27			1.70
7	3.28	2.51	2.16	21.7	5.00				7.96			1.70
8	3.28	2.89	4.05	17.2	5.00				6.77			1.70
9	3.28	3.05		18.4	4.85				5.38			1.70
10	3.28	2.56		23.1	4.70				5.30			1.70
11	3.28			16.0	4.70				4.70			1.70
12	3.28			12.5	4.56				4.35			1.70
13	3.28			10.5	4.41				4.14		1.76	1.70
14	3.28			9.45	4.41				4.08		1.76	1.70
15	5.79			8.68	4.28				3.89		1.76	3.69
16	4.63			8.12	4.14				3.89		1.76	2.28
17	5.38			7.75	4.14				3.77		1.76	1.96
18	5.50			7.40	4.01				3.25		1.76	1.86
19	5.50			7.23	3.89				3.10		1.76	1.82
20	5.50			7.05	3.89				3.00		1.76	5.45
21	5.50			6.88	3.89			6.06	3.10		1.76	3.45
22	5.50			6.72	3.89			5.60	3.10		1.73	2.12
23	5.50			6.39	3.89			5.15	2.91		1.70	2.58
24	6.20			6.22	3.89		5.00	4.85	2.73		1.70	2.28
25	7.48			6.22	3.89		15.3	4.56	2.64		1.70	2.49
26	6.08			6.22	20.8		13.2	4.41	2.64		1.70	2.36
27	5.99			6.06	5.79			4.41	2.64		1.70	2.03
28	5.67			5.91	4.14			4.28	2.64		1.70	1.86
29				5.75	4.14			4.14	2.64		1.70	1.79
30				5.60	4.01			9.75	2.64		1.70	1.76
31				5.60					2.64		1.70	1.76
AVE	4.42				5.09				4.42			2.11

STATION : ETHIOPIA WABI SHEBELLE ERRER HAMERO-HEDAD

NUMBER : 13281412

AVERAGE DAILY DISCHARGES 1970-1971 (M3/S)

	FEBR	MARC	APRI	MAY	JUNE	JULY	AUGU	SEPT	OCTO	NOVE	DECE	JANU
1	1.76	18.9	2.16	2.45	5.10	2.10	1.76	7.23	7.67	3.28	1.98	1.98
2	1.76	7.91	2.16	31.2	3.83	2.10	1.76	6.77	9.96	3.28	1.98	1.98
3	1.73	5.09	2.36	4.98	2.64	2.10	1.76	6.66	8.45	2.74	1.98	1.98
4	1.70	3.17	3.97	48.6	2.47	2.10	1.75	6.71	8.57	2.67	1.98	1.98
5	1.70	5.31	3.96	15.4	2.47	2.10	5.03	11.7	7.03	2.67	1.98	1.98
6	1.68	3.30	3.72	28.2	2.33	2.10	3.65	18.0	6.34	2.67	1.98	1.98
7	1.66	2.50	3.22	24.3	2.15	2.10	3.92	13.5	6.15	2.38	1.98	1.98
8	1.66	2.28	2.80	6.66	2.10	2.10	6.93	12.0	5.61	2.28	1.98	1.98
9	1.66	2.45	2.24	4.55	2.10	2.10	3.52	15.8	5.28	2.28	1.98	1.98
10	1.64	6.45	3.87	3.90	2.10	2.07	10.7	29.5	5.00	2.28	1.98	1.98
11	1.62	8.06	10.6	2.97	2.10	1.98	10.6	27.9	4.89	2.28	1.98	1.98
12	1.62	14.7	5.18	5.66	2.10	2.25	6.26	33.4	4.89	2.28	1.98	1.98
13	1.61	7.82	7.64	5.21	2.14	2.95	3.03	17.3	4.89	2.28	1.98	1.98
14	1.60	5.38	5.97	5.92	4.26	2.15	2.10	21.0	4.46	2.15	1.98	1.98
15	1.60	4.54	5.56	4.97	3.31	2.22	1.98	16.6	3.41	2.10	1.98	1.98
16	1.60	9.57	54.9	3.57	4.78	2.81	1.86	13.5	3.33	2.10	1.98	1.98
17	1.60	26.2	18.0	4.13	2.79	2.45	1.86	11.7	16.3	2.10	1.98	1.98
18	1.60	9.33	12.7	5.54	2.53	2.59	1.81	10.5	17.8	2.10	1.98	1.98
19	1.61	5.88	9.64	4.26	3.63	2.75	1.82	9.46	21.9	2.07	1.98	1.98
20	1.62	4.24	5.23	4.72	2.71	4.11	13.6	8.77	17.4	1.98	1.98	1.98
21	1.62	3.64	4.44	10.3	2.47	2.59	50.3	8.33	11.0	1.98	1.98	1.98
22	1.62	2.81	4.74	17.9	2.40	2.10	32.2	8.33	9.90	1.98	1.98	1.98
23	1.62	2.20	3.09	5.82	2.28	2.13	15.9	11.1	6.65	1.98	1.98	1.98
24	1.62	2.03	4.38	3.57	2.28	2.96	11.0	11.4	12.5	1.98	1.98	1.89
25	1.62	1.90	86.0	3.33	2.28	2.11	10.2	17.4	7.84	1.98	1.98	1.86
26	1.62	2.57	14.7	3.33	2.12	1.89	12.2	10.3	12.1	1.98	1.98	1.86
27	1.62	5.42	7.17	3.33	2.10	3.06	9.38	18.7	17.0	1.98	1.98	1.86
28	2.26	4.20	5.55	3.33	2.10	2.39	7.93	11.1	9.50	1.98	1.98	1.86
29		2.71	4.50	3.33	2.10	2.04	14.1	8.57	4.22	1.98	1.98	1.86
30		2.20	3.36	3.64	2.10	1.86	10.2	8.33	3.94	1.98	1.98	1.86
31		2.16		4.25		1.86	8.13		5.00		1.98	1.86
AVE	1.67	5.97	10.1	9.01	2.66	2.33	8.62	13.7	8.68	2.28	1.98	1.95

MEAN ANNUAL DISCHARGE 5.76 M3/S

STATICN : ETHIOPIA WABI SHEBELLE ERRER HAMERO-HEDAD

NUMBER : 13281412

AVERAGE DAILY DISCHARGES 1971-1972 (M3/S)

	FEBR	MARC	APRI	MAY	JUNE	JULY	AUGU	SEPT	OCTO	NOVE	DECE	JANU
1	1.86	1.60	1.86	1.40	2.43	2.27	3.30	2.99	3.61	1.88	2.13	1.90
2	1.79	1.60	10.8	9.87	2.75	2.27	4.56	2.99	3.44	1.85	2.11	1.89
3	1.76	1.60	3.47	33.1	2.26	2.41	3.42	5.04	3.37	1.82	2.10	1.89
4	1.76	1.60	2.92	7.55	2.25	2.60	3.13	9.60	3.61	1.81	2.09	1.88
5	1.76	1.60	3.24	9.54	2.24	2.32	2.78	7.92	4.86	1.81	2.07	1.88
6	1.76	1.60	7.96	20.3	2.22	2.27	10.7	8.22	7.01	1.81	2.06	1.87
7	1.76	1.60	9.38	7.84	2.20	2.27	15.9	8.80	4.41	1.81	2.05	1.86
8	1.76	1.60	3.74	5.22	2.18	2.27	7.65	10.2	7.30	1.81	2.03	1.86
9	1.76	1.60	5.56	6.80	2.16	2.27	5.01	8.99	3.11	1.81	2.02	1.85
10	1.76	1.60	26.3	8.51	2.13	2.27	7.53	9.98	2.60	1.88	2.01	1.85
11	1.76	1.60	12.8	15.7	2.11	2.27	9.84	13.0	3.01	4.76	2.00	1.84
12	1.74	1.60	18.5	5.41	2.09	2.46	6.53	7.65	5.68	16.5	2.00	1.84
13	1.68	1.60	13.0	3.67	2.07	11.7	5.62	6.63	6.41	5.04	1.99	1.83
14	1.68	1.60	5.54	4.23	2.05	7.41	3.93	5.87	9.08	4.97	1.99	1.83
15	1.68	1.60	2.54	10.4	11.1	4.57	3.70	5.50	7.46	5.21	1.98	1.82
16	1.68	1.60	3.40	10.3	8.57	3.46	3.76	5.83	3.46	3.83	1.98	1.82
17	1.68	1.55	2.09	43.0	13.4	2.85	4.28	6.40	3.22	2.89	1.97	1.81
18	1.68	1.54	1.88	12.9	8.29	2.71	5.09	8.55	3.13	2.63	1.97	1.81
19	1.68	1.54	1.78	5.49	23.2	2.41	7.43	8.32	10.7	2.60	1.96	1.80
20	1.68	1.54	1.63	3.20	10.1	2.40	6.36	6.52	2.57	2.60	1.96	1.79
21	1.68	1.54	1.50	2.88	5.02	2.39	5.97	5.99	2.36	2.60	1.95	1.79
22	1.68	1.54	1.41	2.79	7.55	2.36	14.5	5.85	2.09	2.60	1.95	1.78
23	1.68	1.54	1.40	22.0	4.99	2.33	7.60	5.53	14.3	2.59	1.94	1.78
24	1.68	1.64	1.40	5.22	3.19	2.31	5.16	4.96	9.16	2.55	1.94	1.77
25	1.68	5.99	1.40	6.31	2.60	2.28	3.69	4.42	4.57	2.50	1.93	1.77
26	1.62	4.67	1.40	8.78	2.74	2.25	3.41	4.42	2.77	2.46	1.93	1.76
27	1.60	1.84	1.40	7.28	2.70	2.22	3.37	4.42	2.46	2.41	1.92	1.76
28	1.60	1.48	1.40	3.89	2.58	2.20	3.33	4.42	2.32	2.36	1.92	1.75
29		1.43	1.40	2.43	2.45	2.26	3.26	4.17	2.74	2.31	1.91	1.75
30		1.42	1.40	2.43	2.33	3.22	3.18	3.81	2.13	2.23	1.91	1.74
31		1.88		3.65		2.40	3.11		1.92		1.90	1.73
AVE	1.71	1.83	5.08	9.42	4.73	2.96	5.71	6.57	4.67	3.13	1.99	1.82

MEAN ANNUAL DISCHARGE 4.15 M3/S

STATICN : ETHIOPIA WABI SHEBELLE DAKETA HAMERC-HEDAD

NUMBER : 13281109

AVERAGE DAILY DISCHARGES 1968-1969 (M3/S)

	FEBR	MARC	APRI	MAY	JUNE	JULY	AUGU	SEPT	OCTO	NOVE	DECE	JANU
1		21.5	.000					.000	.000	.162	.034	.000
2		5.24	.000		.085		.000	.000	.000	.059	.034	.000
3		1.05	.000		.000		.000	.000	.000	.034	.138	.000
4		.170			.000		.000	.000	.000	.017	.330	.000
5		.000			.000		.000	.000	.000	.000	.017	.000
6	.000	.000			.000		.000	.000	4.37	.000	.000	.000
7	.000	.000					.000	.000	5.58	.000	.000	.000
8	.000	.000					.000	.000	.173	.000	.000	.000
9	.000	.000					.000	.000	.038	.000	.000	.000
10	.000	.000					.000	.000	.000	.000	.000	.000
11	.000	.000					.000	.000	.000	.000	.000	.000
12	.000	.000					.000	.000	.000	.000	.000	.000
13	.000	.000					.000	.000	.000	.000	.000	.000
14	.000	.000					.000	.000	.000	.000	.000	.000
15	.000	.000					.000	.000	.000	.441	.000	.000
16	.000	.000					.000	.000	.000	3.13	.000	.000
17	.000	.000					.000	.000	.000	.467	.000	.000
18	.000	.000					.000	.000	.000	1.25	.000	.000
19	.000	.000					.000	.000	.022	.758	.000	.000
20	.000	.000					.000	.000	.008	4.91	.000	.000
21	.000	.000					.000	.000	5.15	4.52	.000	.000
22	.000	.000					.000	.000	.654	.725	.000	.000
23	.000	.000					.000	.000	.000	.294	.000	.000
24	.000	.000					.000	.000	.000	.196	.000	.000
25	.000	.000					.000	.000	.000	.119	.000	3.33
26	69.6	.000					.000	.000	.000	.125	.000	.914
27	269.	.000					.000	.000	14.6	.119	.000	.102
28	60.2	.000					.000	.000	3.75	.059	.000	.000
29	34.6	.000					.000	.000	2.94	.034	.000	.000
30		.000					.000	.000	2.02	.034	.000	.000
31		.000					.000		.477		.000	.000
AVE		.902						.000	1.28	.582	.018	.140

STATICN : ETHIOPIA WABI SHEBELLE DAKETA HAMERO-HEDAD

NUMBER : 13281109

AVERAGE DAILY DISCHARGES 1969-1970 (M3/S)

	FEBR	MARC	APRI	MAY	JUNE	JULY	AUGU	SEPT	OCTO	NOVE	DECE	JANU
1	.000	.017	.017	38.4			.000	.000	1.04	57.1	.000	.000
2	.000	.000	.000			.000	.000	.000	.337		.000	.000
3	.000	.000	.000			.000	.000	.000	1.12		.000	.000
4	.000	.000	.000			.000	.000	.000	3.79		.000	.000
5	.000	.000	.000			.000	.000	.000	14.5		.000	.000
6	.000	.000	.000			.000	.000	.000			.000	.000
7	.000	6.30	.000			.000	.000	.000			.000	.000
8	.000	.079	7.87			.000	.000	.000			.000	.000
9	.000	.000	8.10			.000	.000	.000	1.35		.000	.000
10	.000	.000	2.45			.000	.000	.000	45.8		.000	.000
11	.000	.000	.759			.000	.000	.000	11.2		.000	.000
12	.000	.000	.349			.000	.000	.000	1.29		.000	.000
13	.000	.000	.196			.000	.000	.000	.396		.000	.000
14	.000	.000	.153			.000	.000	.000	.055		.000	.000
15	.000	.000	.153	.596		.000	.000	.000	.000		.000	.000
16	.000	.000	.119	73.0		.000	.000	.000	.000		.000	.000
17	.000	.000	.085			.000	.000	.000	8.56		.000	.000
18	.000	.000	.085			.000	.000	.000	6.24		.000	.000
19	.000	.000	.085			.000	.000	.000	4.27		.000	.000
20	.000	.000	.059			.000	.000	.000	.441		.000	.042
21	.000	.000	.034			.000	.000	.000	.008	.000	.000	.690
22	.000	6.14	.598			.000	.000	.000	.000	.000	.000	28.7
23	.000	5.01	.520			.000	.000	.000	.000	.000	.000	29.2
24	.000	2.66	.145			.000	.000	.000	.000	.000	.000	3.93
25	.000		.017			.000	.000	.000	.000	.000	.000	1.07
26	1.90		.000			.000	.000	.000	.000	.000	.000	.341
27	.456	3.51	.708			.000	.000	.000	.000	.000	.000	.042
28	.089	.754	.252			.000	.000	.000	.000	.000	.000	.000
29		.439	.327			.000	.000	.000	.000	.000	.000	.000
30		.157	8.75			.000	.000	.000	.000	.000	.000	.000
31		.047				.000	.000		.000		.000	.000
AVE	.087		1.07				.000	.000			.000	2.06

STATION : ETHIOPIA WABI SHEBELLE DAKETA HAMERO-HEDAD

NUMBER : 13281109

AVERAGE DAILY DISCHARGES 1970-1971 (M3/S)

	FEBR	MARC	APRI	MAY	JUNE	JULY	AUGU	SEPT	OCTO	NOVE	DECE	JANU
1	.000	118.	.000	28.5		.000	.000	.000	.065	.477	.000	.000
2	.000	28.0	.000	26.8		.000	.000	.000	.012	.322	.000	.000
3	.000	7.56	.000	29.1		.000	.000	.000	.000	.250	.000	.000
4	.000	.844	43.6	99.7		.000	.000	.000	.000	.187	.000	.000
5	.000	.247	26.8	117.		.000	.000	.000	.000	.146	.000	.000
6	.000	.153	5.70	19.7		.000	.000	.000	.000	.106	.000	.000
7	.000	1.98	2.38	34.7		.000	.000	.000	.000	.095	.000	.000
8	.000	65.0	1.98	17.9		.000	.000	.000	.000	.054	.000	.000
9	.000	3.10	1.27	12.4		.000	.000	.000	.000	.042	.000	.000
10	.000	3.31	.878	24.6		.000	.000	.000	.000	.042	.000	.000
11	.000	2.38	12.9	23.2		.000	.000	.000	2.70	.033	.000	.000
12	.000	1.90	3.68	12.3		.000	.000	.000	.715	.010	.000	.000
13	.000	1.65		18.4		.000	.000	4.77	1.42	.000	.000	.000
14	.000	1.42		10.3		.000	.000	2.98	.586	.000	.000	.000
15	.000	9.12		4.81		.000	.000	.971	.301	.000	.000	.000
16	.000			2.94		.000	.000	.341	.184	.000	.000	.000
17	.000			7.43		.000	.000	.088	58.2	.000	.000	.000
18	.000			6.31		.000	.000	.003	87.2	.000	.000	.000
19	.000			3.96	.000	.000	.000	.000	37.2	.000	.000	.000
20	.000			15.7	.000	.000	.000	.000	103.	.000	.000	.000
21	.000			4.61	.000	.000	.000	.000	65.7	.000	.000	.000
22	.000			6.59	.000	.000	.000	.000	25.6	.000	.000	.000
23	.000			4.00	.000	.000	.000	.000	4.88	.000	.000	.000
24	.000			2.11	.000	.000	.000	.000	2.22	.000	.000	.000
25	.000			1.02	.000	.000	.000	110.	1.37	.000	.000	.000
26	.000				.000	.000	.000	20.8	4.97	.000	.000	.000
27	.000				.000	.000	.000	2.87	12.9	.000	.000	.000
28	.000				.000	.000	.000	.788	8.72	.000	.000	.000
29					.000	.000	.000	.383	6.15	.000	.000	.000
30			4.85		.000	.000	.000	.200	2.22	.000	.000	.000
31		.000				.000	.000		.829		.000	.000
AVE	.000					.000	.000	4.81	13.8	.059	.000	.000

STATION : ETHIOPIA WABI SHEBELLE DAKETA HAMERO-HEDAD

NUMBER : 13281109

AVERAGE DAILY DISCHARGES 1971-1972 (M3/S)

	FEBR	MARC	APRI	MAY	JUNE	JULY	AUGU	SEPT	OCTO	NOVE	DECE	JANU
1	.000	.000	.098	.019	.079	.000	.000	.000	.000	.000	.000	.000
2	.000	.000	.077	.019	.060	.000	.000	.000	.000	.000	.000	.000
3	.000	.000	.822	65.5	.371	.000	.000	.000	.000	.000	.000	.000
4	.000	.000	10.1	71.5	.127	.000	.000	.000	.387	.000	.000	.000
5	.000	.000	9.59	57.1	.068	.000	.000	.000	1.15	.000	.000	.000
6	.000	.000	7.61	296.	.045	.000	.000	.000	.152	.000	.000	.000
7	.000	.000	39.2	22.0	.031	.000	.000	.000	.065	.000	.000	.000
8	.000	.000	4.58	4.98	.021	.000	.000	.000	.028	.000	.000	.000
9	.000	.000	8.84	12.9	.015	.000	.000	.000	.019	.000	.000	.000
10	.000	.000	17.3	9.14	.006	.000	.000	.000	.000	.000	.000	.000
11	.000	.000	63.7	30.4	.000	.000	.000	.870	.000	.000	.000	.000
12	.000	.000	42.0	15.4	.000	.000	.000	2.74	.000	.000	.000	.000
13	.000	.000	52.7	2.91	.000	.000	.000	1.39	.000	.000	.000	.000
14	.000	.000	6.43	.753	.000	.000	.000	.213	.000	.665	.000	.000
15	.000	.000	2.69	.808	9.14	.000	.000	.082	.000	6.91	.000	.000
16	.000	.000	1.16	.435	3.83	.000	.000	.072	.000	23.6	.000	.000
17	.000	.000	1.42	3.89	19.0	.000	.000	.047	.000	8.90	.000	.000
18	.000	.000	.775	5.72	60.5	.000	.000	.042	.000	.512	.000	.000
19	.000	.000	.519	3.04	7.38	.000	.000	.031	.000	.125	.000	.000
20	.000	.000	.634	.974	2.85	.000	.000	6.76	.000	.105	.000	.000
21	.000	.000	.313	.255	1.22	.000	.000	3.13	.000	.085	.000	.000
22	.000	.000	.196	.136	.872	.000	.000	2.12	.000	.018	.000	.000
23	.000	.000	.126	.092	.143	.000	.000	.076	.000	.012	.000	.000
24	.000	.003	.095	.077	.116	.000	.000	.053	.000	.000	.000	.000
25	.000	56.4	.090	.060	.052	.000	.000	.004	.000	.000	.000	.000
26	.000	8.07	.067	.058	.044	.000	.000	.003	.000	.000	.000	.000
27	.000	2.16	.046	10.6	.036	.000	.000	.000	.000	.000	.000	.000
28	.000	.712	.042	9.86	.010	.000	.000	.000	.000	.000	.000	.000
29		.228	.030	1.78	.008	.000	.000	.000	.000	.000	.000	.000
30		.869	.019	.365	.006	.000	.000	.000	.000	.000	.000	.000
31		.122		.128		.000	.000		.000		.000	.000
AVE	.000	2.21	9.04	20.2	3.53	.000	.000	.588	.058	1.36	.000	.000

MEAN ANNUAL DISCHARGE 3.10 M3/S

STATION : ETHIOPIA WABI SHEBELLE JERER DEGAHBOUR

NUMBER : 13284101

AVERAGE DAILY DISCHARGES 1967-1968 (M3/S)

	FEBR	MARC	APRI	MAY	JUNE	JULY	AUGU	SEPT	OCTO	NOVE	DECE	JANU
1										.000	.000	.000
2										.000	.000	.000
3										.000	.000	.000
4										.000	.000	.000
5										.000	.000	.000
6										.000	.000	.000
7										.000	.000	.000
8										.000	.000	.000
9									.000	.000	.000	.000
10									.000	.000	.000	.000
11									.843	1.92	.000	.000
12									.866	.599	.000	.000
13									.335	.222	.000	.000
14									.106	.151	.000	.000
15									.004	.468	.000	.000
16									.000	.130	.000	.000
17									.000	.000	.000	.000
18									.000	1.36	.000	.000
19									.000	1.57	.000	.000
20									.000	.832	.000	.000
21									.000	.648	.000	.000
22									.000	.484	.000	.000
23									.000	.113	.000	.000
24									.000	.000	.000	.000
25									.000	.000	.000	.000
26									.000	.000	.000	.000
27									.000	.089	.000	.000
28									.000	.072	.000	.000
29									.000	.000	.000	.000
30									.000	.000	.000	.000
31									.000		.000	.000
AVE										.289	.000	.000

STATION : ETHIOPIA WABI SHEBELLE JERER DEGAHBOUR

NUMBER : 13284101

AVERAGE DAILY DISCHARGES 1968-1969 (M3/S)

	FEBR	MARC	APRI	MAY	JUNE	JULY	AUGU	SEPT	OCTO	NOVE	DECE	JANU
1	.000	.000	.000	1.13	.636	.000	.000	.000	.000	.000	.000	.000
2	.000	.000	.000	.582	5.45	.000	.000	.000	.000	.000	.000	.000
3	.000	.000	6.22	.565	6.30	.000	.000	.000	.000	.000	.000	.000
4	.000	.000	1.09	.573	5.66	.000	.000	.000	.000	.000	.000	.000
5	.000	.000	2.16	.386	1.37	.000	.000	.000	.000	.000	.000	.000
6	.000	.000	1.85	.109	.324	.000	.000	.000	.000	.000	.000	.000
7	.000	.000	2.26	.151	.000	.000	.000	.000	.000	.000	.000	.000
8	.000	.000	.316	.309	.000	.000	.000	.000	.000	.000	.000	.000
9	.000	.000	2.08	.120	.000	.000	.000	.000	.000	.000	.000	.000
10	.000	.000	1.20	.037	.000	.000	.000	.000	.000	.000	.000	.000
11	.000	.000	.674	.140	.181	.000	.000	.000	.000	.000	.000	.000
12	.000	.000	.199	.271	.043	.000	.000	.000	.000	.000	.000	.000
13	.000	.000	.360	.000	.173	.000	.000	.000	.000	.000	.000	.000
14	.000	.000	.472	.319	.444	.000	.000	.000	.000	.000	.000	.000
15	.000	.000	3.50	.655	.087	.000	.000	.000	.000	.000	.000	.000
16	.000	.000	2.00	.590	.251	.000	.000	.000	.000	.000	.000	.000
17	9.03	.000	1.76	.319	.300	.000	.000	.058	.000	.000	.000	.000
18	.000	.000	1.50	.000	.188	.000	.000	.000	.000	.584	.000	.000
19	.000	.000	.616	.000	.037	.000	.000	.000	.000	.283	.000	.000
20	.000	.000	.434	.051	.000	.000	.000	.000	.000	.000	.000	.000
21	.000	.000	.817	1.04	.000	.000	.000	.000	.000	.000	.000	.000
22	.000	.000	5.92	2.77	.000	.000	.000	.000	.000	.000	.000	.000
23	.000	.000	3.35	1.04	.000	.000	.000	.000	.000	.000	.000	.000
24	.000	.000	1.22	.414	.000	.000	.000	.000	.000	.000	.000	.000
25	.000	.000	.446	.225	.000	.000	.000	.000	.000	.000	.000	.000
26	.000	.000	.497	.014	.000	.000	.000	.000	8.87	.000	.000	.000
27	.000	.000	1.56	.000	.000	.000	.000	.000	1.11	.000	.000	.000
28	.000	.000	.305	.000	.000	.000	.000	.000	.285	.000	.000	.000
29	.000	.000	2.27	.000	.000	.000	.000	.000	.084	.000	.000	.000
30		.000	2.22	32.0	.000	.000	.000	.000	.000	.000	.000	.000
31		.000		.826		.000	.000		.000		.000	.000
AVE	.311	.000	1.58	1.44	.715	.000	.000	.002	.334	.029	.000	.000

MEAN ANNUAL DISCHARGE .366 M3/S

STATION : ETHIOPIA WABI SHEBELLE JERER DEGAHBOUR

NUMBER : 13284101

AVERAGE DAILY DISCHARGES 1969-1970 (M3/S)

	FEBR	MARC	APRI	MAY	JUNE	JULY	AUGU	SEPT	OCTO	NOVE	DECE	JANU
1	.000	.000	.000	.000	.000	.000	.000	.000	.000	4.31	.000	.000
2	.000	.000	.000	.000	.000	.000	.000	.000	.138	1.06	.000	.000
3	.000	.000	.000	.000	.000	.000	.000	.000	1.13	.000	.000	.000
4	.000	.000	.000	.000	.000	.000	.000	.000	1.61	.000	.000	.000
5	.000	.000	.000	.000	.000	.000	.000	.000	.655	.000	.000	.000
6	.000	.000	.000	.000	.000	.000	.000	.000	.408	.000	.000	.000
7	.000	.000	.000	.000	.000	.000	.000	.000	.634	.000	.000	.000
8	.000	.000	.000	.000	.000	.000	.000	.000	.506	.000	.000	.000
9	.000	.000	.000	.000	.000	.000	.000	.000	.114	.000	.000	.000
10	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
11	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
12	.000	.000	.000	.087	.000	.000	.000	.000	.000	.000	.000	.000
13	.000	.000	.000	.095	.000	.000	.000	.000	.000	.000	.000	.000
14	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
15	.000	.000	.000	1.05	.000	.000	.000	.000	.000	.000	.000	.000
16	.000	.000	.000	.763	.000	.000	.000	.000	.000	.000	.000	.000
17	.000	.000	.000	.007	.000	.000	.000	.000	.000	.000	.000	.000
18	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
19	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
20	.000	1.43	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
21	.000	.546	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
22	.573	.446	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
23	3.61	2.72	.000	1.23	.000	.000	.000	.000	.000	.000	.000	.000
24	6.36	1.07	.000	.356	.000	.000	.000	.000	.000	.000	.000	.000
25	.551	1.86	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
26	.195	1.54	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
27	.000	1.37	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
28	.000	.438	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
29		.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
30		.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
31		.000		.000		.000	.000		1.79		.000	.000
AVE	.403	.368	.000	.116	.000	.000	.000	.000	.225	.179	.000	.000

MEAN ANNUAL DISCHARGE .106 M3/S

STATION : ETHIOPIA WABI SHEBELLE JERER DEGAHBCUR

NUMBER : 13284101

AVERAGE DAILY DISCHARGES 1970-1971 (M3/S)

	FEBR	MARC	APRI	MAY	JUNE	JULY	AUGU	SEPT	OCTO	NOVE	DECE	JANU
1	.000	.163	.000	.963	.000	.000	.000	.000	.000	.000	.000	.000
2	.000	9.93	.000	6.26	.000	.000	.000	.000	.000	.000	.000	.000
3	.000	2.90	.000	.879	.000	.000	.000	.000	.000	.000	.000	.000
4	.000	1.26	.000	4.64	.000	.000	.000	.000	.046	.000	.000	.000
5	.000	.325	.000	6.96	.000	.000	.000	.000	.100	.000	.000	.000
6	.000	.059	.000	2.72	.000	.000	.000	.000	.000	.000	.000	.000
7	.000	.000	.000	7.49	.000	.000	.000	.000	.000	.000	.000	.000
8	.000	.000	.000	2.84	.000	.000	.000	.000	.000	.000	.000	.000
9	.000	3.27	.000	.860	.000	.000	.000	.000	.006	.000	.000	.000
10	.000	1.44	.874	1.15	.000	.000	.000	.000	.024	.000	.000	.000
11	.000	.387	.213	3.67	.000	.000	.000	.000	.036	.000	.000	.000
12	.000	.269	3.13	.048	.000	.000	.000	.000	.485	.000	.000	.000
13	.000	.909	.350	.000	.037	.000	.000	.000	.303	.000	.000	.000
14	.000	1.27	.004	.000	.058	.000	.000	.000	.001	.000	.000	.000
15	.000	4.53	2.50	.000	.000	.000	.000	.000	.000	.000	.000	.000
16	.000	5.35	6.94	.000	.000	.000	.000	.000	1.11	.000	.000	.000
17	.000	4.58	3.78	.178	.000	.000	.000	.000	1.34	.000	.000	.000
18	.000	2.01	17.9	.473	.000	.000	.000	.000	.644	.000	.000	.000
19	.000	.707	5.08	.182	.000	.000	.000	.000	2.42	.000	.000	.000
20	.000	.158	1.29	.000	.000	.000	.000	.000	1.11	.000	.000	.000
21	.000	.000	.139	.097	.000	.000	.000	.000	1.14	.000	.000	.000
22	.000	.000	.000	.200	.000	.000	.000	.000	.137	.000	.000	.000
23	.000	.000	.000	.161	.000	.000	.000	.000	.451	.000	.000	.000
24	.000	.000	.000	.083	.000	.000	.000	.000	3.16	.000	.000	.000
25	.000	.000	3.69	1.29	.192	.000	.000	.000	.449	.000	.000	.000
26	.000	.000	2.74	.946	.000	.000	.000	.000	1.39	.000	.000	.000
27	.000	.000	.025	3.44	.000	.000	.000	.000	.248	.000	.000	.000
28	.000	.000	.000	.269	.000	.000	.000	.000	.036	.000	.000	.000
29		.000	.000	.000	.001	.000	.000	.000	.000	.000	.000	.000
30		.000	9.50	.000	.000	.000	.000	.000	.000	.000	.000	.000
31		.000		.000		.000	.000		.000		.000	.000
AVE	.000	1.27	1.94	1.48	.010	.000	.000	.000	.472	.000	.000	.000

MEAN ANNUAL DISCHARGE .434 M3/S

STATION : ETHIOPIA WABI SHEBELLE JERER DEGAHBOUR

NUMBER : 13284101

AVERAGE DAILY DISCHARGES 1971-1972 (M3/S)

	FEBR	MARC	APRI	MAY	JUNE	JULY	AUGU	SEPT	OCTO	NOVE	DECE	JANU
1	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
2	.000	.000	.000	.000	.000	.000	.000	.000	.356	.000	.000	.000
3	.000	.000	.462	.154	.000	.000	.000	.000	1.48	.000	.000	.000
4	.000	.000	1.63	34.1	.000	.000	.000	.000	.000	.000	.000	.000
5	.000	.000	1.98	8.23	.000	.000	.000	.000	.000	.000	.000	.000
6	.000	.000	3.23	2.61	.000	.000	.000	.000	.000	.000	.000	.000
7	.000	.000	5.41	.217	.000	.000	.000	.000	1.23	.000	.000	.000
8	.000	.000	2.74	10.2	.000	.000	.000	.066		.000	.000	.000
9	.000	.000	1.28	4.70	.000	.000	.000	.475		.000	.000	.000
10	.000	.000	2.45	2.92	.000	.000	.000	.000		.000	.000	.000
11	.000	.000	4.38	1.53	.000	.000	.000	.000		.000	.000	.000
12	.000	.000	5.55	1.97	.000	.000	.000	.000		.000	.000	.000
13	.000	.000	2.94	4.29	.000	.000	.000	.000		.000	.000	.000
14	.000	.000	.687	.757	.000	.000	.000	.000		.000	.000	.000
15	.000	.000	2.89	.349	.000	.000	.000	.000		.000	.000	.000
16	.000	.000	1.04	1.07	2.89	.000	.000	.000		.000	.000	.000
17	.000	.000	.147	1.46	.846	.000	.000	.000	.000	.000	.000	.000
18	.000	.000	.000	5.48	2.54	.000	.000	.347	.000	.000	.000	.000
19	.000	.000	.110	3.31	3.04	.000	.000	.162	.000	.000	.000	.000
20	.000	.000	.226	.291	2.15	.000	.000	.000	.000	.000	.000	.000
21	.000	.000	.007	.000	2.11	.000	.000	.000	.000	.000	.000	.000
22	.000	.000	.000	.000	1.09	.000	.000	.000	.000	.000	.000	.000
23	.000	.000	.000	.045	.463	.000	.000	.000	.000	.000	.000	.000
24	.000	.000	.000	.185	.083	.000	.000	.000	.000	.000	.000	.000
25	.000	.000	.000	2.25	.000	.000	.000	.000	.000	.000	.000	.000
26	.000	.000	.000	1.77	.000	.000	.000	.000	.000	.000	.000	.000
27	.000	.000	.000	1.01	.000	.000	.000	.000	.000	.000	.000	.000
28	.000	.000	.000	.697	.000	.000	.000	.000	.000	.000	.000	.000
29		.000	.000	.492	.000	.000	.000	.000	.000	.000	.000	.000
30		.000	.000	.278	.000	.000	.000	.000	.000	.000	.000	.000
31		.000		.000		.000	.000		.000		.000	.000
AVE	.000	.000	1.24	2.92	.507	.000	.000	.035		.000	.000	.000

STATION : ETHIOPIA WABI SHEBELLE FAFEN KEBRI DAHAR

NUMBER : 13281602

AVERAGE DAILY DISCHARGES 1968-1969 (M3/S)

	FEBR	MARC	APRI	MAY	JUNE	JULY	AUGU	SEPT	OCTO	NOVE	DECE	JANU
1						.000	.000	.000	.000	.405	.000	.000
2						.000	.000	.000	.000	.153	.000	.000
3						.000	.000	.000	.000	.053	.000	.000
4						.000	.000	.000	.000	.006	.000	.000
5						.000	.000	.000	.000	.000	.000	.000
6						.000	.000	.000	.000	.000	.000	.000
7						.000	.000	.000	.000	.000	.000	.000
8						.000	.000	.000	.000	.000	.000	.000
9						.000	.000	.000	.000	.000	.000	.000
10						.000	.000	.000	.000	.000	.000	.000
11						.000	.000	.000	.000	.000	.000	.000
12						.000	.000	.000	.000	.000	.000	.000
13						.000	.000	.000	.000	.000	.000	.000
14						.000	.000	.000	.000	.376	.000	.000
15						.000	.000	.000	.490	.835	.000	.000
16						.000	.000	.000	.170	.216	.000	.000
17						.000	.000	.000	.008	.166	.000	.000
18						.000	.000	.000	.000	.056	.000	.000
19						.000	.000	.000	.000	.006	.000	.000
20						.000	.000	.000	.000	.093	.000	.000
21						.000	.000	.000	.000	.030	.000	.000
22						.000	.000	.000	.000	.076	.000	.000
23						.000	.000	.000	.000	.013	.000	.000
24						.000	.000	.000	.000	.000	.000	.000
25						.000	.000	.000	.000	.000	.000	.000
26						.000	.000	.000	.000	.000	.000	.000
27						.000	.000	.000	.000	.000	.000	.000
28					.000	.000	.000	.000	.000	.000	.000	.000
29					.000	.000	.000	.000	.000	.000	.000	.000
30					.000	.000	.000	.000	8.08	.000	.000	.000
31						.000	.000		1.69		.000	.000
AVE						.000	.000	.000	.337	.083	.000	.000

STATION : ETHIOPIA WABI SHEBELLE FAFEN KEBRI DAHAR

NUMBER : 13281602

AVERAGE DAILY DISCHARGES 1969-1970 (M3/S)

	FEBR	MARC	APRI	MAY	JUNE	JULY	AUGU	SEPT	OCTO	NOVE	DECE	JANU
1	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
2	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
3	.000	.000	.000	.000	.000	.000	.000	.000	.000	25.3	.000	.000
4	.000	.000	.000	14.8	.000	.000	.000	.000	.000	13.5	.000	.000
5	.000	.000	.000	9.92	.000	.000	.000	.000	.000	1.69	.000	.000
6	.000	.000	.000	6.32	.000	.000	.000	.000	.000	.579	.000	.000
7	.000	.000	.000	26.1	.000	.000	.000	.000	.000	.201	.000	.000
8	.000	.000	.000	44.9	.000	.000	.000	.000	.000	1.71	.000	.000
9	.000	.000	.000	2.37	.000	.000	.000	.000	.000	.080	.000	.000
10	.000	.000	.000	.862	.000	.000	.000	.000	1.67	.000	.000	.000
11	.000	.000	.000	5.15	.000	.000	.000	.000	1.13	.000	.000	.000
12	.000	.000	.000	9.19	.000	.000	.000	.000	2.37	.000	.000	.000
13	.000	.000	.000	17.0	.000	.000	.000	.000	.579	.000	.000	.000
14	.000	.000	.000	6.68	.000	.000	.000	.000	.141	.000	.000	.000
15	.000	.000	.000	2.47	.000	.000	.000	.000	.036	.000	.000	.000
16	.000	.000	.000	5.70	.000	.000	.000	.000	.008	.000	.000	.000
17	.000	.000	.000	6.46	.000	.000	.000	.000	.000	.000	.000	.000
18	.000	.000	.000	7.33	.000	.000	.000	.000	.000	.000	.000	.000
19	.000	.000	.000	2.71	.000	.000	.000	.000	.000	.000	.000	.000
20	.000	.000	.000	1.13	.000	.000	.000	.000	.000	.000	.000	.000
21	.000	.000	.000	.270	.000	.000	.000	.000	.000	.000	.000	.000
22	.000	.000	.000	.163	.000	.000	.000	.000	.000	.000	.000	.000
23	.000	.000	.000	.076	.000	.000	.000	.000	.000	.000	.000	.000
24	.000	.000	.000	.011	.000	.000	.000	.000	.000	.000	.000	.000
25	.000	1.88	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
26	.000	.707	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
27	.000	.400	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
28	.000	.080	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
29		.013	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
30		.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
31		.000		.000		.000	.000		.000		.000	.000
AVE	.000	.099	.000	5.47	.000	.000	.000	.000	.192	1.44	.000	.000

MEAN ANNUAL DISCHARGE .608 M3/S

STATION : ETHIOPIA WABI SHEBELLE FAFEN KEBRI DAHAR

NUMBER : 13281602

AVERAGE DAILY DISCHARGES 1970-1971 (M3/S)

	FEBR	MARC	APRI	MAY	JUNE	JULY	AUGU	SEPT	OCTO	NOVE	DECE	JANU
1	.000	.000	.000	3.17	.598	.000	.000	.000	.005	.734	.000	.000
2	.000	.000	.000	11.2	.336	.000	.000	.000	.000	.292	.000	.000
3	.000	.000	.000	13.0	.201	.000	.000	.000	.000	.072	.000	.000
4	.000	5.29	.420	7.27	.033	.000	.000	.000	.000	.010	.000	.000
5	.000	1.32	6.42	3.46	.016	.000	.000	.000	.000	.000	.000	.000
6	.000	1.42	5.13	1.57	.000	.000	.000	.000	.000	.000	.000	.000
7	.000	.716	.970	13.4	.000	.000	.000	.000	.000	.000	.000	.000
8	.000	.231	.180	7.33	.000	.000	.000	.000	.000	.000	.000	.000
9	.000	.048	.048	2.60	.000	.000	.000	.000	.000	.000	.000	.000
10	.000	.006	.033	1.93	.000	.000	.000	.000	.000	.000	.000	.000
11	.000	.000	2.20	4.88	.000	.000	.000	.000	.000	.000	.000	.000
12	.000	.000	.615	28.3	.000	.000	.000	.000	.014	.000	.000	.000
13	.000	.000	16.9	8.78	.000	.000	.000	.000	.426	.000	.000	.000
14	.000	.000	5.29	2.12	.000	.000	.000	.000	.247	.000	.000	.000
15	.000	.000	3.26	1.18	.000	.000	.000	.000	2.45	.000	.000	.000
16	.000	17.6	.926	.862	.000	.000	.000	.000	1.17	.000	.000	.000
17	.000	5.13	15.5	.850	.000	.000	.000	.000	4.05	.000	.000	.000
18	.000	6.68	14.0	.579	.000	.000	.000	.000	2.17	.000	.000	.000
19	.000	3.86	7.05	.216	.000	.000	.000	.000	4.82	.000	.000	.000
20	.000	3.01	16.2	6.68	.000	.000	.000	.000	5.71	.000	.000	.000
21	.000	4.67	21.5	1.23	.000	.000	.000	.000	3.35	.000	.000	.000
22	.000	4.25	7.19	.405	.000	.000	.000	.000	2.32	.000	.000	.000
23	.000	1.56	3.23	.115	.000	.000	.000	.000	.915	.000	.000	.000
24	.000	.928	18.3	.801	.000	.000	.000	.000	1.81	.000	.000	.000
25	.000	.420	4.21	.896	.000	.000	.000	.000	2.00	.000	.000	.000
26	.000	.180	4.55	.243	.000	.000	.000	.000	2.17	.000	.000	.000
27	.000	.036	2.91	.067	.000	.000	.000	7.40	2.23	.000	.000	.000
28	.000	.001	.928	.021	.000	.000	.000	1.26	12.8	.000	.000	.000
29		.000	4.00	3.25	.000	.000	.000	.281	3.94	.000	.000	.000
30		.000	2.18	5.38	.000	.000	.000	.066	1.23	.000	.000	.000
31		.000		1.44		.000	.000		.430		.000	.000
AVE	.000	1.85	5.47	4.30	.041	.000	.000	.300	1.75	.037	.000	.000

MEAN ANNUAL DISCHARGE 1.15 M3/S

STATION : ETHIOPIA WABI SHEBELLE FAFEN KEBRI DAHAR

NUMBER : 13281602

AVERAGE DAILY DISCHARGES 1971-1972 (M3/S)

	FEBR	MARC	APRI	MAY	JUNE	JULY	AUGU	SEPT	OCTO	NOVE	DECE	JANU
1	.000	.000	.000	.000	.534	.585	.000	.000	.000	.010	.000	.000
2	.000	.000	.000	.000	.430	.261	.000	.000	.000	.000	.000	.000
3	.000	.000	.000	.000	.242	.092	.000	.000	.000	.372	.000	.000
4	.000	.000	.000	.000	.092	.047	.000	.000	.000	.036	.000	.000
5	.000	.000	.000	.000	.034	.022	.000	.000	.000	.559	.000	.000
6	.000	.000	1.26	21.8	.007	.007	.000	.000	.000	.267	.000	.000
7	.000	.000	2.57	24.2	.000	.000	.000	.000	.000	.026	.000	.000
8	.000	.000	1.14	25.9	.000	.000	.000	.000	1.23	.003	.000	.000
9	.000	.000	6.44	5.64	.000	.000	.000	.000	9.97	.000	.000	.000
10	.000	.000	2.99	16.2	.000	.000	.000	.000	5.67	.000	.000	.000
11	.000	.000	3.23	7.72	.000	.000	.000	.000	3.81	.000	.000	.000
12	.000	.000	.864	3.59	.000	.000	.000	.000	.267	.000	.000	.000
13	.000	.000	1.01	1.90	.000	.000	.000	.000	.061	.000	.000	.000
14	.000	.000	3.50	2.17	.000	.000	.000	6.06	7.33	.000	.000	.000
15	.000	.000	1.81	1.00	.000	.000	.000	1.02	11.2	.000	.000	.000
16	.000	.000	2.11	3.26	.000	.000	.000	.231	1.93	.000	.000	.000
17	.000	.000	1.41	1.23	.000	.000	.000	.213	.243	1.33	.000	.000
18	.000	.000	.373	5.31	.000	.000	.000	.086	.111	.615	.000	.000
19	.000	.000	.177	1.66	.000	.000	.000	.040	.030	.226	.000	.000
20	.000	.000	.149	2.10	4.44	.000	.000	.021	.013	.131	.000	.000
21	.000	.000	.166	5.16	2.42	.000	.000	.000	.000	.053	.000	.000
22	.000	.000	.091	2.25	1.18	.000	.000	.000	.000	.025	.000	.000
23	.000	.000	.040	.847	.496	.000	.000	.000	.000	.010	.000	.000
24	.000	.000	.005	.321	1.78	.000	.000	.000	.340	.000	.000	.000
25	.000	.000	.000	.075	1.45	.000	.000	.000	.053	.000	.000	.000
26	.000	.000	.000	.051	.729	.000	.000	.000	10.1	.000	.000	.000
27	.000	.000	1.90	.012	1.87	.000	.000	.000	7.12	.000	.000	.000
28	.000	.000	.117	.001	1.03	.000	.000	.000	1.15	.000	.000	.000
29		.000	.031	.361	.411	.000	.000	.000	.469	.000	.000	.000
30		.000	.005	.981	.573	.000	.000	.000	.143	.000	.000	.000
31		.000		.331		.000	.000		.030		.000	.000
AVE	.000	.000	1.05	4.32	.591	.033	.000	.256	1.98	.122	.000	.000

MEAN ANNUAL DISCHARGE .704 M3/S

ANNEXE II

MONTHLY EVAPORATION

TABLE 2.20

RESULTS OF PAN EVAPORATION TESTS
THROUGHOUT THE SURVEY PERIOD (mm)

Year	J	F	M	A	M	J	J	A	S	O	N	D	Total p/year
ADABA													
1968							143	133	130	154	129	163	
1969	140	109	140	144	149	138	104	105	120	140	165	180	1 634
1970	142	171	180	177	180	170	136	130	147	177	175	183	1 968
1971	160	168	175	143	174	(154)	113	119	113	127	155	175	1 776
TICHO													
1968								124	119	107	130	121	
1969	112	106	105	129	136	114	105	115	103	127	127	155	1 434
1970	105	129	101	105	148	132	111	99	102	87	139	138	1 394
1971	125	151	123	118	108	117	111	113	105	80			
GIRANA													
1968							87	84	84	152	139	143	
1969	143	143	183	150	149	129	102	118	102	136	183	232	1 565
1970	226	199	112	126	132	128	112	87	99	(126)	164	182	1 693
1971	217	171	161	125	206	105	93	123	96	101	110	130	1 638
MEDAGALOLA													
1968					164	138	136	150	165	202	150	227	
1969	239	202	251	267	164	168	136	167	177	171	165	186	2 233
1970	149	202	121	149	167	153	156	130	126	106	204	195	1 858
1971	180	165	180	169	143	(130)	122	137	141	150	137	132	1 836
HAMERO-HEDAD													
1968					189	240	240	279	310	217	210	250	
1969	267	274	295	298	276								
1970			319	295	244	251	283	275	273	208	255	274	
1971	275	280	275	223	195	225	266	282	274	202	198	231	2 896
GODE													
1968							298	272	339	226	194	260	
1969	307	330	341	324	257	327	350	375	342	229	237	304	3 723
1970	332	336	353	216	273	304	348	380	362	253	283	333	3 773
1971	369	310	333	274	231	298		369	384	243	265	333	

ANNEXE III

SUSPENDED SEDIMENT TRANSPORTATION

TABLE 10.1

SUSPENDED SEDIMENT TRANSPORTATION OF THE WABI SHEBELLE AT MALKA WACANA

N°	Date	H scale m.	discharge m³/s	Turbidity g/m³	sedim/disch. kg/s
Year 1968					
1	27- 9	1,39	40,9	68,0	1,70
2	1-10	1,42	42,9	54,1	2,30
3	3-10	1,56-1,55	52,0	57,5	3,00
4	4-10	1,40	41,6	56,5	2,40
5	7-10	1,53	50,3	59,4	3,00
6	9-10	1,28	34,7	59,5	2,10
7	12-10	0,97-0,96	18,4	61,6	1,10
8	14-10	0,89	14,6	45,9	0.70
9	15-10	0,85	13,0	48,2	0,60
10	16-10	0,84	12,0	45,5	0,60
11	17-10	0,81	11,5	43,5	0,50
12	19-11	0,80	11,3	20,2	0,20
13	4-12	0,67	7,00	25,6	0,20
Year 1969					
14	23- 1	0,63	5,90	44,0	0,30
15	26- 2	1,75	67,4	99,7	6,70
16	28- 2	1,62	56,9	54,5	3,10
17	30- 3	1,49	47,5	48,1	2,30
18	4- 4	0,95	18,0	25,5	0,50
19	16- 4	0,79	10,8	30,0	0,30
20	17- 4	0,77	10,1	20,0	0,20
21	19- 4	0,79	10,8	25,0	0,30
22	20- 4	0,81	11,5	25,0	0,30
23	21- 4	0,83	12,2	34,4	0,30
24	22- 4	0,85	13,0	24,8	0,30
25	25- 4	0,93	16,7	24,4	0,40
26	27- 4	0,97	18,6	31,6	0,60
27	2- 5	1,46	45,6	80,0	3,60
28	13- 5	1,14	27,2	120	3,30
29	3- 6	0,72	8,50	17,5	0,20
30	7- 7	0,99	19,5	74,4	1,40
31	15- 7	1,11	25,7	37,7	1,00
32	27- 7	1,81	71,7	121	8,70
33	28- 7	2,18	108	305	32,8
34	29- 7	2,05	93,7	151	14,1
35	30- 7	1,93	87,4	137	11,9
36	31- 7	2,11	100	162	16,2
37	5- 8	2,02	91,2	231	21,0
38	6- 8	1,92	81,3	134	10,9
39	12- 8	1,87	76,8	122	9,30
40	13- 8	1,94	83,1	107	8,90
41	15- 8	1,69	62,2	120	7,40
42	22- 8	2,24	115	185	21,2
43	23- 8	2,27	118	225	26,4
44	23- 8	2,38	130	296	38,5
45	27- 8	1,86	75,9	169	12,8
46	1- 9	1,78	69,3	99,1	6,90
47	2- 9	1,59	54,7	71,5	3,90
48	13- 9	1,95	84,0	70,7	5,90
49	14- 9	1.85	75,0	52.4	3,90
50	15- 9	1,86	76,4	63,3	4,80
51	16- 9	1,63	57,6	51,0	2,90
52	17- 9	1,44	44,2	54,8	2,40
53	20- 9	1,31	36,2	87,3	3,20
54	21- 9	1,21	30,9	57,5	1,80
55	23- 9	1,17	29,0	37,0	1,10
56	24- 9	1,21	30,9	46,7	1,40
57	25- 9	1,23	32,0	39,3	1,30
58	26- 9	1,09	24,9	80,8	2,00
59	28- 9	1,00	20,0	45,0	0,90

TABLE 10.2

SUSPENDED SEDIMENT TRANSPORTATION OF THE WABI SHEBELLE AT HAMERO-HEDAD

N°	Date	H scale m	dis-charg. m^3/s	Turbidity g/m^3	sedim/disch. kg/s
year 1968					
1	20- 7	2,32	120	246	29,6
2	14- 7	3,11	227	1 465	333
3	16- 8	3,39	269	1 736	466
4	17- 8	3,35	263	1 765	462
5	22- 9	3,71	321	822	264
year 1969					
6	12- 4	2,50	150	651	97,7
7	16- 4	2,02	95,6	405	38,7
8	30- 7	2,97	219	1 058	232
9	3- 8	3,54	300	878	270
10	4- 8	3,23	258	1 494	336
11	16- 8	2,67	174	467	73,7
12	24- 8	2,95	216	352	75,9
13	26- 8	3,25	261	3 340	873
14	27- 8	3,18	251	1 463	367
15	28- 8	3,31	271	1 247	337
16	28- 8	3,40	286	1 423	406
17	29- 8	2,96	218	1 168	254
18	30- 8	3,29	267	612	164
19	31- 8	2,82	196	1 695	332
20	1- 9	2,96	218	501	109
21	2- 9	2,95	216	608	131
22	3- 9	2,68	175	659	115
23	4- 9	2,46	145	634	91,9
24	5- 9	2,34	130	570	74,2
25	8- 9	2,59	163	580	94,3
26	9- 9	2,91	210	1 138	239
27	10- 9	2,89	207	1 259	261
28	16- 9	3,30	269	528	142
29	18- 9	2,68	175	408	71,5
30	23- 9	2,10	104	96,8	10,0
31	26- 9	1,93	86,2	104	9,00
32	28- 9	1,86	79,2	205	16,3
33	29- 9	1,76	70,1	97,5	6,80
34	30- 9	1,73	67,6	86,0	5,80
35	1-10	1,89	82,0	980	80,4
36	2-10	1,68	63,3	1 127	71,3
37	3-10	1,71	65,8	262	17,2
38	4-10	1,64	59,9	548	32,6
39	6-10	1,69	64,2	648	41,6
40	7-10	1,67	62,4	85,8	5,40
41	10-10	1,74	68,4	510	34,9
42	11-10	1,70	65,0	294	19,1
43	12-10	1,64	59,9	147	8,90
44	13-10	1,56	53,3	194	10,3
45	16-10	1,41	42,2	40,4	1,70
46	18-10	1,34	37,6	106	4,00
47	22-10	1,27	33,0	19,9	0,70
48	27-10	1,22	29,8	14,3	0,40
year 1970					
49	23- 3	2,46	147	1 117	164
50	27- 3	1,91	80,8	520	42,0
51	28- 3	1,95	84,2	1 053	88,7
52	31- 3	1,98	86,8	750	65,1
53	2- 4	1,77	69,8	200	18,0
54	3- 4	1,67	62,6	260	16,3
55	9- 4	1,62	59,3	375	22,3
56	11- 4	1,83	74,4	287	21,3
57	12- 4	1,77	69,8	3 565	249
58	14- 4	1,98	86,8	3 600	313
59	15- 4	1,98	86,8	2 707	235
60	16- 4	2,50	153	3 587	549
61	16- 4	2,85	208	14 727	3 056
62	17- 4	3,84	385	8 077	3 110

TABLE 10.2 (...)

SUSPENDED SEDIMENT TRANSPORTATION OF THE WABI SHEBELLE AT HAMERO-HEDAD

N°	Date	H scale m	dis-char. m³/s	Turbidity g/m³	sedim/disch. kg/s
Year 1968		(.../...)			
63	19- 4	2,91	218	6 220	1 354
64	21- 4	2,49	152	1 813	275
65	23- 4	2,38	135	1 163	157
66	25- 4	3,50	324	38 253	12375
67	25- 4	2,26	117	880	103
68	28- 4	2,28	120	3 477	417
69	30- 4	2,14	102	1 117	114
70	1- 5	1,99	87,6	670	58,7
71	5- 5	2,14	102	3 333	341
72	6- 5	2,69	183	10 700	1 953
73	9- 5	2,48	150	1 983	298
74	21- 7	2,50	152	590	90,0
75	22- 7	2,38	136	1 000	136
76	23- 7	2,10	104	2 000	208
77	24- 7	2,12	106	460	49,0
78	26- 7	2,27	123	290	36,0
79	27- 7	2,[illegible]	210	1 290	271
80	28- 7	2,67	175	2 750	481
81	29- 7	2,61	167	1 740	291
82	30- 7	2,41	140	1 380	193
83	31- 7	2,68	177	1 310	232
84	1- 8	2,44	144	1 400	202
85	5- 8	2,49	150	750	112
86	6- 8	3,67	340	4 140	1 408
87	7- 8	3,34	283	4 990	1 412
88	8- 8	3,22	262	4 800	1 258
89	10- 8	3,03	230	2 150	495
90	11- 8	3,21	260	6 360	1 654

N°	Date	H scale m	discharg m³/s	Turbidity g/m³	sedim/disch. kg/s
91	12- 8	3,42	296	3 810	1 128
92	13- 8	3,82	368	2 430	394
93	14- 8	3,59	326	4 500	1 467
94	16- 8	3,88	378	1 700	643
95	17- 8	3,42	296	1 980	586
96	18- 8	5,05	606	5 230	3 169
97	21- 8	4,31	456	8 650	3 944
98	22- 8	4,72	537	7 690	4 129
99	23- 8	4,57	506	5 840	2 955
100	24- 8	3,95	391	3 040	1 189
101	25- 8	3,60	328	1 920	630
102	26- 8	3,24	263	1 690	444
103	27- 8	3,02	230	1 100	253
104	29- 8	3,49	308	1 250	385
105	30- 8	3,51	312	1 450	452
Year 1971					
106	10- 8	2,68	178	2 190	390
107	16- 8	2,71	180	2 900	522
108	20- 8	3,60	330	4 150	1 370
109	21- 8	3,10	242	13 610	329
110	28- 8	3,27	(272)	(1 670)	454
111	29- 8	3,05	235	1 431	336
112	1- 9	3,00	227	1 290	292
113	4- 9	2,82	198	3 590	711
114	6- 9	2,98	223	4 410	983
115	12- 9	2,96	220	3 510	772
116	16- 9	2,42	142	1 900	270
117	21- 9	2,08	102	650	66,3
118	28- 9	1,98	90,0	200	18,0

TABLE 10.3

SUSPENDED SEDIMENT TRANSPORTATION OF THE DAKETA AT HAMERO-HEDAD

N°	Date	H scale m	dis-char. m^3/s	Turbidity kg/m^3	sedim/disch. kg/s
Year 1970					
1	2[illegible]- 9	2,79	430	32,9	14 147
2	26- 9	0,8[illegible]	15,0	34,4	516
3	28- 9	0,48	3,20	13,1	419
4	17-10	0,90	18,0	50,8	914
5	17-10	1,72	114	60,7	6 920
6	21-10	2,14	210	61,3	12 873
7	22-10	1,14	26,0	26,6	692
8	23-10	0,68	4,50	13.1	59,0
9	24-10	0,50	2,30	6,00	14,0
10	27-10	0,90	13,0	59,0	767
11	29-10	0,62	6,50	14,7	95,6
Year 1971					
12	25- 3	1,60	78,0	22,1	1 724
13	26- 3	0,91	8,00	5,30	42,0
14	28- 3	0,40	0,50	2,60	1,30
15	3- 4	0,47	1,00	7,10	7,10
16	4- 4	0,90	13,0	13,4	174
17	6- 4	0,95	15,0	25,7	385
18	7- 4	2,30	225	24,3	5 467
19	11- 4	1,55	70,0	12.8	896
20	11- 4	1,25	35,0	16,4	574
21	15- 4	0,51	2,20	5,50	12,1
22	17- 4	0.39	1,00	0,59	0,59
23	27- 4	0.18	0,[illegible]0	0,25	-
24	3- 5	1,92	140	25,0	3 500
25	4- 5	1,48	60.0	16,1	966
26	5- 5	1,20	30,0	12,3	369
27	6- 5	2,70	345	20,4	7 038
28	7- 5	1,13	22,0	14,6	321
29	8- 5	0,87	12,0	5,70	68,0
30	9- 5	1,00	17,0	7,90	134
31	11- 5	0,80	9,50	13,9	132

TABLE 10.4

SUSPENDED SEDIMENT TRANSPORTATION OF THE WABI SHEBELLE AT GODE

N°	Date	H scale m	dis-char. m³/s	Turbidity g/m³	sedim/disch. kg/s
Year 1968					
1	6- 9	0,73	104	1 175	123
2	8- 9	0,63	92,6	948	87,8
3	10- 9	0,77	110	1 128	124
4	13- 9	0,91	132	1 303	172
5	14- 9	1,03	147	1 639	240
6	19- 9	1,28	184	1 602	294
7	21- 9	1,16	166	1 898	315
8	28- 9	0,81	115	1 057	121
9	18-10	0,49	75,4	728	54,9
10	20-10	0,39	65,2	816	53,2
11	25-10	0,32	57,2	662	37,8
12	30-10	0,63	92,6	6 171	571
13	4-11	0,18	44,2	1 097	48,5
14	6-11	0,10	37,0	702	26,0
15	11-11	0,00	33,0	415	13,7
16	27-11	1,33	192	13 136	2 522
17	27-11	0,10	37,0	94,5	3,50
Year 1969					
18	15- 1	-0,10	25,5	86,2	2,20
19	22- 1	-0,15	19,0	51,4	1,00
20	17- 2	-0,22	15,0	83,0	1,20
21	21- 2	-0,27	12,5	55,5	0,70
22	22- 2	1,67	261	6 028	1 573
23	23- 2	1,43	218	4 257	927
24	6- 3	1,45	221	2 451	542
25	9- 3	0,90	132	1 483	196
26	12- 3	1,61	249	2 214	551
27	13- 3	1,83	291	1 906	555
28	15- 3	1,82	289	3 071	889
29	15- 3	1,93	297	2 979	889
30	17- 3	1,26	180	3 872	697
31	7- 4	0,65	96,5	812	78,3
32	8- 4	0,58	87,4	750	65,6
33	9- 4	0,50	77,0	613	47,2
34	10- 4	0,45	71,0	577	41,0
35	11- 4	0,40	65,7	499	32,8
36	12- 4	1,05	155	870	135
37	13- 4	1,30	197	1 579	311
38	14- 4	1,02	150	2 876	422
39	15- 4	0,97	143	2 763	394
40	16- 4	0,87	128	1 541	197
41	18- 4	0,70	103	955	98,3
42	19- 4	0,60	90,0	773	69,6
43	20- 4	0,55	83,5	655	54,7
44	21- 4	0,48	74,3	891	66,2
45	22- 4	0,40	65,7	666	43,7
46	23- 4	0,35	60,5	693	41,9
47	24- 4	0,32	57,3	612	35,0
48	25- 4	0,28	53,4	1 030	55,0
49	26- 4	0,26	51,2	510	26,0
50	27- 4	0,29	54,2	464	25,2
51	28- 4	0,37	62,6	440	27,6
52	29- 4	0,45	71,0	1 423	101
53	30- 4	0,60	90,0	1 038	93,4
54	1- 5	0,63	93,9	764	71,7
55	2- 5	1,22	183	1 423	261
56	3- 5	1,30	197	9 253	1 823
57	4- 5	2,15	340	4 400	1 496
58	4- 5	2,40	374	8 605	3 218
59	5- 5	3,06	475	71 464	33 945
60	5- 5	2,87	445	12 560	5 592
61	6- 5	2,43	379	10 767	4 075
62	6- 5	2,77	429	13 967	5 995
63	6- 5	2,30	360	10 605	3 818
64	8- 5	1,65	257	5 983	1 538
65	9- 5	1,67	261	2 935	766
66	10- 5	1,59	245	2 704	663
67	11- 5	1,24	187	5 836	1 090
68	12- 5	1,18	177	5 581	986
69	25- 8	1,22	183	1 288	236
70	28- 8	1,63	253	1 427	361
71	30- 8	1,64	255	3 366	858
72	1- 9	1,62	251	1 843	463
73	4- 9	1,36	207	1 624	336

TABLE 10.4. (.../...)

SUSPENDED SEDIMENT TRANSPORTATION OF THE WABI SHEBELLE AT GODE

Nº	Date	H scale m	dis-char. m³/s	Turbi-dity g/m³	sedim/disch. kg/s
Year 1969 (.../...)					
74	6- 9	1,15	172	929	159
75	7- 9	1,01	149	1 012	150
76	9- 9	0,92	135	1 221	165
77	10- 9	0,85	125	1 047	130
78	12- 9	1,29	195	1 275	249
79	15- 9	1.59	245	1 532	376
80	16- 9	1,40	213	1 374	293
81	18- 9	1,49	227	1 693	385
82	20- 9	1,29	195	2 004	391
83	22- 9	1,15	172	1 353	233
84	24- 9	0,90	132	890	117
85	25- 9	0,81	119	727	86,0
86	29- 9	0,64	95,2	436	41,5
87	1-10	0,55	83,5	1 183	98,8
88	3-10	0,49	75,4	315	23,7
89	8-10	1,07	158	865	137
90	15-10	0,51	78,3	3 050	239
91	17-10	0,34	59,4	6 539	388
92	19-10	0,28	53,4	610	32,6
93	22-10	0,60	90,0	5 700	513
94	24-10	0,20	45,5	2 376	108
95	26-10	0,14	40,2	932	37,4
96	30-10	0,13	39,4	653	25,7
97	1-11	0,07	34,6	358	12,4
98	3-11	0,05	33,0	450	14,8
99	4-11	2,01	320	11 377	3 645
100	5-11	1,64	255	16 310	4 159
101	5-11	1,84	293	16 030	4 694
102	5-11	2,05	326	14 430	4 704
103	5-11	2,11	334	14 200	4 748
104	10-11	0,11	37,8	5 840	221
105	12-11	0,01	29,8	377	11,2
106	14-11	-0,02	27,6	459	12,6
107	17-11	-0,07	24,1	374	9,00
108	20-11	-0,10	22,0	194	4,30
109	23-11	-0,15	19,0	106	2,00
110	11-12	-0,20	16,0	529	8,50
111	18-12	-0,25	13,5	41,6	0,60
Year 1970					
112	2- 1	-0,32	10,0	26,0	0,30
113	20- 1	-0,37	7,70	42,4	0,30
114	23- 2	-0,28	12,0	50,0	0,60
115	2- 3	-0,33	9,40	80,0	0,80
116	4- 3	1,33	191	19 300	3 688
117	6- 3	0.44	69,9	21 720	1 518
118	8- 3	0,34	59,4	23 500	1 396
119	10- 3	0,82	116	20 300	2 363
120	13- 3	0,70	101	7 130	718
121	15- 3	0,69	99,5	5 180	515
122	17- 3	0,74	106	14 000	1 477
123	18- 3	2,00	309	15 450	4 774
124	19- 3	2,86	447	11 450	5 114
125	20- 3	3,16	496	12 800	6 344
126	21- 3	3,32	521	11 450	5 968
127	22- 3	3,25	510	5 740	2 928
128	23- 3	2,31	359	5 970	2 141
129	23- 3	2,15	333	4 940	1 645
130	23- 3	2,03	314	4 750	1 491
131	23- 3	1,98	306	5 250	1 604
132	24- 3	1,64	243	4 200	1 021
133	24- 3	1,51	221	4 100	905
134	25- 3	1,31	188	4 170	783
135	26- 3	1,10	157	2 930	468
136	27- 3	0,93	134	2 300	307
137	15- 4	0,82	116	7 310	851
138	16- 4	0,92	132	4 050	536
139	17- 4	1,85	283	12 400	3 503
140	18- 4	2,03	314	15 310	4 804
141	19- 4	2,02	312	13 400	4 184
142	19- 4	2,18	338	11 [illegible]	3 750
143	20- 4	1,89	290	15 400	4 468
144	21- 4	1,81	275	9 450	2 598
145	22- 4	3,82	598	10 550	6 311

TABLE 10.4. (.../...)

SUSPENDED SEDIMENT TRANSPORTATION

OF THE WABI SHEBELLE AT GODE

N°	Date	H scale m	dis-char. m^3/s	Turbi-dity g/m^3	sedim/disch. kg/s
Year 1970 (.../...)					
146	23- 4	3,42	537	7 300	3 922
147	23- 4	3,48	547	19 100	10 444
148	24- 4	2,55	397	6 750	2 680
149	24- 4	2,11	327	6 700	2 188
150	24- 4	2,03	314	7 250	2 275
151	25- 4	3,39	532	2 950	1 571
152	25- 4	3,35	526	3 800	1 999
153	25- 4	3,12	489	2 950	1 443
154	26- 4	2,24	347	5 450	1 893
155	27- 4	1,41	205	3 700	757
156	28- 4	2,01	311	3 600	1 118
157	29- 4	1,73	260	3 500	909
158	30- 4	1,12	160	17 950	2 868
159	1- 5	0,97	138	12 150	1 682
160	2- 5	0,99	141	7 100	1 000
161	3- 5	0,86	124	4 600	569
162	4- 5	0,76	103	3 450	373
163	7- 5	1,68	250	8 700	2 179
164	8- 5	1,23	176	9 500	1 667
165	9- 5	1,76	265	23 550	6 250
166	10- 5	1,51	221	12 700	2 808
167	11- 5	1,70	254	10 900	2 769
168	12- 5	1,24	177	9 350	1 655
169	14- 5	0,94	135	5 300	714
170	16- 5	0,87	125	5 950	743
171	18- 5	0,69	99,5	7 250	721
172	21- 5	0,60	88,0	2 550	724
173	23- 5	0,45	71,0	4 700	334
174	28- 5	0,36	61,5	2 600	160
175	31- 5	0,21	46,4	6 650	309
176	4- 6	0,10	35,0	800	28,0
177	6- 6	0,09	34,0	620	21,0
178	11- 6	0,02	29,0	360	10,4
179	15- 6	0,12	37,0	280	10,4
180	20- 6	0,90	128	200	25,6
181	5- 8	1,13	164	1 850	303
182	12- 8	1,64	248	5 500	1 364
183	19- 8	2,16	338	3 100	1 048
184	26- 8	2,91	455	4 650	2 116
185	2- 9	1,96	304	1 750	532
186	9- 9	1,43	213	3 540	754
187	16- 9	1,74	265	2 340	620
188	2-10	1,55	232	2 350	545
189	9-10	0,87	123	850	104
190	16-10	1,07	154	1 690	260
191	23-10	1,27	186	14 290	2 660
192	30-10	1,11	161	4 590	739
193	6-11	0,36	122	1 700	207
194	13-11	0,39	64,0	450	29,0
195	20-11	0,17	41,0	200	8,00
196	27-11	0,03	29,5	80,0	2,40
197	3-12	-0,07	22,5	50,0	1,10
198	10-12	-0,12	19,0	50,0	0,90
199	18-12	-0,17	16,5	50,0	0,80
200	25-12	-0,21	14,5	30,0	0,40
Year 1971					
201	1- 1	-0,23	13,1	10,0	0,10
202	15- 1	-0,27	11,7	50,0	0,60
203	22- 1	-0,28	11,3	10,0	0,10
204	29- 1	-0,31	10,1	20,0	0,20
205	5- 2	-0,32	9,70	100	1,00
206	12- 2	-0,34	8,90	100	0,90
207	19- 2	-0,34	8,90	100	0,90
208	26- 2	-0,38	7,10	50,0	0,40
209	3- 3	-0,42	6,10	50,0	0,30
210	13- 3	-0,46	4,90	60,0	0,30
211	26- 3	-0,48	4,00	100	0,40
212	2- 4	0,27	42,2	5 300	224
213	9- 4	0,52	77,9	5 620	438
214	16- 4	1,09	169	9 800	1 656
215	23- 4	0,62	89,3	5 880	525
216	29- 4	0,25	53,9	2 840	153
217	7- 5	1,52	241	23 220	5 596
218	14- 5	1,38	198	6 470	1 281
219	21- 5	0,80	109	4 390	479
220	28- 5	0,54	79,5	3 350	266
221	4- 6	0,45	69,3	9 000	624

TABLE 10.5

SUSPENDED SEDIMENT TRANSPORTATION OF THE WABI SHEBELLE AT BURKUR

N°	Date	H scale m	discharg. m^3/s	Turbidity g/m^3	sedim/disch. kg/s
Year 1970					
1	1- 7	0,36	18,6	50,0	0,96
2	4- 8	2,55	102	400	41,0
3	11- 8	2,90	112	190	21,0
4	18- 8	3,43	136	180	25,0
5	25- 8	4,83	30,0	186	5,60
6	1- 9	5,62	30,0	235	7,10
7	8- 9	5,88	40,0	243	9,70
8	15- 9	5,69	20,0	229	4,60

TABLE 10.6.

SUSPENDED SEDIMENT TRANSPORTATION OF THE FAFEN AT KEBRI-DAHAR

N°	Date	H scale m	discharg. m^3/s	Turbidity kg/m^3	sedim/disch. kg/s
Year 1970					
1	13-10	0,64-0,65	0,85	10,9	9.30
2	14-10	0,58	0,27	66,4	17,9
3	15-10	0,67	1,20	79,0	94,8
4	15-10	0,78	3,23	77,3	250
5	19-10	0,86	5,81	106	618
6	26-10	0,89-0,87	6,35	52,3	332
7	28-10	1,11-1,10	15,7	74,5	1 170
Year 1971					
8	7- 4	0,78-0,77	1,93	133	257
9	7- 4	0,79	2,42	119	288
10	8- 4	0,73-0,72	1,56	50,9	79.4
11	8- 4	0,68-0,67	0,96	50,5	48,5
12	8- 4	0,65-0,64	0,62	42,3	26,2
13	9- 4	0,77	2,12	51,5	109
14	9- 4	0,97-1,00	7,07	121	855
15	10- 4	0,82	3,61	55,0	199
16	11- 4	0,88-0,85	4,48	65,4	293
17	11- 4	0,74	1,88	42,9	80,7
18	12- 4	0,67	0,90	72,2	65,0
19	13- 4	0,70	1,36	75,1	102
20	14- 4	0,87-0,86	4,39	(160)	702
21	14- 4	0,81-0,80	3,37	(170)	573
22	16- 4	0,75-0,74	1,95	110	214
23	16- 4	0,78	2,79	97,5	272
24	18- 4	0,60	0,29	37,4	10,8
25	20- 4	0,56	0,12	2,90	0,35
26	21- 4	0,59	0,25	0,50	0,12
27	27- 4	0,75	2,35	15,7	36,9
28	6- 5	1,29-1,28	24,1	91,8	2 212
29	6- 5	1,25-1,24	20,1	72,5	1 457
30	7- 5	1,27-1,29	22,8	70,0	1 596
31	7- 5	1,36-1,37	28,4	81,7	2 320
32	8- 5	1,41	32,0	44,7	1 430

ANNEXE IV

RESULTS OF CHEMICAL ANALYSIS

TABLE 11.1

CHEMICAL ANALYSIS OF THE WABI SHEBELLE WATER (mg/l)

Station	Date	Dischar. m^3/s	Conductivity 10^{-3} mhos/cm.	PH Labo	TAC CO_3Ca	Cl^-	SO_4^{--}	K^+	Na^+	Ca^{++}	Mg^{++}	SiO_2
MELKA-WAKANA	14- 7-1970	29,3	0,082	6,85	38,0	1,3	< 5	2,8	5,0	6,3	2,1	26,5
	21- 7-1970	32,1	0,077	6,90	34,0	1,3	< 5	2,6	4,6	5,7	1,7	22,5
	28- 7-1970	37,0	0,068	7,40	33,0	1,0	< 5	2,0	3,7	5,7	1,8	20,0
	4- 8-1970	48,8	0,064	7,00	33,0	1,1	< 5	2,6	4,0	4,8	1,7	24,0
	11- 8-1970	98,8	0,064	6,70	30,0	1,4	< 5	3,2	3,8	4,8	1,7	18,4
	18- 8-1970	123	0,069	7,10	34,0	1,2	< 5	2,3	3,9	5,4	1,8	16,9
	25- 8-1970	101	0,078	6,95	38,0	1,3	< 5	2,0	4,2	5,3	2,3	24,1
	1-12-1970	5,12	0,19	7,45	89,0	2,4	< 5	4,6	10,0	12,3	4,8	25,3
	8-12-1970	4,87	0,20	7,40	92,0	2,7	< 5	4,8	11,0	14,5	5,1	37,0
	15-12-1970	4,62	0,23	6,85	95,0	3,1	< 5	5,8	12,0	12,8	5,1	21,1
HAMERO-HEDAD	30- 7-1970	143	0,30		180	4,0		1,6	6,0	40	10	
	6- 8-1970	298	0,36		159	4,2		2,0	6,0	50	12	
	7- 8-1970	285	0,42		185	3,8		2,9	6,0	64	14	
	13- 8-1970	358	0,34		170	3,8		1,7	6,0	56	10	
	16- 8-1970	343	0,33		190	3,4		1,8	5,0	47	12	
	17- 8-1970	354	0,34		145	3,3		1,2	6,0	47	11	
	18- 8-1970	535	0,43		161	3,5		1,6	6,0	53	21	
	21- 8-1970	462	0,39		185	5,5		2,4	8,0	44	15	
	26- 8-1970	260	0,33		185	5,0		1,9	7,0	47	13	
	1- 9-1970	213	0,37		197	5,0		1,6	6,0	45	11	
	7- 9-1970	212	0,35		150	6,0		1,6	7,0	36	18	
	13- 9-1970	284	0,43		120	6,0		1,9	9,0	45	20	
IMI	20-12-1970	13,0	0,64	7,7	140	21,8	140	4,1	24,0	50,2	25	30,0
	2- 2-1971	12,6	0,72	7,4	138	24,2	160	4,7	26,0	58,5	27,5	30,5

TABLE 11.1 (.../1)

CHEMICAL ANALYSIS OF THE WABI SHEBELLE WATER (mg/l)

Station	Date	Dischar. m^3/s	Conductivity 10^{-3} mhos/cm	PH Labo	TAC CO_3Ca	Cl^-	SO_4^{--}	K^+	Na^+	Ca^{++}	Mg^{++}	SiO_2
GODE	25- 8-1969	175	0,31	7,7	136	3,9		1,6	9,0	46	19	
	28- 8-1969	242	0,27	7,4	95	4,9		1,6	10,0	36	17	
	30- 8-1969	250	0,30	8,0	117	6,4		1,6	10,0	36	10	
	1- 9-1969	234	0,40	7,7	134	6,1		2,3	11,0	44	10	
	4- 9-1969	199	0,34	8,0	118	4,1		1,6	10,0	46	12	
	5- 8-1970	165	0.42	7,9	184	6,0			10,0	60	8	
	12- 8-1970	239	0,52	7,6	128	7,0		1,9	9,0	67	11	
	19- 8-1970	335	0,42	7,7	177	7,0		1,9	9,0	62	8	
	26- 8-1970	436	0,42	7,8	90	9,0			10,0	58	8	
	2- 9-1970	282	0,40	7,6	151	9,0		2,3	10,0	54	8	
	9- 9-1970	216	0,48	7,6	175	7,0		1,9	11,0	66	13	
	16- 9-1970	273	0,46	7,6	200	10,0			12,0	64	14	
	2-10-1970	237	0,44		227	9,0		1,6	13,0	58	14	
	9-10-1970	123	0,42		185	9,0		1,6	10,0	62	7	
	16-10-1970	157	0,58	7,5	182	13,0		2,3	18,0	64	19	
	23-10-1970	195	1,01	7,3	130	22,0		4,0	23,0	156	31	
	30-10-1970	189	1,98	7,4	121	24,0		3,2	23,0	182	17	
	6-11-1970	121	0,41	7,3	162	10,0		1,9	14,0	60	12	
	13-11-1970	61,4	0,42	7,6	162	11,0		1,6	13,0	60	12	
	20-11-1970	38,6	0,52	7,5	148	14,5	92	3,8	16,0	50	10	23,1
	27-11-1970	29,0	0,52	7,6	133	18,0	112	3,2	18,0	63	15	24,4
	3-12-1970	23,8	0,61	7,7	139	21,2	135	3,6	22,0	73	19	26,7
	10-12-1970	19,3	0,64	7,6	136	24,7	180	3,8	22,0	58	21	27,0
	18-12-1970	16,5	0,67	7,6	134	26,6	173	4,2	26,0	52	23	27,3
	25-12-1970	14,5	0,68	8,0	132	29,0	180	4,3	27,0	55	25	27,0
	1- 1-1971	13,1	0,70	7,9	129	30,6	190	4,4	30,0	55	26	27,6
	8- 1-1971	11,7	0,70	7,5	128	32,2	200	4,5	30,0	64	26	27,0
	15- 1-1971	11,7	0,73	7,6	127	33,0	203	4,7	36,0	60	27	27,6

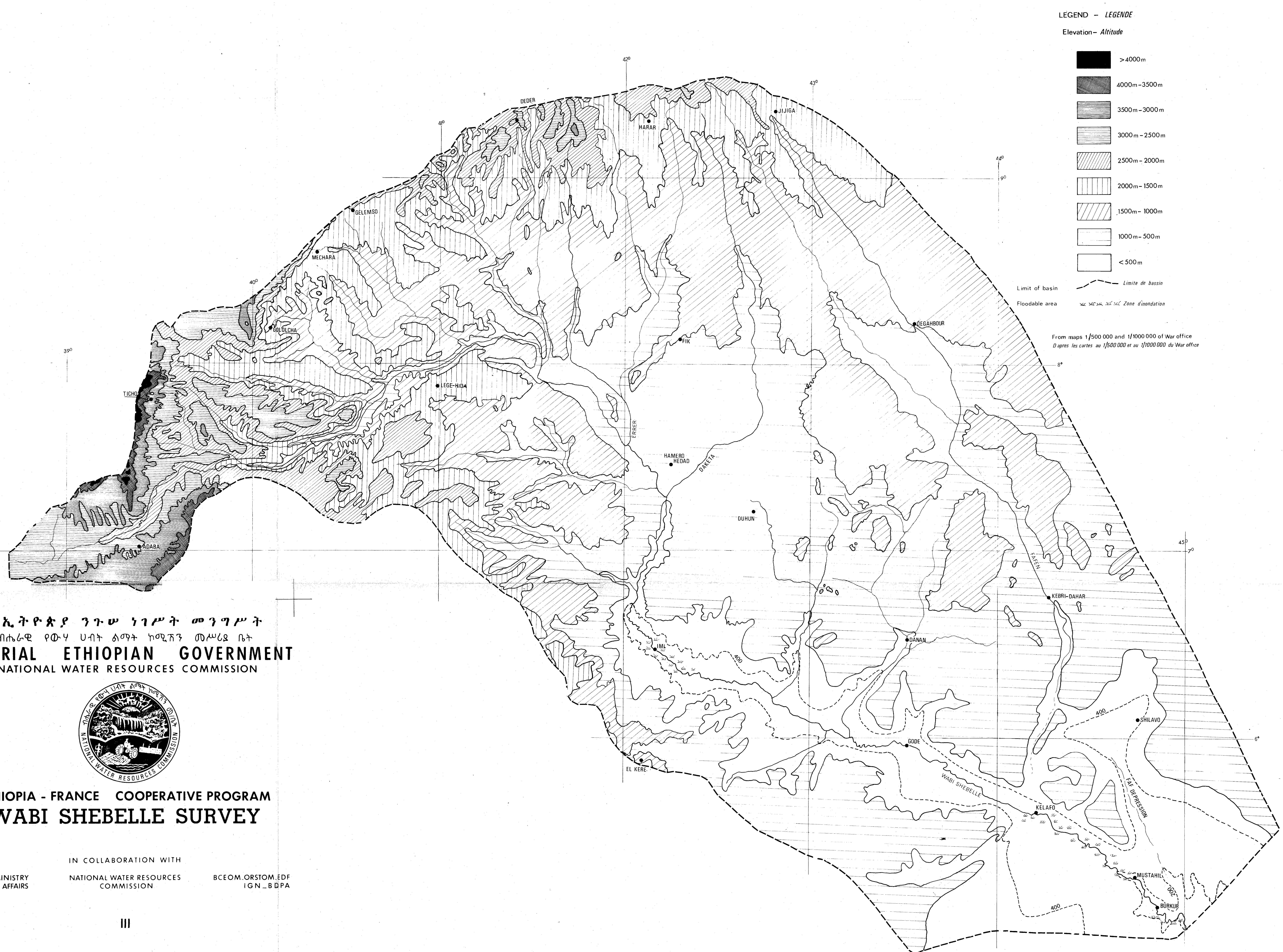
TABLE 11.1 (.../2)

CHEMICAL ANALYSIS OF THE WABI SHEBELLE WATER (mg/l)

Station	Date	Dischar. m^3/s	Conductivity 10^{-3} mhos/cm	PH Labo	TAC CO_3Ca	Cl^-	SO_4^{--}	K^+	Na^+	Ca^{++}	Mg^{++}	SiO_2
GODE (.../...)	22- 1-1971	11,3	0,78	7,7	124	33,5	202	5,0	31,0	63	27	27,7
	29- 1-1971	10,1	0,78	7,6	125	33,8	195	5,0	34,0	60	27	28,0
	5- 2-1971	9,66	0,78	7,6	123	35,0	205	5,1	35,0	55	29	29,1
KELAFO	29- 6-1970	18,6	0,71	7,3	120	18,0		2,7	23	80	25	
	2- 8-1970	134	0,34	7,9	121	4.8		1,9	11	36	13	
	8- 8-1970	142	0,40	8,0	150	3,4		1,9	9	45	10	
	9- 8-1970	205	0,47	7,7	130	6,0		1,9	11	62	11	
	10- 8-1970	244	0,50	7,0	170	7,5		2,0	12	61	13	
	16- 8-1970	291	0,45	7,0	145	5,7		1,9	11	47	12	
	24- 8-1970	308	0,45	8,2	90	6,0		1,9	11	50	10	
	30- 8-1970	247	0,44	8,3	112	7,8		1,9	12	53	9	
	6- 9-1970	256	0,39	7,4	100	9,0		2,1	13	47	12	
	13- 9-1970	220	0,39	7,8	104	8,0		1,6	15	69	18	
	5- 2-1971	7,51	0,78	7,5	130	40,0	225	5,3	35	89	28	27,7
BURKUR	6- 2-1971	6,97	0,91	7,4	132	58	250	<6	48	30	31	26,4

CONTENTS OF THE ENVELOPE :

MAP I	Hypsometric map
MAP II	Drainage pattern and hydro-meteorological installations
MAP III	Homogeneous rainfall zones
MAP IV	Isohyets for hydrological year 1969 - 1970
MAP V	Isohyets for hydrological year 1970 - 1971
MAP VI	Isohyets for hydrological year 1971 - 1972



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III

HYPSOMETRIC MAP

CARTE HYPSOMETRIQUE

Scale 1/1000 000
February 1973
Map N° I

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DRAINAGE PATTERN AND HYDRO - METEOROLOGICAL INSTALLATIONS

EQUIPEMENT HYDRO- METEOROLOGIQUE ET RESEAU HYDROGRAPHIQUE

Scale 1/1,000,000
February 1973
Map Nº III

ETR_291823

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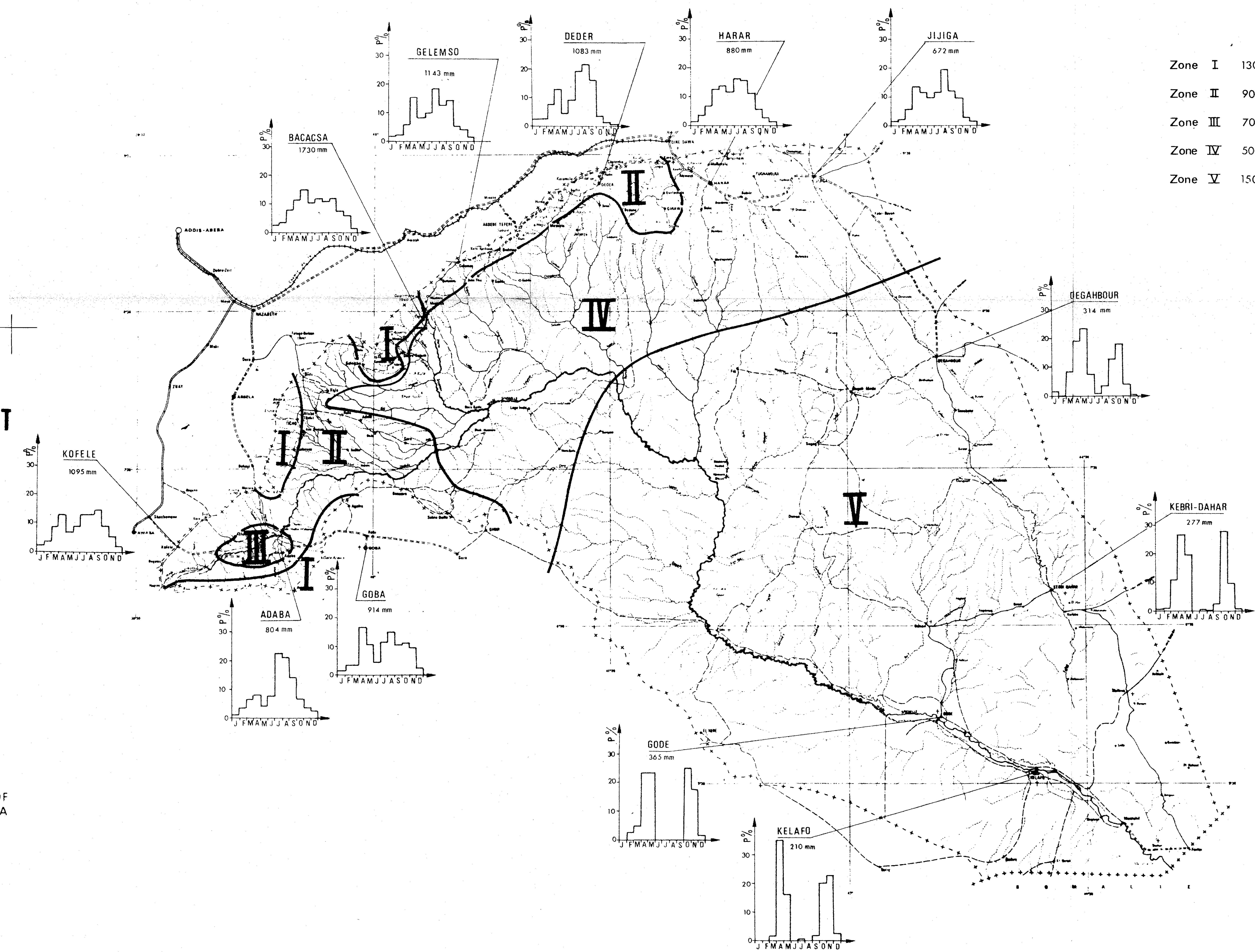

Zone I	1300 mm < P < 1800 mm	
Zone II	900 mm < P < 1300 mm	
Zone III	700 mm < P < 900 mm	
Zone IV	500 mm < P < 900 mm	
Zone V	150 mm < P < 500 mm	

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HOMOGENEOUS RAINFALL ZONES

ZONES A PLUVIOSITE HOMOGENE

Scale 1/2000 000
February 1973
Map N° III

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ISOHYETS FOR HYDROLOGICAL YEAR 1969-1970

ISOHYETES POUR L'ANNEE HYDROLOGIQUE 1969-1970

Scale 1/1000 000
February 1973
Map Nº IV

ETR_291825

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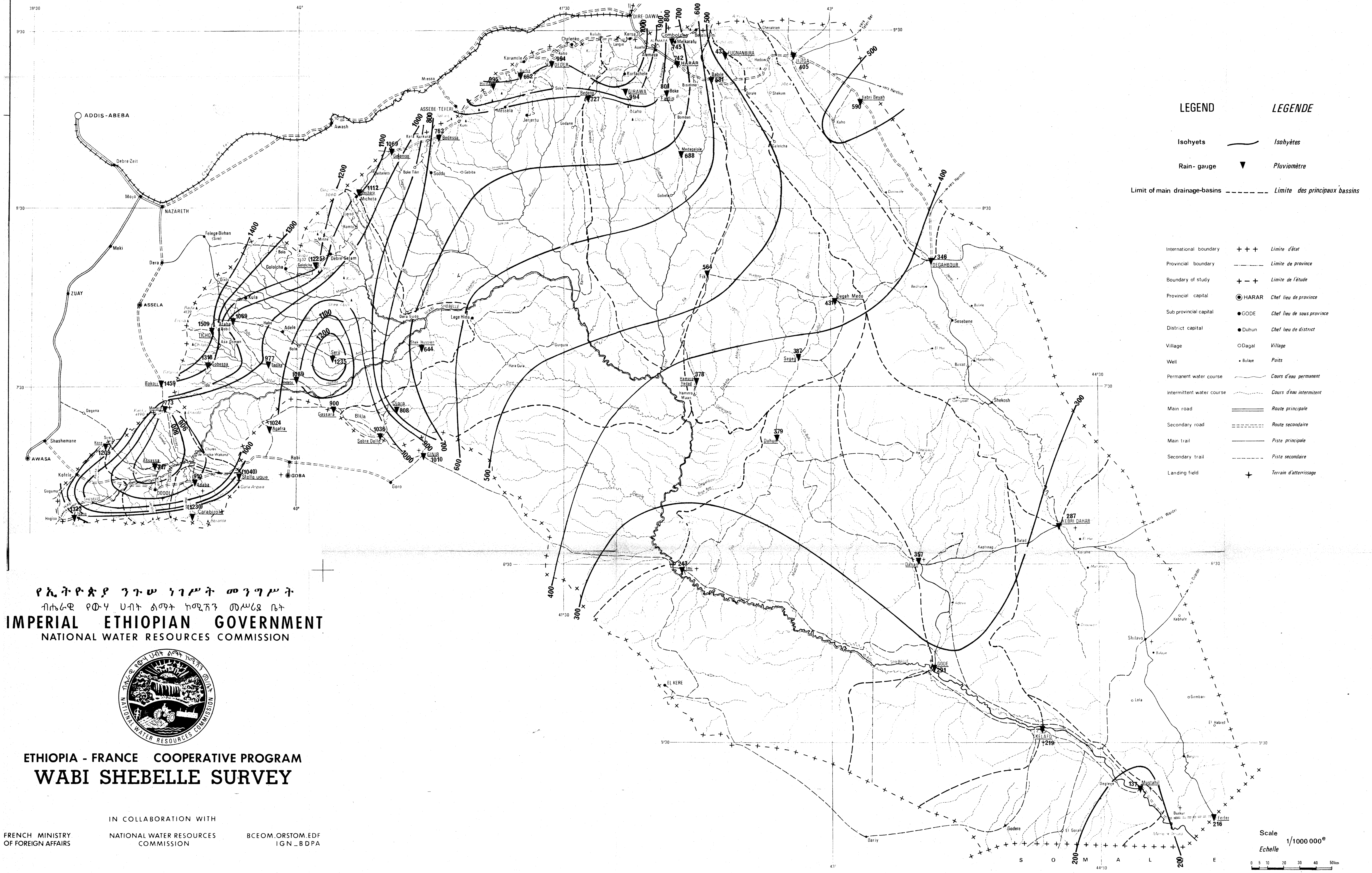

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ISOHYETS FOR HYDROLOGICAL YEAR 1970 - 1971

ISOHYETES POUR L'ANNEE HYDROLOGIQUE 1970 - 1971

Scale 1/1,000 000
February 1973
Map Nº V

ORSTOM

E.T.R. 291826

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ISOHYETS FOR HYDROLOGICAL YEAR 1971 -1972

ISOHYETES POUR L'ANNEE HYDROLOGIQUE 1971-1972

Scale 1/1.000.000
February 1973
Map N° VI

ORSTOM

ETR_291827