Discharge Measurements at Niger River and its Tributaries Bagoé, Baoulé, Kouroukélé and Niandan

Hannover and Niamey, June 2013

Bundesanstalt für Geowissenschaften und Rohstoffe

german cooperation
DEUTSCHE ZUSAMMENARBEIT

Authors: Bashir Talimoun, Kone Soungalo, Torsten Krekeler

Commissioned by: Federal Ministry for Economic Cooperation and Development (Bundesministerium für wirtschaftliche Zusammenarbeit und Entwicklung, BMZ)

Project: *Groundwater Advice to the Niger Basin Authority (NBA)*

BMZ-No.: 2009.2470.4
BGR-No.: *05-2346*
BGR-Archive No.:

Date: 17.06.2013

Summary

Authors: Bashir Talimoun, Kone Soungalo, Torsten Krekeler

Title: *Discharge Measurements at Niger River and its Tributaries Bagoé, Baoulé, Kouroukélé and Niandan*

Keywords: Niger Basin, hydrology, discharge, flow measurement, rating curve

Between 6th and 12th February 2013, discharge measurements were carried out on the Niger River and selected tributaries in Ivory Coast and Guinea. The stations selected for the measurements were all equipped with gauge plates that are regularly monitored. For all stations rating curves exist. Some results differ strongly from the values given in the rating curve. Two of the measured discharges were higher than the values from the corresponding rating curve and four were lower. It was recommended to check the validity of the rating curves regularly by further measurements especially in the dry season and after floods. Furthermore it was recommended to carry out discharge measurements in the Niger River at the upstream and the downstream edge of the pilot area to find out if the river gains water from groundwater exfiltration or if it is a losing stream.

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Abbreviations

A	Area in m^2
ADCP	Acoustic Doppler Currentmeter Profiler
AGES	Groundwater Advice to the Niger Basin Authority
BGR	Bundesanstalt für Geowissenschaften und Rohstoffe
DEM	Digital Elevation Model
DVWK	German Association for Water, Wastewater and Waste (Now DWA)
Fig.	Figure
h	Water Level in m
m	Meter
m^3/s	Cubic meter per second
NBA	Niger Basin Authority
Q	Discharge in m^3/s
RCI	National Hydrological Service of Ivory Coast
RDI	Teledyne RD Instruments (manufacturer of hydrometric instruments)
SRTM	Shuttle Radar Topographic Mission
V	Flow velocity in m/s

Overview

Under the framework of BGR project activities, a joint mission of NBA and BGR was organized to carry out discharge measurements during the dry season in the Upper Niger region (Fig. 1) with the participation of the National Hydrological Service technicians of Ivory Cost and Guinea. This was carried out on the Niger River at stations of Kouroussa and Dialakoro (Siguiri) in Guinea and its tributaries Bagoé at Kouto, Baoulé at Samatiguila, Kouroukélé at Irradougou in Ivory Cost and Niandan at Baro in Guinea.

The main objective of this mission was to cross check the validity of rating curves for the hydrological stations. This is necessary to gain valuable data for analysis of the interaction between the surface water and ground water resources.

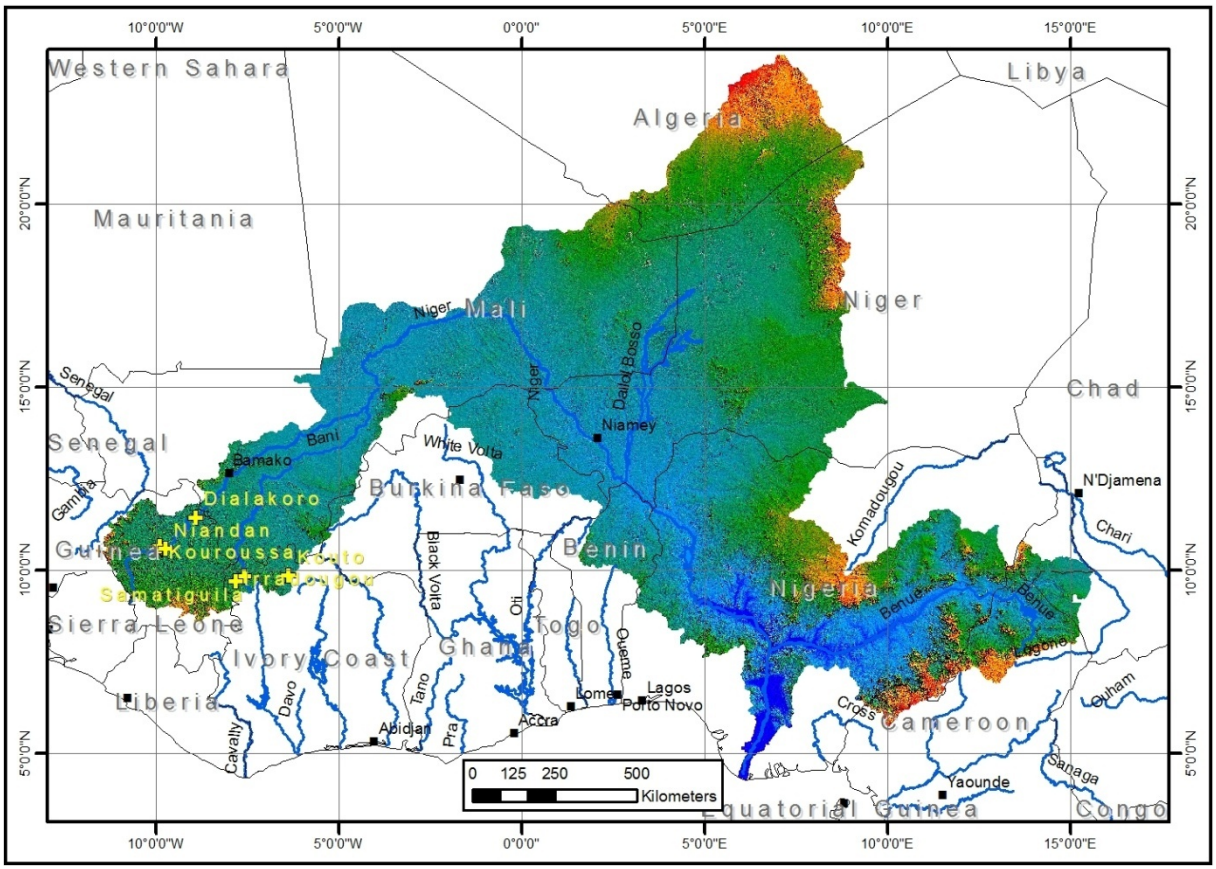

Fig. 1 Niger Basin and locations of gauging stations (DEM derived from SRTM data)

The locations of the gauging stations are summarized in Table 1 with reference to the WGS 84 coordinate system.

Table 1 Coordinates of gauging stations

River	Station	Latitude (decimal degrees)	Longitude (decimal degrees)
Bagoé	Kouto	9.8667	-6.35
Baoulé	Samatiguila	9.85772	-7.56808
Kouroukélé	Irradougou	9.70553	-7.80411
Niger	Dialakoro	11.44811	-8.89814
Niger	Kouroussa	10.65767	-9.86997
Baro	Niandan	10.59969	-9.72611

Discharge Measurements in Ivory Coast

Participants:

Bashir TANIMOUN (NBA)
KONE Soungalo (NBA)
Brehima COULIBALY (NBA)
Ouattara PETIN (RCI)
SOUHALIO Djané (RCI)
Martin JAEGER (AGES / BGR)
Sven MENGE (AGES / BGR)
Torsten KREKELER (BGR)

Discharges were measured at three stations in Ivory Coast (Fig. 2). Bagoé River at Kouto Station, Baoulé River at Samatiguila Station and Kouroukélé River at Irradougou Station were measured with screw current meter (moulinet) and two of them also with an ADCP.

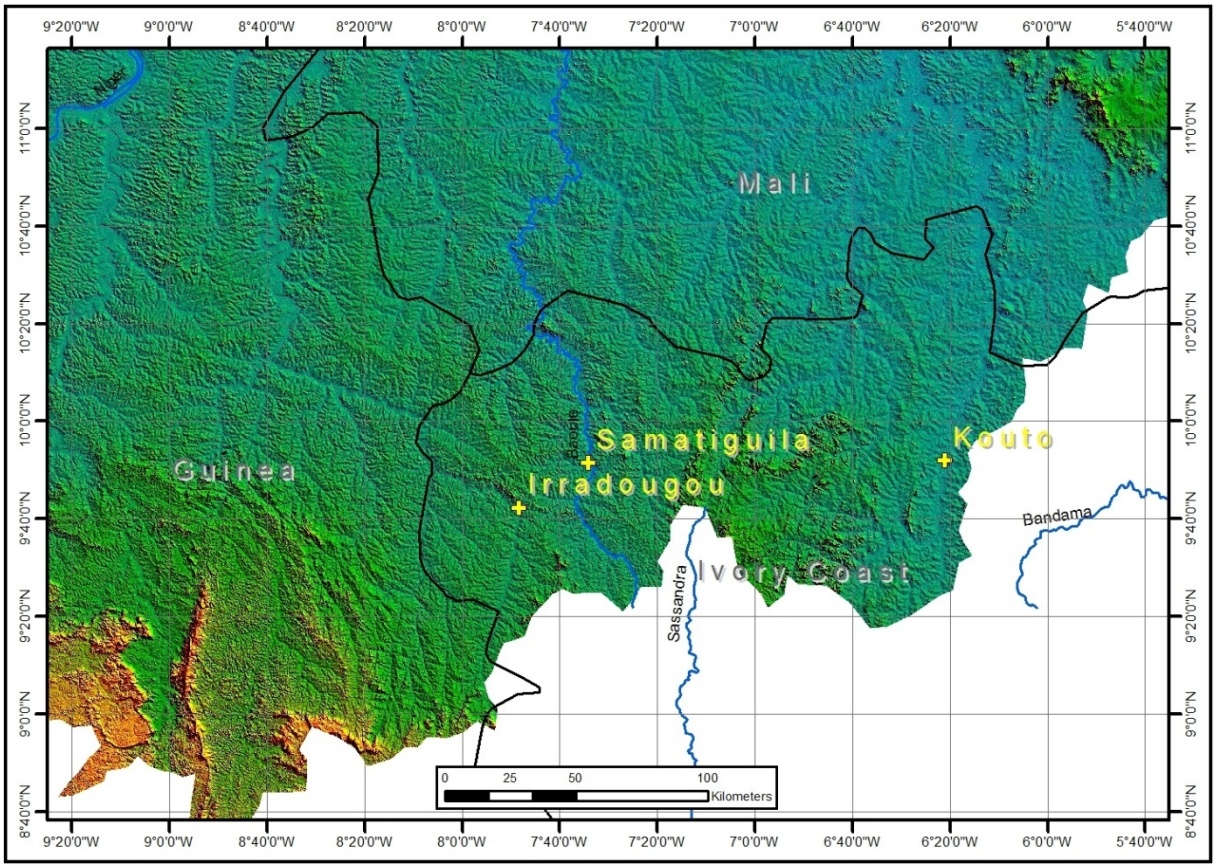

Fig. 2 Visited gauging stations in Ivory Coast (DEM derived from SRTM data)

Bagoé River at Kouto Station

At Kouto Station on Bagoé River, measurements were carried out by the NBA and Ivory Coast technicians, before the complete team arrived. A classic screw current meter was used to carry out the measurements. The gauge height was 172 cm.

Fig. 3 Discharge measurement at Kouto River with moulinet (classic current meter)

Results of discharge measurements of Kouto at Bagoué Station are summarized in Table 2.

Table 2 Results of discharge measurements at Bagoué gauging station

Date	Discharge (m^3/s)	Section length (m)	Wetted area (m^2)	Water level at start (cm)	Water level at end (cm)
06/02/2013	1.196	13	5.477	172	172

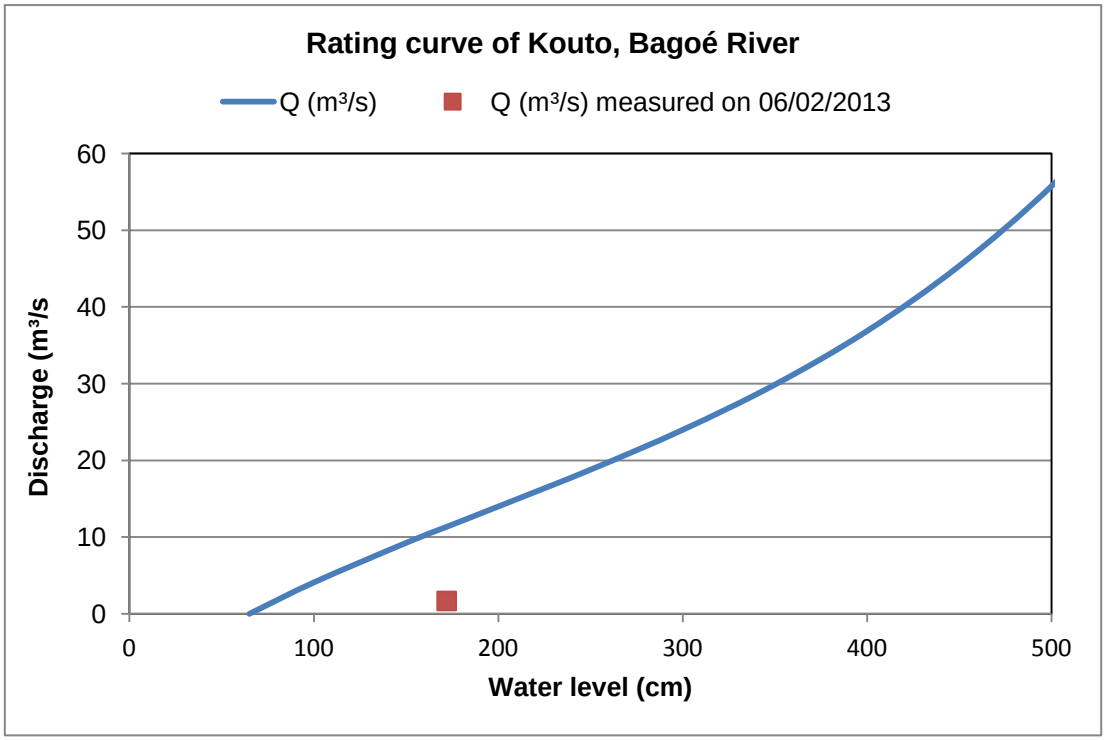

Fig. 4 Rating curve of Bagoé River at Kouto gauging station

According to the rating curve (Fig. 4), the discharge at the water level of 1.72 m is 11.35 m³/s. The measured discharge of 1.196 m³/s is 89 % lower.

Baoulé River at Samatiguila Station

Water level at Samatiguila station at Baoulé River (Fig. 2) was quite low. A level of only 0.55 m was measured on the gauge plate.

Discharge measurements were carried out by pulling the ADCP from one river bank to the other. Additionally measurements with a classic screw current meter were carried out at this station (Fig. 5).

Fig. 5 Discharge measurement at Samatiguila with ADCP and moulinet

The maximum water depth measured with the ADCP was less than 1 m (Fig. 6). The same cross-section was used for both measurements.

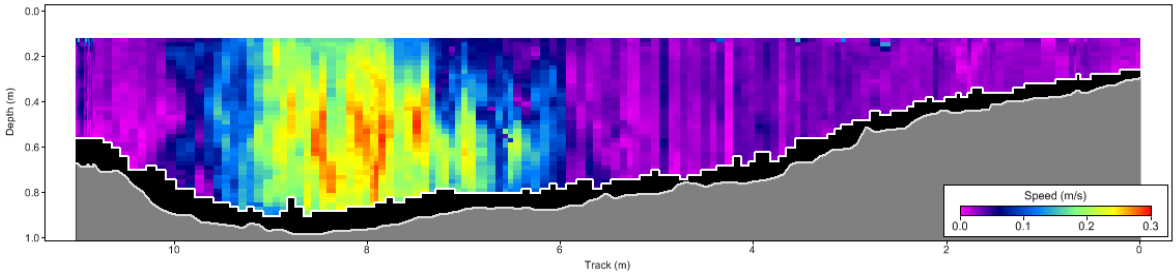

Fig. 6 Cross-section of Niger at Samatiguila gauging station

The mean discharge of four single measurements with the BGR instrument at a water level of 0.55 m was 0.52 m³/s. The discharge for a corresponding water level of 0.55 m read from the rating table (Fig. 7) is 0.37 m³/s. The measured discharge is 29 % higher than the value that was read from the rating table.

The result of the measurement with the moulinet was 0.68 m³/s.

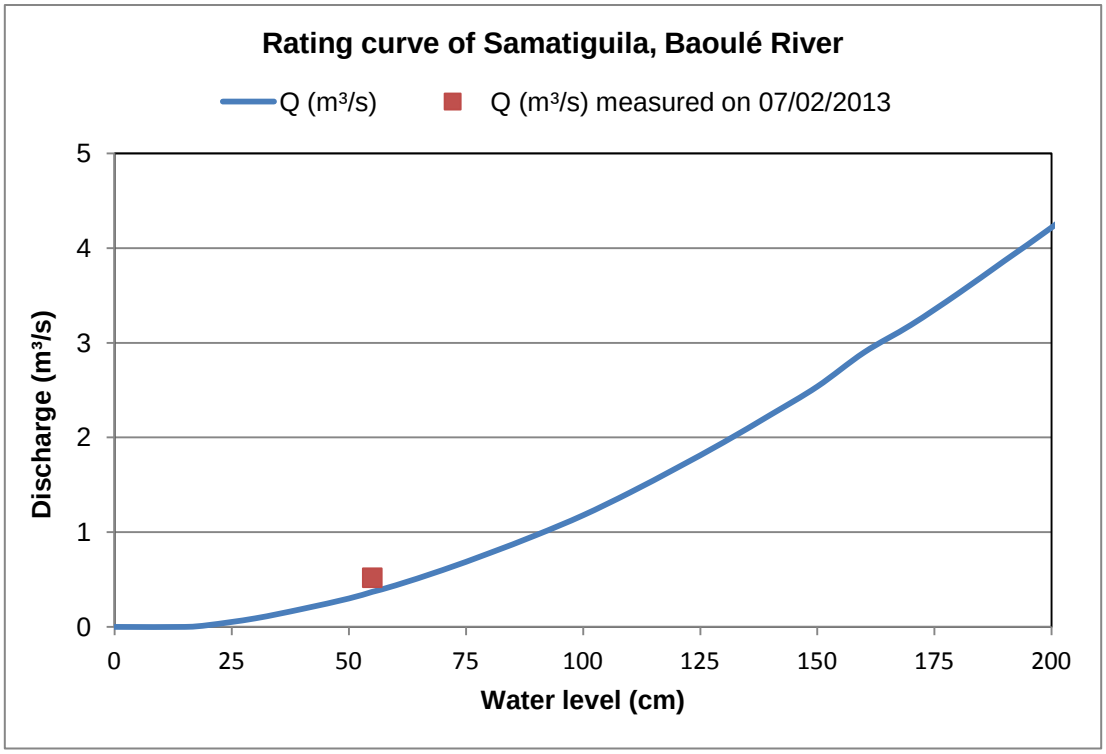

Fig. 7 Rating curve of Baoulé River at Samatiguila gauging station

Kouroukélé River at Irradougou Station

The Kouroukélé River at Irradougou gauging station showed a water level of 1.28 m. Due to a missing 1 to 2 m gauge plate, a 7 to 8 m gauge plate was installed.

Fig. 8 Discharge measurement Irradougou gauging station with ADCP and moulinet

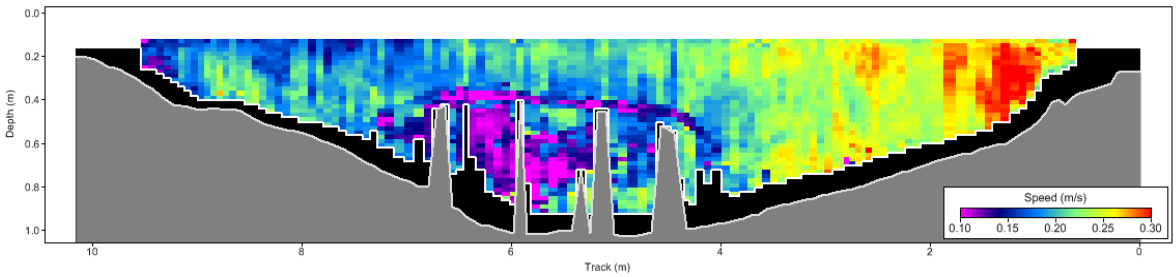

Fig. 9 Cross-section and velocity distribution at Irradougou gauging station

The measured discharge is 1.26 m³/s for a corresponding water level of 1.28 m.

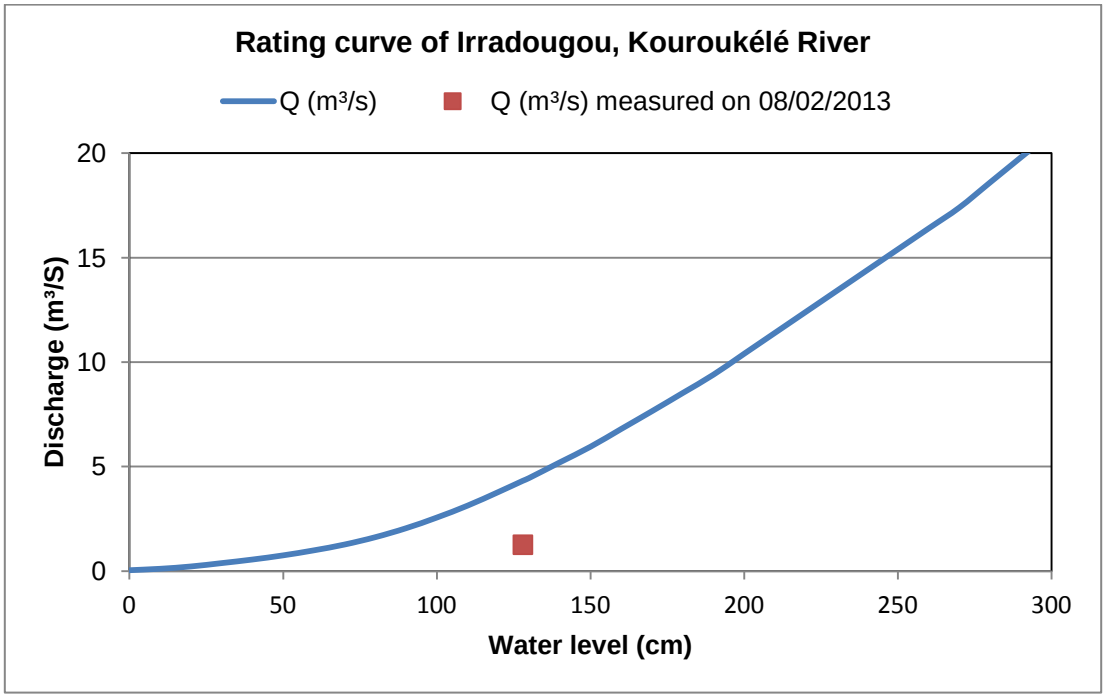

Fig. 10 Rating curve of Irradougou gauging station

On the rating table the discharge corresponding to a water level of 1.28 m is 4.32 m³/s. This value is 3.4 times higher than the measured discharge of 1.26m³/s.

The result of the moulinet measurement was 1.15 m³/s.

Discharge Measurements in Guinea

Participants:

Bashir TANIMOUN(NBA)

KONE Soungalo (NBA)

Bréhima COULIBALY (NBA)

Allyo BARRY (Guinea)

Diallo Aissatou NINA (Guinea)

Sven MENGE (AGES / BGR)

Torsten KREKELER (BGR)

Three discharge measurements were carried out in Guinea; two of them on the Niger River, at Dialakoro Station and at Koroussa Station. A third measurement was carried out at Niandan Station on Baro River (Fig. 11).

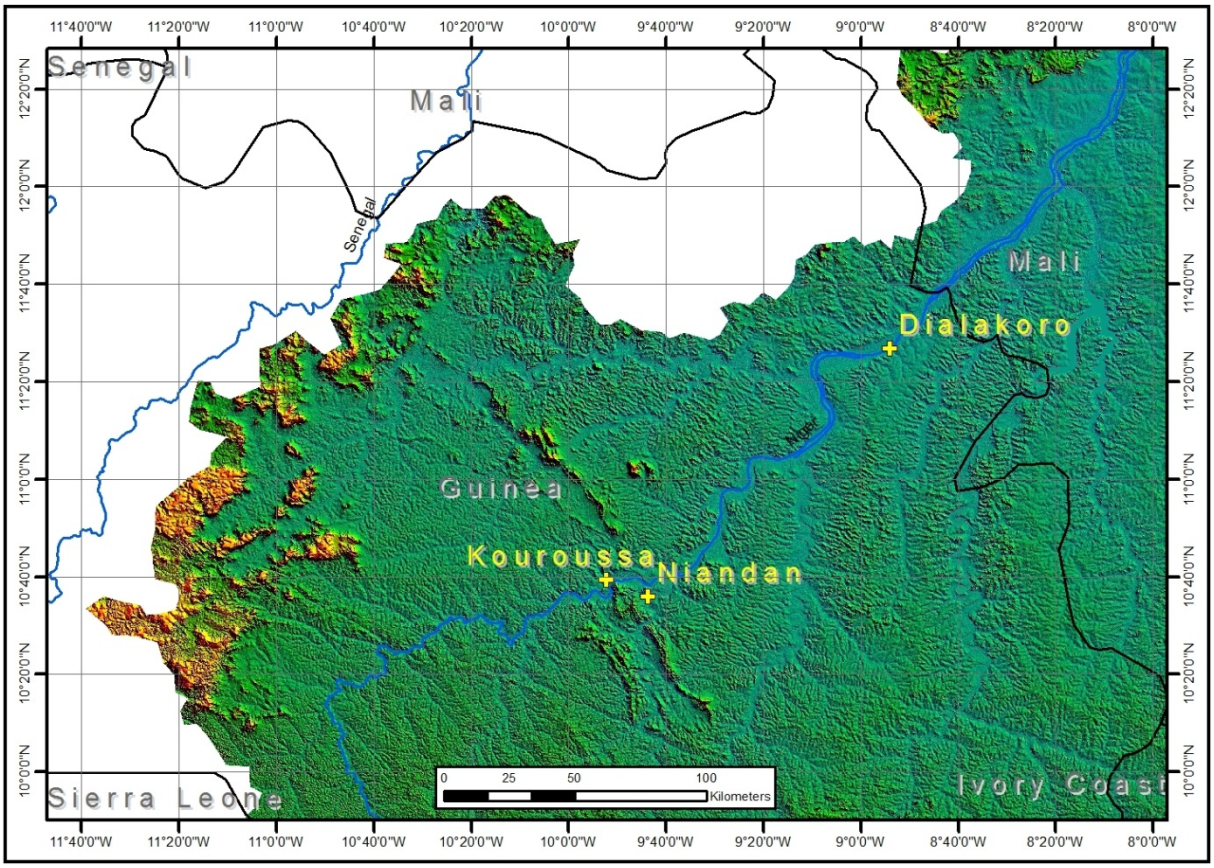

Fig. 11 Measured gauging stations in Guinea (DEM derived from SRTM data)

Niger River at Dialakoro Station

Dialakoro gauging station on Niger River was the furthest downstream situated site measured during this mission. The measured gauge height was 0.6 m.

Fig. 12 Discharge measurement at Dialakoro gauging station (Photo: Sven Menge, BGR)

Measurements were only carried out with the BGR owned SonTec ADCP from a pirogue (Fig. 12).

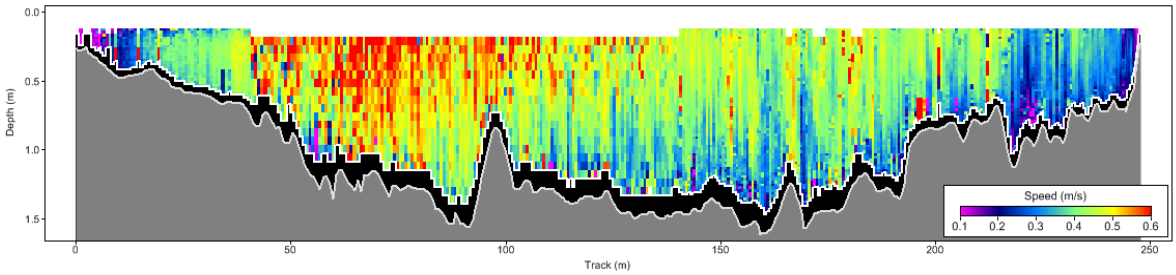

Fig. 13 Cross-section of Niger River at Dialakoro gauging station

The mean discharge of six single measurements at Niger River, Dialakoro gauging station for a corresponding water level of 0.6 m is 81.8 m³/s.

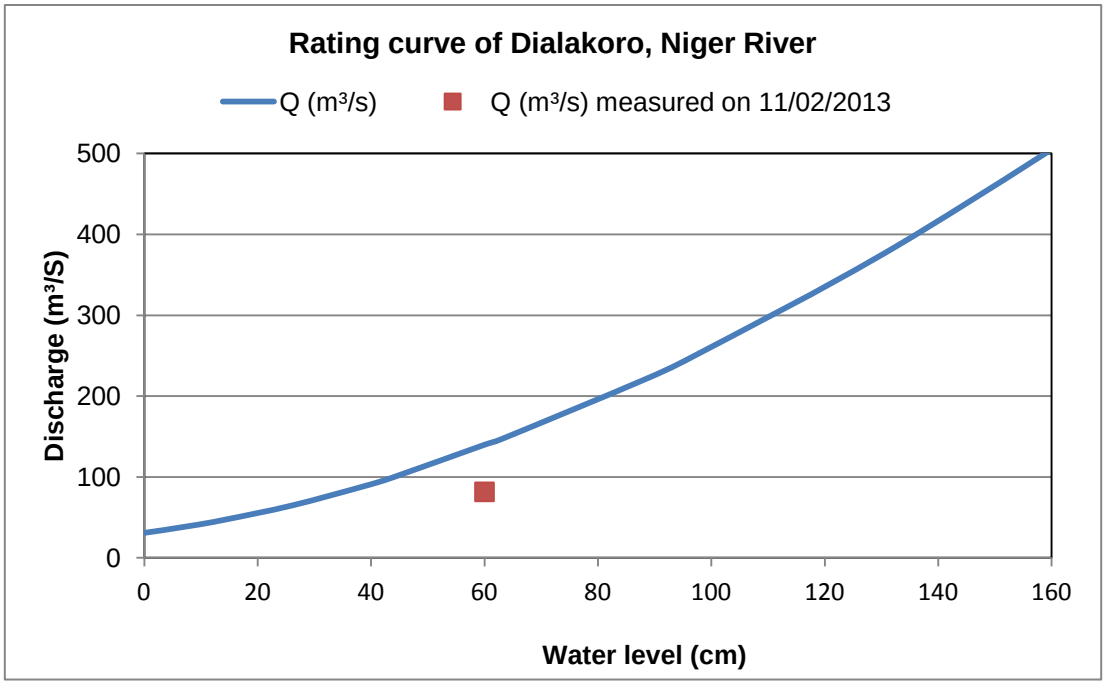

Fig. 14 Rating curve of Niger River at Dialakoro gauging station

According to the rating curve (Fig. 14), the discharge corresponding to a water level of 0.6 m is 140 m³/s. The measured discharge is 42 % lower than the value taken from the rating curve.

Niger River at Kouroussa Station

Flow velocity at Kouroussa gauging station was very low. Downstream of the gauging station, where water from a wide pool discharged into a small channel, was the best site for measuring discharge.

Fig. 15 Niger River at Kouroussa gauging station (Photo: Sven Menge, BGR)

At Kouroussa gauging station a gauge height of 0.8 m was measured.

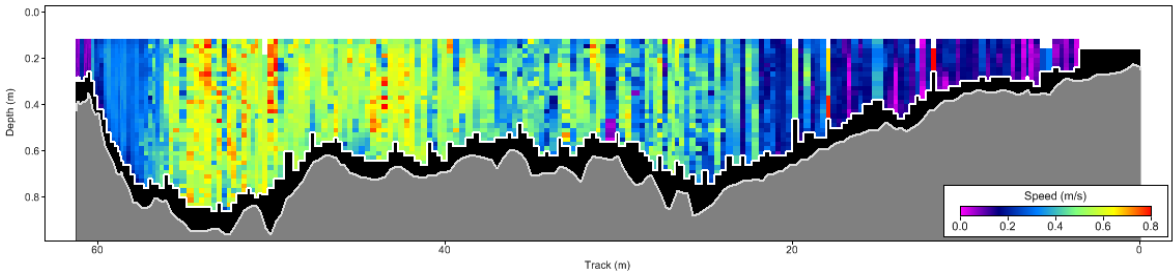

Fig. 16 Cross section of Niger at Kouroussa gauging station

The mean discharge from four single measurements was 13.3 m³/s.

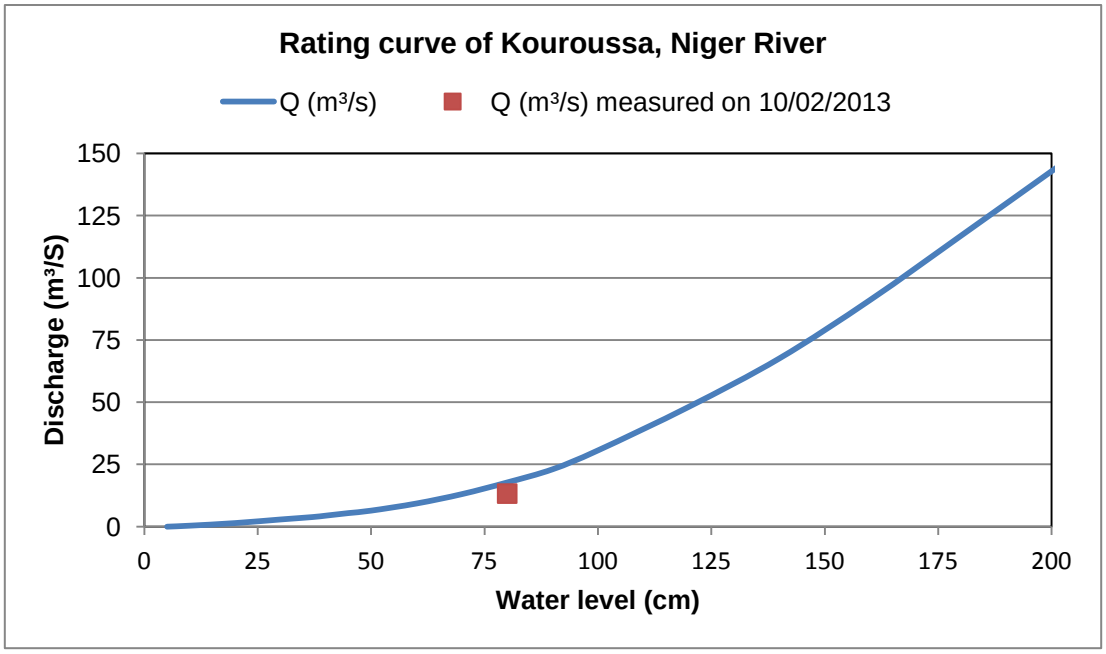

Fig. 17 Rating curve of Niger River at Kouroussa gauging station

From the rating curve, a total discharge of 17.8 m³/s was read for a corresponding water level of 0.8 m. The measured discharge of 13.3 m³/s was 25 % lower.
The measurement with the screw current meter resulted in a discharge of 13 m³/s.

Niandan River at Baro Station

A wide railway bridge was available at Niandan River, Baro gauging station to carry out measurements. In the middle of the river a sandbank surrounded the bridge pier. This is displayed in the middle of the following sketch (Fig. 18).

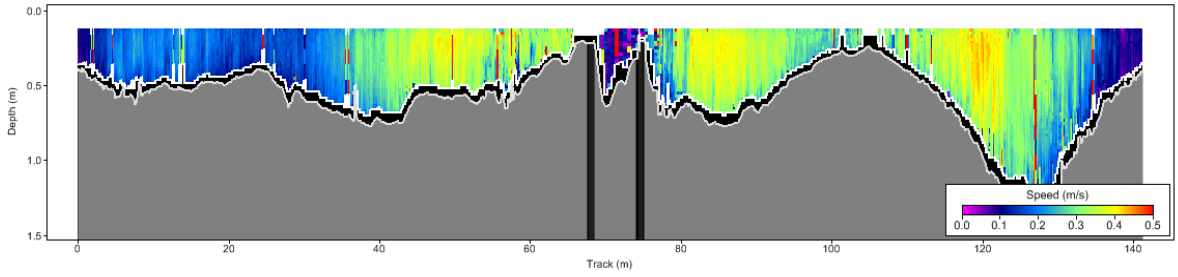

Fig. 18 Cross-section of Niandan River at Baro gauging station

The water level was found at 0.58 m. At Baro gauging station only two measurements with the ADCP were carried out. The mean result of the two single measurements was 19.1 m³/s.

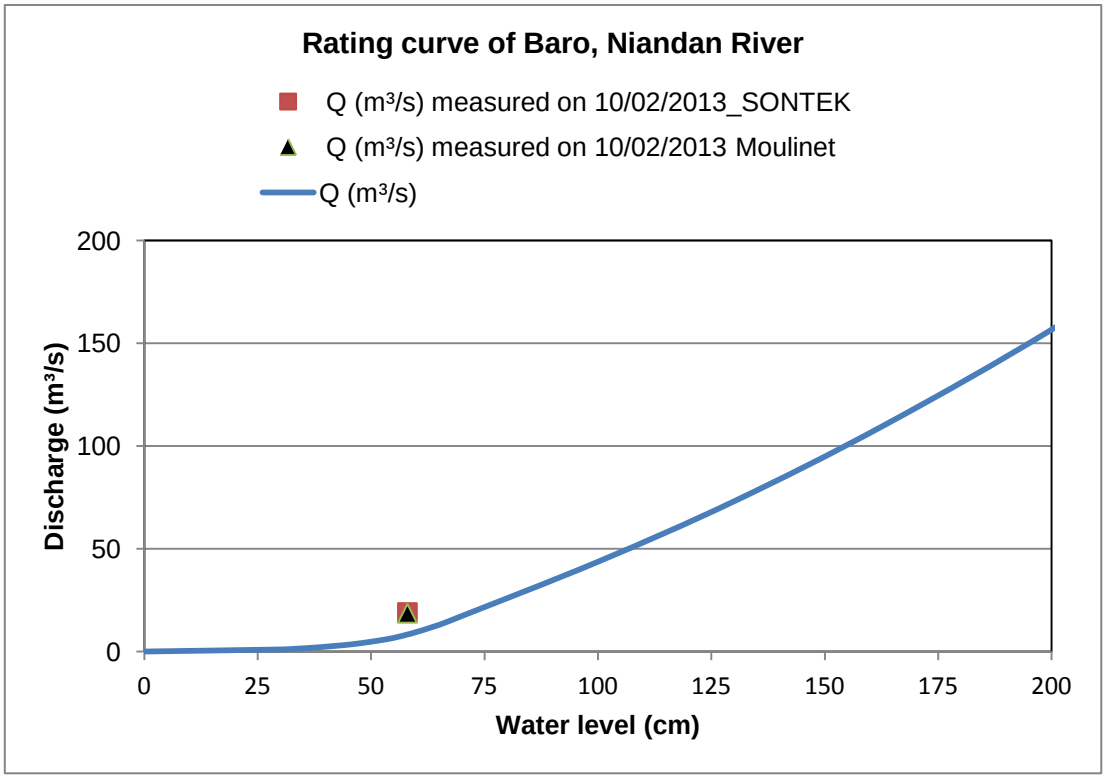

Fig. 19 Rating curve of Niandan River at Baro gauging station

The measurement with the moulinet resulted in a discharge of 18.7 m³/s.

From the rating table a discharge of 8.3 m³/s was read for a corresponding water level of 0.58 m. The discharge measured with the ADCP is 2.3 times higher than the value taken from the rating table.

General Findings

The NBA has appropriate instruments and highly skilled personal to carry out discharge measurements. Generally, the gauging stations are in good conditions, but some are frequently under stress from strong flow or e.g. from cattle that might use it for scratching.

Fig. 20 Irradougou gauging station, drinking cattle

The results of measurements with the moulinet and with the ADCP are very similar.
For the low water levels, the results of discharge measurements and the values taken from the rating tables are not matching very well. Some rating curves base on discharge values that were measured in the 1980s and that were not reviewed and adjusted yet.

Recommendations

The discharge values from the lower end of the rating tables (dry season) should be reviewed and adjusted. For this purpose the new ADCP (RDI River Ray), NBA is currently purchasing, can be used. The River Ray ADCP has a velocity profiling range of 30 cm to 40 m water depth and is therefore applicable for these measurements.

When carrying out measurements at high water levels it is very important to do this while the water level is stable. Rapidly changing water levels lead to hysteresis effects as observed during a NBA/BGR mission to Niger, Benin and Guinea in 2012 at Malanville gauging station (Krekeler, 2012). Hysteresis effects give water level / discharge relations that are not applicable to develop rating curves.

The rating curves should be checked frequently by further discharge measurements. The validity of rating curves is limited in time. River morphology frequently changes and the rating curves need to be adjusted to give correct values. According to the German DVWK Guideline *Manual for Water Level Gauging and Discharge Measurements*, discharge measurements are necessary:

- *at least every three month*
- *at gauges where water levels are subject to variable influences, e.g. severe aquatic vegetation, at least once a month*
- *after each flood if the river bed tends to change*
- *shortly after and if possible before each removal of aquatic vegetation on the river reach*
- *additionally during low water periods and, if possible several times during each flood*
- *at gauges with fixed weirs and free overfall once or twice a year as a control*

If it can be assumed, that aquatic vegetation is not removed in these rivers and is not of variable influence on the water level, these points can be neglected.
If any modifications on the river cross-sections were carried out, additional measurements are necessary.

For a better understanding of the interaction of groundwater and surface water in the pilot area at Niamey it is essential to know if water in this reach infiltrates into the ground or exfiltrates into the river. For this purpose it is recommended to carry out discharge measurements in the Niger at the upstream and downstream edge of the pilot area during dry and rain periods.

The gauge plates should be checked after each rain period. It must be made clear, that the gauge plates are properly fixed on the poles. Furthermore, the correct fit should be checked by levelling in accordance to one or better two benchmarks that are part of each gauging station.

Extended Summary

Between 6th and 12th February 2013, a joint mission of NBA and BGR was organized to carry out discharge measurements during the dry season in the Upper Niger region with the participation of the National Hydrological Service technicians of Ivory Cost and Guinea. This was carried out on the Niger River at stations of Kouroussa and Dialakoro (Siguiri) in Guinea and its tributaries Bagoé at Kouto, Baoulé at Samatiguila, Kouroukélé at Irradougou in Ivory Cost and Niandan at Baro in Guinea. The stations were all equipped with gauge plates that are regularly monitored. For all stations rating curves exist.

The main objective of this mission was to cross check the validity of rating curves for the hydrological stations. This is necessary to gain valuable data for analysis of the interaction between the surface water and ground water resources.

The measurements were carried out with classic flow meters (moulinet) and with an ADCP. ADCP measurements were repeated at least four times until the results of the single measurements do not differ more than five per cent from the mean. It was found, that the results of ADCP and flow meter measurements were quite similar.

In relation to the values given in the rating curves, some results of the measurements were strongly different. The highest difference was found at Bagoé River, where the measured discharge was 89 % lower than the value given by the rating curve. Two of the measured discharges were higher than the values from the corresponding rating curve and four were lower. Some rating curves are based on rather old discharge values.

It was recommended to check the validity of the rating curve regularly by further measurements especially in the dry season and after floods. Furthermore it was recommended to measure discharges in the Niger River at the upstream and the downstream edge of the pilot area in Niamey during high and low water levels to clarify if gaining or losing stream conditions are prevailing.

References

DVWK, 1990 (now: DWA – German Association for Water, Wastewater and Waste) Guidelines 301/1990. Manual for Water Level Gauging and Discharge Measurements, Hennef 1990

Krekeler, 2012. Rapport sur la mission au Niger, Benin et Guinée – Mesure des débits au fleuve Niger et ses tributairs, unpublished report, Hannover 2012

SRTM Shuttle Radar Topographic Mission. Digital Elevation data provided by NASA (National Aeronautics and Space Administration of the U.S.) and the U.S. Geological Survey, 2000

ANNEX

Discharge Measurement Summary

Date Measured: Saturday, May 04, 2013

Site Information

Site Name	Samatiguila
Station Number	-
Location	Baoulé

Measurement Information

Party	BGR/ABN
Boat/Motor	pull from bank
Meas. Number	4

System Information

System Type	RS-M9
Serial Number	2456
Firmware Version	2.00
Software Version	3.01

System Setup

Transducer Depth (m)	0.06
Salinity (ppt)	0.0
Magnetic Declination (deg)	-5.0

Units

Distance	m
Velocity	m/s
Area	m2
Discharge	m3/s
Temperature	degC

Discharge Calculation Settings

Track Reference	Bottom-Track	Left Method	Vertical Bank
Depth Reference	Vertical Beam	Right Method	Sloped Bank
Coordinate System	ENU	Top Fit Type	Power Fit
		Bottom Fit Type	Power Fit

Discharge Results

Width (m)	11.38
Area (m2)	7.4
Mean Speed (m/s)	0.070
Total Q (m3/s)	0.519

Measurement Results

Tr		Time			Distance				Mean Vel		Discharge							%
#		Time	Duration	Temp.	Track	DMG	Width	Area	Boat	Water	Left	Right	Top	Middle	Bottom	Total	MBTotal	Measured
2	R	1:25:13 PM	0:03:44	23.2	18.32	11.01	12.41	6.8	0.082	0.077	0.01	0.00	0.10	0.38	0.03	0.520	--	72.6
5	R	1:47:19 PM	0:03:16	22.3	10.82	9.54	11.04	7.7	0.055	0.072	0.00	0.00	0.08	0.43	0.04	0.550	--	78.7
6	L	1:51:20 PM	0:03:22	22.7	10.72	9.66	11.16	7.8	0.053	0.064	0.00	0.00	0.07	0.40	0.03	0.504	--	78.9
7	R	1:55:14 PM	0:03:09	22.3	11.11	9.41	10.91	7.5	0.059	0.067	0.00	0.00	0.07	0.40	0.03	0.503	--	78.2
			Mean	22.6	12.74	9.91	11.38	7.4	0.062	0.070	0.00	0.00	0.08	0.40	0.03	0.519	0.000	77.1
			Std Dev	0.4	3.22	0.64	0.60	0.4	0.011	0.005	0.00	0.00	0.01	0.02	0.00	0.019	0.000	2.6
			COV	0.0	0.253	0.065	0.053	0.054	0.185	0.067	0.561	-0.728	0.152	0.048	0.065	0.037	0.000	0.034

Exposure Time: 0:13:31

Tr2=20130504132512.riv; Tr5=20130504134719.riv; Tr6=20130504135119.riv; Tr7=20130504135513.riv;

Comments

Tr2=20130504132512.riv - very small river; Tr5=20130504134719.riv - very small river; Tr6=20130504135119.riv - very small river; Tr7=20130504135513.riv - very small river;

Compass Calibration

Results: PASS
Score is excellent.
Magnetic interference is very low.

Calibration score: M5.00Q9

System Test

System Test: PASS

Parameters and settings marked with a * are not constant for all files.

Report generated using SonTek RiverSurveyor Live v3.01

Discharge Measurement Summary

Date Measured: Sunday, May 05, 2013

Site Information

Site Name	Iradougou
Station Number	-
Location	Kouroukélé

Measurement Information

Party	BGR/ABN
Boat/Motor	pull from bank
Meas. Number	4

System Information

System Type	RS-M9
Serial Number	2456
Firmware Version	2.00
Software Version	3.01

System Setup

Transducer Depth (m)	0.06
Salinity (ppt)	0.0
Magnetic Declination (deg)	-5.0

Units

Distance	m
Velocity	m/s
Area	m2
Discharge	m3/s
Temperature	degC

Discharge Calculation Settings

Track Reference	Bottom-Track*	Left Method	Sloped Bank
Depth Reference	Vertical Beam	Right Method	Sloped Bank
Coordinate System	ENU	Top Fit Type	Power Fit
		Bottom Fit Type	Power Fit

Discharge Results

Width (m)	10.56
Area (m2)	6.7
Mean Speed (m/s)	0.187
Total Q (m3/s)	1.258

Measurement Results

Tr		Time			Distance				Mean Vel		Discharge							%
#		Time	Duration	Temp.	Track	DMG	Width	Area	Boat	Water	Left	Right	Top	Middle	Bottom	Total	MBTotal	Measured
1	L	9:51:03 AM	0:05:12	22.3	15.20	9.91	10.81	6.6	0.049	0.189	0.00	0.00	0.24	0.87	0.14	1.255	--	69.7
2	R	9:56:58 AM	0:03:11	22.2	10.60	9.18	10.08	6.7	0.056	0.188	0.00	0.00	0.24	0.89	0.13	1.258	--	70.9
3	L	10:00:53 AM	0:03:25	22.0	12.08	10.41	11.31	7.2	0.059	0.181	0.00	0.00	0.25	0.91	0.13	1.301	--	70.3
4	R	10:04:38 AM	0:02:35	21.9	10.71	9.15	10.05	6.4	0.069	0.190	0.00	0.00	0.24	0.86	0.12	1.219	--	70.5
			Mean	22.1	12.15	9.66	10.56	6.7	0.058	0.187	0.00	0.00	0.24	0.89	0.13	1.258	0.000	70.3
			Std Dev	0.2	1.86	0.53	0.53	0.3	0.007	0.003	0.00	0.00	0.01	0.02	0.01	0.029	0.000	0.4
			COV	0.0	0.153	0.054	0.050	0.041	0.127	0.018	0.000	0.000	0.028	0.023	0.043	0.023	0.000	0.006

Exposure Time: 0:14:23

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Comments

Tr1=20130505095140.riv - ; Tr2=20130505095736.riv - ; Tr3=20130505100131.riv - ; Tr4=20130505100515.riv - ;

Compass Calibration

Results: PASS
Score is excellent.
Magnetic interference is very low.

Calibration score: M5.00Q9

System Test

System Test: PASS

Parameters and settings marked with a * are not constant for all files.

Report generated using SonTek RiverSurveyor Live v3.01

Discharge Measurement Summary

Date Measured: Monday, February 11, 2013

Site Information

Site Name	Niger Dialakoro
Station Number	-
Location	Niger

Measurement Information

Party	BGR/ABN
Boat/Motor	Pirogue
Meas. Number	6

System Information

System Type	RS-M9
Serial Number	2456
Firmware Version	2.00
Software Version	3.01

System Setup

Transducer Depth (m)	0.06
Salinity (ppt)	0.0
Magnetic Declination (deg)	-5.0

Units

Distance	m
Velocity	m/s
Area	m2
Discharge	m3/s
Temperature	degC

Discharge Calculation Settings

Track Reference	Bottom-Track	Left Method	Sloped Bank
Depth Reference	Vertical Beam	Right Method	Sloped Bank
Coordinate System	ENU	Top Fit Type	Power Fit
		Bottom Fit Type	Power Fit

Discharge Results

Width (m)	198.25
Area (m2)	199.4
Mean Speed (m/s)	0.411
Total Q (m3/s)	81.772

Measurement Results

Tr		Time			Distance				Mean Vel		Discharge							%
#		Time	Duration	Temp.	Track	DMG	Width	Area	Boat	Water	Left	Right	Top	Middle	Bottom	Total	MBTotal	Measured
1	L	1:52:15 PM	0:08:27	26.0	220.74	181.64	187.24	175.5	0.435	0.469	0.00	0.00	15.71	59.50	7.11	82.315	--	72.3
2	R	2:07:39 PM	0:06:54	28.6	218.16	193.97	198.57	203.4	0.527	0.388	0.00	0.01	13.77	58.62	6.52	78.921	--	74.3
3	L	2:15:14 PM	0:06:57	25.8	206.89	194.07	199.67	205.6	0.496	0.406	0.00	0.00	13.82	62.80	6.83	83.453	--	75.3
4	R	2:22:38 PM	0:06:59	28.9	210.87	194.86	200.46	207.1	0.503	0.395	0.00	0.00	13.81	61.51	6.51	81.832	--	75.2
5	L	2:30:25 PM	0:06:53	25.9	247.78	195.18	200.78	202.7	0.600	0.410	0.00	0.00	13.62	62.61	6.94	83.166	--	75.3
6	R	2:37:32 PM	0:06:49	28.9	212.80	197.19	202.79	202.3	0.520	0.400	0.00	0.00	14.01	60.44	6.50	80.943	--	74.7
			Mean	27.4	219.54	192.82	198.25	199.4	0.514	0.411	0.00	0.00	14.12	60.91	6.73	81.772	0.000	74.5
			Std Dev	1.4	13.43	5.11	5.09	10.8	0.049	0.027	0.00	0.01	0.72	1.54	0.24	1.521	0.000	1.1
			COV	0.1	0.061	0.026	0.026	0.054	0.095	0.065	0.000	2.236	0.051	0.025	0.035	0.019	0.000	0.014

Exposure Time: 0:42:59

Tr1=20130211135214.riv; Tr2=20130211140738.riv; Tr3=20130211141514.riv; Tr4=20130211142238.riv; Tr5=20130211143023.riv; Tr6=20130211143731.riv;

Comments

Tr1=20130211135214.riv - ; Tr2=20130211140738.riv - ; Tr3=20130211141514.riv - ; Tr4=20130211142238.riv - ; Tr5=20130211143023.riv - ; Tr6=20130211143731.riv - ;

Compass Calibration

Results: PASS
Score is excellent.
Magnetic interference is very low.

Calibration score: M5.00Q9

System Test

System Test: PASS

Parameters and settings marked with a * are not constant for all files.

Report generated using SonTek RiverSurveyor Live v3.01

Discharge Measurement Summary

Date Measured: Sunday, February 10, 2013

Site Information

Site Name	Niger Kouroussa
Station Number	-
Location	Niger

Measurement Information

Party	BGR/ABN
Boat/Motor	wading
Meas. Number	6

System Information

System Type	RS-M9
Serial Number	2456
Firmware Version	2.00
Software Version	3.01

System Setup

Transducer Depth (m)	0.06
Salinity (ppt)	0.0
Magnetic Declination (deg)	-5.5

Units

Distance	m
Velocity	m/s
Area	m2
Discharge	m3/s
Temperature	degC

Discharge Calculation Settings

Track Reference	Bottom-Track	Left Method	Sloped Bank
Depth Reference	Vertical Beam	Right Method	Sloped Bank
Coordinate System	ENU	Top Fit Type	Power Fit
		Bottom Fit Type	Power Fit

Discharge Results

Width (m)	60.09
Area (m2)	37.0
Mean Speed (m/s)	0.359
Total Q (m3/s)	13.289

Measurement Results

Tr		Time			Distance				Mean Vel		Discharge							%
#		Time	Duration	Temp.	Track	DMG	Width	Area	Boat	Water	Left	Right	Top	Middle	Bottom	Total	MBTotal	Measured
1	R	1:50:14 PM	0:04:52	27.2	60.77	57.48	58.98	36.4	0.208	0.364	0.00	0.00	2.66	9.37	1.23	13.260	--	70.7
2	L	1:55:23 PM	0:04:26	28.3	60.55	58.27	60.07	36.9	0.228	0.363	0.03	0.00	2.58	9.50	1.28	13.392	--	70.9
3	R	2:00:32 PM	0:04:38	27.0	61.73	57.76	60.76	37.1	0.222	0.351	0.01	0.00	2.48	9.26	1.25	13.000	--	71.2
4	L	2:26:57 PM	0:03:45	28.3	61.11	58.76	60.56	37.5	0.272	0.360	0.01	0.00	2.64	9.72	1.14	13.506	--	71.9
			Mean	27.7	61.04	58.07	60.09	37.0	0.232	0.359	0.01	0.00	2.59	9.46	1.22	13.289	0.000	71.2
			Std Dev	0.6	0.45	0.49	0.69	0.4	0.024	0.005	0.01	0.00	0.07	0.17	0.05	0.189	0.000	0.5
			COV	0.0	0.007	0.008	0.011	0.010	0.102	0.014	0.875	0.000	0.027	0.018	0.043	0.014	0.000	0.007

Exposure Time: 0:17:41

Tr1=20130210135014.riv; Tr2=20130210135522.riv; Tr3=20130210140031.riv; Tr4=20130210142655.riv;

Comments

Tr1=20130210135014.riv - ; Tr2=20130210135522.riv - ; Tr3=20130210140031.riv - ; Tr4=20130210142655.riv - ;

Compass Calibration

Results: PASS
Score is excellent.
Magnetic interference is very low.

Calibration score: M7.00Q9

System Test

System Test: PASS

Parameters and settings marked with a * are not constant for all files.

Report generated using SonTek RiverSurveyor Live v3.01

Discharge Measurement Summary

Date Measured: Sunday, February 10, 2013

Site Information

Site Name	Baro
Station Number	-
Location	Niandan

Measurement Information

Party	BGR/ABN
Boat/Motor	bridge
Meas. Number	2

System Information

System Type	RS-M9
Serial Number	2456
Firmware Version	2.00
Software Version	3.01

System Setup

Transducer Depth (m)	0.06
Salinity (ppt)	0.0
Magnetic Declination (deg)	-5.5

Units

Distance	m
Velocity	m/s
Area	m2
Discharge	m3/s
Temperature	degC

Discharge Calculation Settings

Track Reference	Bottom-Track	Left Method	Sloped Bank
Depth Reference	Vertical Beam	Right Method	Sloped Bank
Coordinate System	ENU	Top Fit Type	Power Fit
		Bottom Fit Type	Power Fit

Discharge Results

Width (m)	134.78
Area (m2)	78.1
Mean Speed (m/s)	0.245
Total Q (m3/s)	19.101

Measurement Results

Tr		Time			Distance				Mean Vel		Discharge							%
#		Time	Duration	Temp.	Track	DMG	Width	Area	Boat	Water	Left	Right	Top	Middle	Bottom	Total	MBTotal	Measured
1	R	4:24:19 PM	0:15:27	27.9	162.71	124.14	133.14	77.6	0.176	0.245	0.05	0.08	4.04	13.36	1.48	19.009	--	70.3
2	L	4:40:30 PM	0:15:19	28.2	141.50	127.42	136.42	78.6	0.154	0.244	0.05	0.06	4.08	13.50	1.50	19.192	--	70.3
			Mean	28.0	152.11	125.78	134.78	78.1	0.165	0.245	0.05	0.07	4.06	13.43	1.49	19.101	0.000	70.3
			Std Dev	0.1	10.61	1.64	1.64	0.5	0.011	0.000	0.00	0.01	0.02	0.07	0.01	0.092	0.000	0.0
			COV	0.0	0.070	0.013	0.012	0.006	0.065	0.001	0.044	0.123	0.005	0.005	0.010	0.005	0.000	0.000

Exposure Time: 0:30:46

Tr1=20130210162417.riv; Tr2=20130210164028.riv;

Comments

Tr1=20130210162417.riv - ; Tr2=20130210164028.riv - ;

Compass Calibration

Results: PASS
Score is excellent.
Magnetic interference is very low.

Calibration score: M5.00Q9

System Test

System Test: PASS

Parameters and settings marked with a * are not constant for all files.

Report generated using SonTek RiverSurveyor Live v3.01