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## Observations about hydrodynamics and sediment transport in the Congo River

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### Abstract

The Congo River is the second largest river in the world in terms of basin area and discharge. Several field studies were carried out from 2010 to 2019 under different flow conditions due to the cooperation among SCVN-GIE, the ECHOBACO Project and HYBAM to characterize hydrodynamics and sediment transport in the reach close to the city of Brazzaville (Republic of the Congo) and Kinshasa (Democratic Republic of Congo) and in that about the city of Maluku. During these field campaigns Acoustic Doppler Velocity Profiling (ADCP) was used as well as water sampling for the TSS measurement. The ADCP measurements gained a comprehensive characterization of the basic hydrodynamics and sediment transport parameters in those reaches as well as their variation in different flow conditions during the hydrological year. The discharge was in the range from 24000 to 66000 m<sup>3</sup>/s. Large velocities up to almost 3 m/s were observed in Brazzaville-Kinshasa, while water depth was in the range from 9 to 23 m from low to high flow conditions. Finally, grain-related bed shear stress distribution identified dominant transport mode and maximum suspended grain size, being in the range order of fine sands for each flow condition. At the end, this study is the first comprehensive analysis of hydrodynamics and sediment transport in the Congo River using a combination of field data over about a decade.

**Keywords:** River hydrodynamics; Sediment transport; Congo River; ADCP; Water sampling

World's large rivers and their floodplains have been historically key locations for the establishment of human civilization. Yellow River, Indus, Nile, Tigris and Euphrates have been the cradle of old civilizations (Macklin and Lewin, 2015). Latrubesse (2008) proposed to define a *large river* and *mega-river* as having an average annual discharge  $Q_{avg}$  larger than 1000 m<sup>3</sup>/s and 17000 m<sup>3</sup>/s, respectively. Following this definition, there are 11 mega-rivers on the Earth: Amazon, Congo, Orinoco, Yangtze, Madeira, Negro, Brahmaputra, Japurá, Paraná, Mississippi and Yenisei. The *mega rivers* share several common characteristics. They are predominantly sand-bed channels, with low gradients (<10 cm/km), flow depths up to 25-50m or more, individual channels with large widths  $W$  (1–10 km) and width to depth ratios  $W/h$  ( $W/h=30–200$ ), low Froude numbers, that are typically <0.3 (Amsler and Garcia, 1997) and a wide range of roughness scales associated with alluvial bedforms including ripples, dunes, and unit bars (Latrubesse, 2008).

Few comprehensive studies focused on hydrodynamics and sediment transport in such very large riverine systems are available. Getirana and Paiva (2013) presented a map of river hydrodynamic in the Amazon Basin using a classification method based on the analysis of Saint-Venant equation terms, while Yopez et al. (2018) and Gualtieri et al. (2022) reported hydrodynamics and sediment transport in the lower Orinoco. A limited number of field studies were conducted at *mega rivers* confluences, such as Jamuna/Ganges-Brahmaputra (Best and Ashworth, 1997), Paraná-Paraguay (Lane et al., 2008), Negro/Solimões (Gualtieri et al., 2018; Gualtieri et al., 2019) and Yangtze/Poyang Lake (Yuan et al., 2021; Xu et al., 2022). Among the *mega rivers*, studies about hydrodynamics and sediment transport in the Congo River are completely lacking.

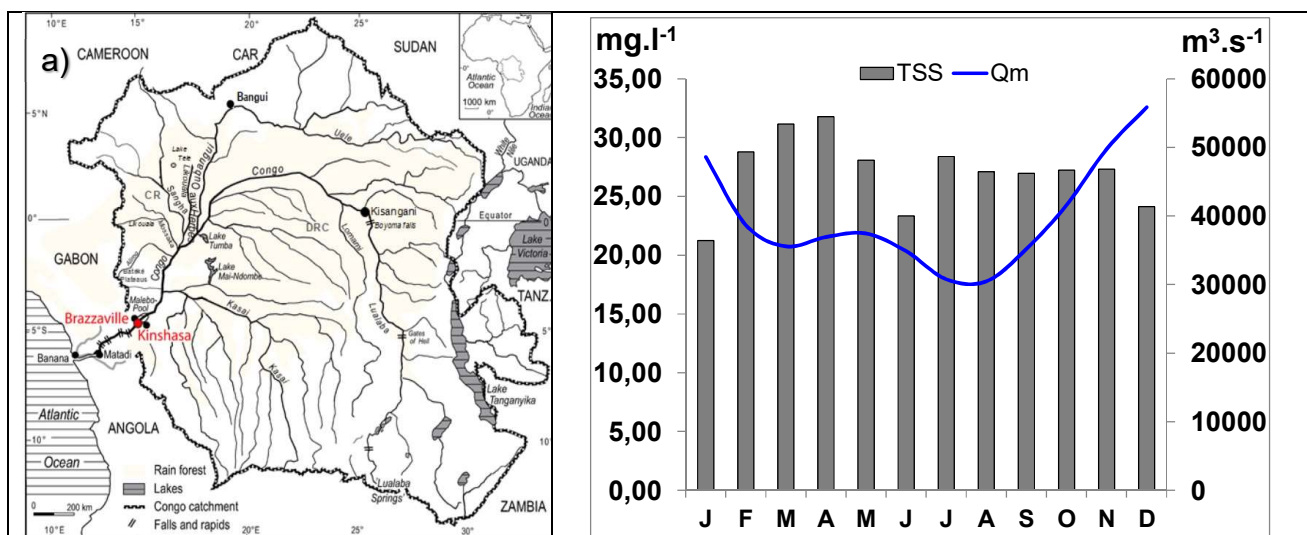
The paper presents the results from a series of field studies conducted from 2010 to 2019 in low and high flow conditions in the Congo River at the outlet of the Malebo Pool and at the city of Maluku. The main objective

of this study is to present and discuss the main hydrodynamics and sediment transport features and their changes observed during the field studies.

## 2 CONGO RIVER. FIELD SITE, INSTRUMENTATION AND DATA POST-PROCESSING Congo River

The Congo River is the second largest river in the world in terms of flow (40,500 m<sup>3</sup>/s) with a basin area of 3.7 x 10<sup>6</sup> km<sup>2</sup> (Moukandi N'kaya, et al. 2022), while its load of total suspended solids (TSS) accounts for 38% of total riverine material transport, with an average concentration of 25 mg/l (Moukandi N'kaya et al., 2020). Congo River basin extends between parallels 9°N and 14°S and meridians 11°E and 34°E, with a globally concentric physiographic structure around a vast basin perched at an altitude of nearly 300 m. Its center, rightly called the Central Basin, is a depression, flooded according to the hydro-rainfall cycle (Laraque, Bricquet, et al. 2009) (Figure 1a). This basin, covered by the great rainforest, directly sustains more than 80 million people. In addition, the rainfall generated by its forests provides a livelihood for 300 million rural Africans, as far as the Sahel and the Ethiopian highlands, thus playing a key role in regulating the World's climate.

Rainfall in Congo ranges from an average of about 1900 mm/year in the central basin to about 1100 mm/year at its northern and southern boundaries (Bultot 1971). Rainfall generally follows a south-north migration, with the southern parts of the basin experiencing their annual maximum from December to March, while rainfall peaks in the northern areas of the basin from July to October. The central areas of the basin experience two precipitation maxima, with a smaller peak in March to May and a larger peak in September to November. Traditionally, the driver of this seasonal precipitation migration was attributed to the Intertropical Convergence Zone (ITCZ), suggesting that it enhances local convection. However, meteorologists have recently recognized that mesoscale convective systems bounded by migratory jets are a more likely driver of precipitation migration (Nicholson, 2009). Seasonal variation in precipitation produces bimodal river flow on the main Congo River (Aldorf, et al. 2016), in which high flow conditions are typically observed from October to January and from April to May (Fig. 1b). As it takes between two weeks and two months, depending on flow distance, for local flood waves to migrate downstream, flood peaks timing occurs later than associated precipitation maxima. In Kinshasa-Brazzaville, the small flood peak is around May, associated with rainfall in the southern basin, and the large peak is around December, associated with rainfall in the northern basin. Monthly variation in discharge and TSS has a coefficient of variation of 1.8 and < 1.5, respectively. Monthly TSS concentrations are related to monthly discharge, with two small peaks during the year, one in March-April, just before the first rise of the Congo River, and a second in August-September, just at the beginning of the main Congo River rise (Figure 1b) (Moukandi N'kaya, 2020).



**Figure 1.** (a) Congo River Basin; (b) Annual variation of monthly average total suspended solids (TSS) concentration, at the Brazzaville-Kinshasa section, in relation to monthly average discharge (Qm), from 2006 to 2017 (Moukandi N'kaya, et al. 2022)

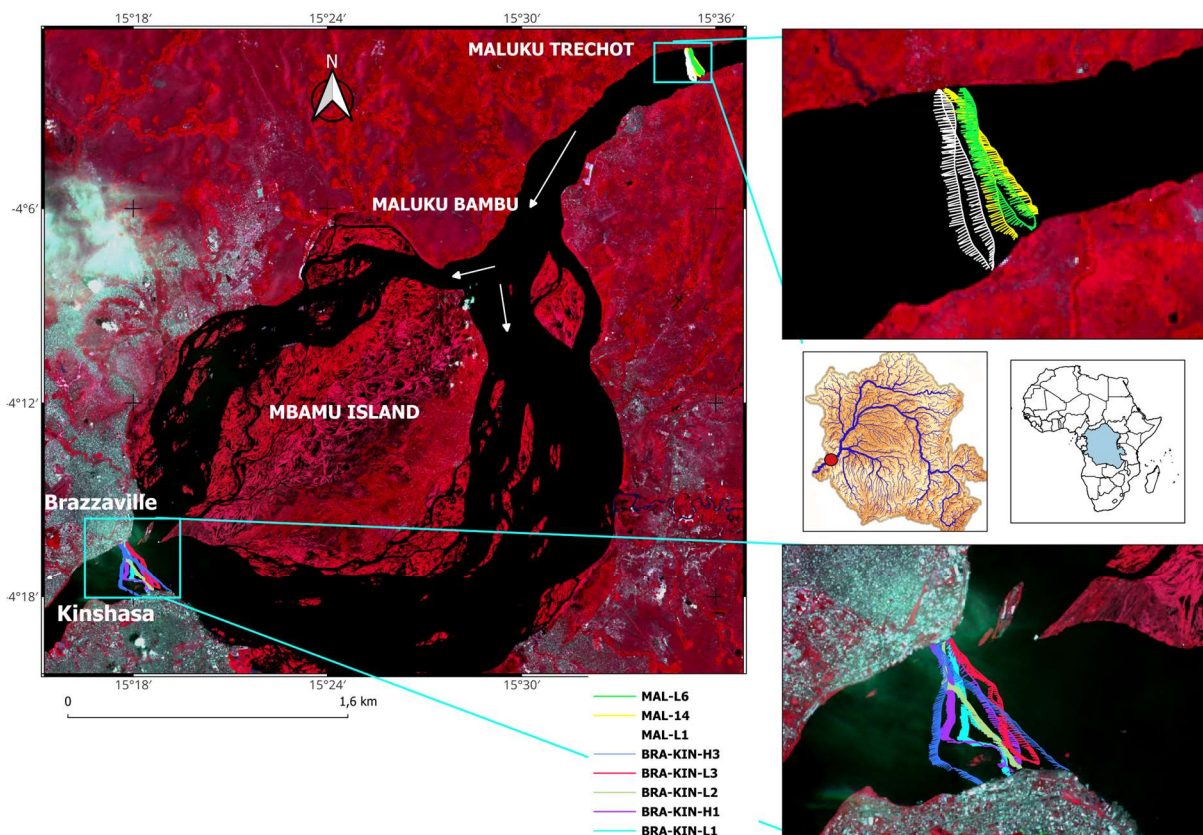
The main branch of the Congo River originates at the Zambian-DRC border, near the Zambezi River basin, south of the Katanga plateau (near the village of Musofi). The upper Congo River is named Lualaba upstream of Kisangani, where several waterfalls and narrows probably indicate variable channel bathymetry, controlled by geology and tectonics. Downstream of Kisangani, the middle reaches of the Congo River flows through the "Cuvette Centrale" covered with swamps, floating grasslands, and equatorial forest, which could be partially flooded with very few areas of dry land. The end of its middle course is characterized by a steep valley called the *Corridor* (Figure 2), due to the succession of almost 200 km of almost straight sections that shear sandstone formations, where the river can exceed 50 m in depth for a relatively small width (1 to 1.5 km). The Maluku-



Tréchet gauging section, used by ORSTOM (now the Institut de recherche pour le développement - IRD) from 1971 to 1981, is located at the exit of the *Corridor*, upstream of the Malebo Pool (Figure 2).

## 2.2 Field site and instrumentation

Our study area is located at the exit of the Congo River corridor and extends from Maluku Tréchet to the outlet of the Malebo Pool. The Malebo Pool is about 25 km wide and 35 km long, having a main arm on the left bank diverting about 85% of its flows (Laraque, 2013). The rest bypasses Mbamou Island, where on the right bank, it divides into several anastomosing arms separating multiple sandbanks of all sizes partially or totally emerged according to the hydrological cycle. Depths rarely exceed 5 m (Laraque et al., 2022). At its downstream outlet, the Malebo Pool narrows into a single reach that separates Brazzaville (BZV) and Kinshasa (KIN), the World's closest capitals, respectively of the Republic of Congo and the Democratic Republic of Congo (DRC). The gauging section (BZV-KIN), currently in use since 2010, is located at the outlet of the Malebo Pool and links the river ports of Beach-BZV and KIN. Maluku and BZV-KIN stations are separated by less than 30 km (Figure 2) and have the same climatic characteristics. Water levels in the Congo River have been daily collected since 1902 at the BZV-KIN station. In 2010, under the guidance of SOHybam (Service d'Observations des Contrôles géodynamique, hydrologique et biogéochimique de l'érosion/altération et des transferts de matière dans les bassins de l'Amazonie, de l'Orénoque et du Congo - acronym summarized = SOH), a program initiated in the Congo in 2005 by IRD, GIE-SCEVN has acquired a 600 kHz ADCP (Rio Grande Teledyne RDI) At the BZV-KIN section, water depth and velocity exceed 25 m and 2 m/s, respectively. Its riverbed presents channels lined with sandy dunes of several m in amplitude. The ADCP measurements presented in this study were collected from 2010 to 2021 during high and low flow conditions while sampling for TSS was carried out every 10th of the month by the HYBAM project in partnership with the GIE -SCEVN. The ADCP transducer was placed on a mobile float for profile monitoring.



**Figure 2.** Study area on the Congo River. The Sentinel-2 background image is presented in false-color composite acquired on March 23, 2023

Tables 1 and 2 list the measured discharge, channel width and the flow conditions in Brazzaville-Kinshasa reach, just at the outlet of the Malebo Pool, and in Maluku reach, respectively. In each cross-section, repeated measurements, up to 3, were mostly carried out. The transects collected from Brazzaville to Kinshasa from 2011 to 2019 had a width from 3.0 to 3.7 km and lasted in average about 40 minutes. In Maluku an average of 30 minutes was required for each one of the transects collected from 2010 to 2018 having a width from 1.2 to 2.0 km. The ADCP measurements were collected in low and high flow conditions with a discharge of

approximately from 25000 to 66000 m<sup>3</sup>/s, respectively, and generally under strong wind and very difficult measurement conditions.

**Table 1.** Transects collected in Brazzaville-Kinshasa reach of Congo River during the 2011/2019 field studies.

Name	Date	Transects	Q (m <sup>3</sup> /s)	W (m)	Flow conditions	Comments
BRA-KIN-L1	14/07/2011	2	24,822	3208	Low flow	ADCP, TSS
BRA-KIN-H1	28/11/2012	2	49,757	3210	High flow	ADCP, TSS
BRA-KIN-L2	28/03/2013	1	37,627	3195	Low flow	ADCP, TSS
BRA-KIN-L3	10/06/2013	2	36,124	3286	Low flow	ADCP, TSS
BRA-KIN-H2	19/12/2014	2	60,080	3736	High flow	ADCP, TSS
BRA-KIN-H3	23/12/2019	2	65,710	3116	High flow	ADCP, TSS

Legend: Q = discharge; W = transect width

**Table 2.** Transects collected in Maluku reach of Congo River during the 2010/2018 field studies.

Name	Date	Transects	Q (m <sup>3</sup> /s)	W (m)	Flow conditions	Comments
MAL-L1	03/07/2010	2	36,574	2019	Low	ADCP, TSS
MAL-L2	15/07/2011	2	25,361	1719	Low	ADCP, TSS
MAL-L3	01/08/2011	2	23,967	1817	Low	ADCP, TSS
MAL-L4	05/09/2013	1	33,158	1677	Low	ADCP, TSS
MAL-L5	22/07/2017	3	28,835	1168	Low	ADCP, TSS
MAL-L6	23/08/2018	2	30,268	1704	Low	ADCP, TSS

Legend: Q = discharge; W = transect width

### 2.3 Data post-processing

The analysis of the ADCP data first gained basic geometric and hydrodynamics parameters, while further information was derived using the Velocity Mapping Tool software (VMT) (Parsons et al., 2013).

In open channel flows, any deviation from the assumption of a uniform velocity distribution over the cross-section is accounted for using two coefficients, the Coriolis coefficient  $\alpha$  for kinetic energy and the Boussinesq coefficient  $\beta$  for momentum (Chanson, 2004). If water density is constant, they are defined as:

$$\alpha = \frac{\int_A V^3 dA}{V_{avg}^3 A} \quad [1]$$

$$\beta = \frac{\int_A V^2 dA}{V_{avg}^2 A} \quad [2]$$

where  $V_{avg}$  is the average cross-sectional velocity and  $V$  is the effective velocity in any point. In this study, the depth-averaged velocity was applied to represent the distribution of the velocity in the river cross-section.

In alluvial channels friction is related both to the grain resistance and to the form of bedforms. Hence, the total friction is the sum of these terms as (Chanson, 2004):

$$\tau_b = \tau'_b + \tau''_b \quad [3]$$

where  $\tau'_b$  and  $\tau''_b$  are the skin friction shear stress and the form-related shear stress, respectively.

The approach proposed by Sime et al. (2007) for moving boat ADCP profiling was applied to estimate skin friction shear stress. They demonstrated that a quadratic-stress approach based upon the depth-averaged velocity and a zero-velocity height related to the bed grain size is the most accurate method. Hence, the skin friction shear stress can be calculated as:

$$\tau'_b = \rho C_d V_{depth-avg}^2 \quad [4]$$

where  $C_d$  is the drag coefficient, which was obtained as:

$$C_d = \frac{\kappa^2}{\ln^2(h/e z_0)} \quad [5]$$

where  $\kappa$  is the von Kármán constant,  $e$  is the Euler number and  $z_0$  is the zero-velocity height above the bed.

Sime et al. (2007) assumed that  $z_0 = 0.1 d_{84}$ , where  $d_{84}$  is bed grain diameter such that 84% of diameters are finer. Bed sediment sampling provided a  $d_{84}$  of 0.250 mm (fine sand). Using the above method, the skin friction stress, which is related to the *bed load mode*, was calculated. The different modes of transport were determined using the *Rouse number*  $Ro$ :

$$Ro = \frac{w_s}{\kappa u^*} \quad [6]$$

where  $w_s$  is the fall (settling) velocity of the particles. If the Rouse number varies between 0.8 and 2.5, the transport is within the *suspended load* mode; when it goes beyond 2.5, the transport is as *bed load* (Bombardelli and Moreno, 2012). Finally, the skin friction shear stress can also be applied to approximate the maximum particle size in suspension (Trevethan and Aoki, 2009):

$$d_{ss} = \sqrt{\frac{18\rho\nu \cdot 0.8 \cdot \sqrt{\tau_b / \rho}}{g(\rho_s - \rho)}} \quad [7]$$

where  $\rho_s$  is the particle density and  $\nu$  is the water kinematic viscosity.

### 3 RESULTS Basic hydrodynamics parameters

The analysis of the ADCP data first gained the basic hydrodynamics parameters such as area, wetted perimeter, hydraulic ratio, average/median water depth, aspect ratio, cross-sectional average velocity, and average/median depth-averaged velocity. Some of these parameters are listed in Tables 3 and 4, in which the median value from each field study is presented.

In the Brazzaville-Kinshasa reach, the flow discharge was in the range from 24000 to 66000 m<sup>3</sup>/s. Large velocities up to almost 3 m/s were observed, while water depth was in the range from 9 to 13 m from low to high flow conditions. In Maluku, the flow discharge was in the range from 29000 to 34000 m<sup>3</sup>/s. The average velocity was in the range from 0.8 to 1.1 m/s, while water depth was in the range from 15 to 23 m from low to high flow conditions.

**Table 3.** Main flow properties measured in Brazzaville-Kinshasa reach during the 2010/2019 field studies.

Date	Flow conditions	Q (m <sup>3</sup> /s)	A (m <sup>2</sup> )	W (m)	h <sub>med</sub> (m)	W/h <sub>rect</sub> (-)	V <sub>avg</sub> (m/s)	V <sub>depth-avg</sub> (m/s)	Dir (°)	V <sub>max</sub> (m/s)
14/07/2011	Low flow	24,822	28,562	3208	9.0	361	0.87	1.19	255	2.22
28/11/2012	High flow	49,757	39,323	3210	11.0	262	1.27	1.49	265	2.48
28/03/2013	Low flow	37,627	35,576	3195	10.4	287	1.06	1.18	257	2.24
10/06/2013	Low flow	36,124	36,475	3286	10.9	296	0.99	1.15	257	2.14
19/12/2014	High flow	60,080	56,004	3736	13.8	249	1.07	1.29	260	2.33
23/12/2019	High flow	65,710	42,002	3116	13.0	231	1.56	1.62	249	2.83

Legend: Q = discharge; A = cross-sectional area; h<sub>med</sub> = median depth; W/h<sub>rect</sub> = aspect ratio; V<sub>avg</sub> = cross-section velocity (Q/A); V<sub>depth-avg</sub> = median of the depth-averaged velocity; Dir = median of flow direction degrees from North; V<sub>max</sub> = maximum depth-averaged velocity

**Table 4.** Main flow properties measured in Maluku reach during the 2010/2018 field studies.

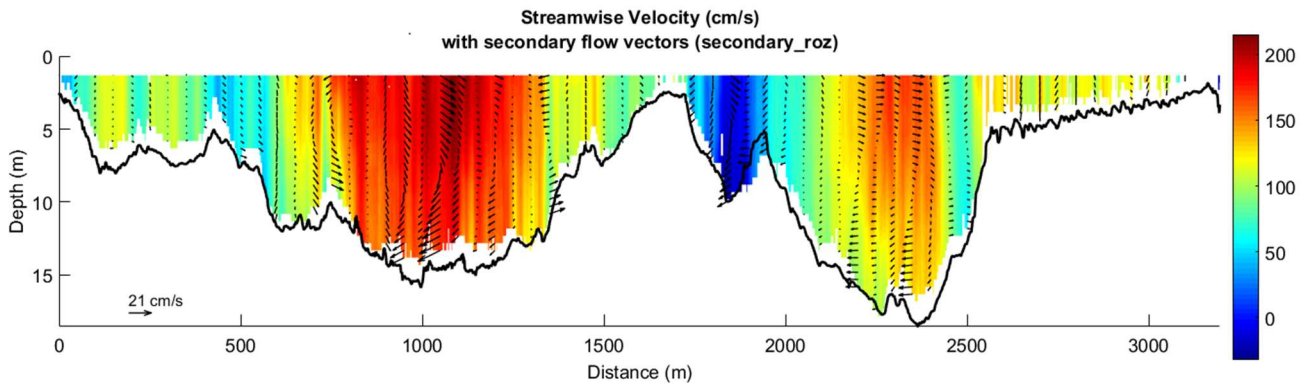
Date	Flow conditions	Q (m <sup>3</sup> /s)	A (m <sup>2</sup> )	W (m)	h <sub>med</sub> (m)	W/h <sub>rect</sub> (-)	V <sub>avg</sub> (m/s)	V <sub>depth-avg</sub> (m/s)	Dir (°)	V <sub>max</sub> (m/s)
03/07/2010	Low flow	36,574	31,929	2019	15.0	128	1.15	1.13	257	1.77
15/07/2011	Low flow	25,361	29,769	1719	17.6	99	0.85	0.84	263	1.49
01/08/2011	Low flow	23,967	29,294	1817	17.4	113	0.82	0.83	259	1.51
05/09/2013	Low flow	33,158	33,712	1677	22.6	83	0.98	1.11	267	1.82
22/07/2017	Low flow	28,835	27,033	1168	23.8	50	1.08	1.05	242	1.67
23/08/2018	Low flow	30,268	32,313	1704	20.5	90	0.94	0.98	265	1.55

Legend: Q = discharge; A = cross-sectional area; h<sub>med</sub> = median depth; W/h<sub>rect</sub> = aspect ratio; V<sub>avg</sub> = cross-section velocity (Q/A); V<sub>depth-avg</sub> = median of the depth-averaged velocity; Dir = median of flow direction degrees from North; V<sub>max</sub> = maximum depth-averaged velocity

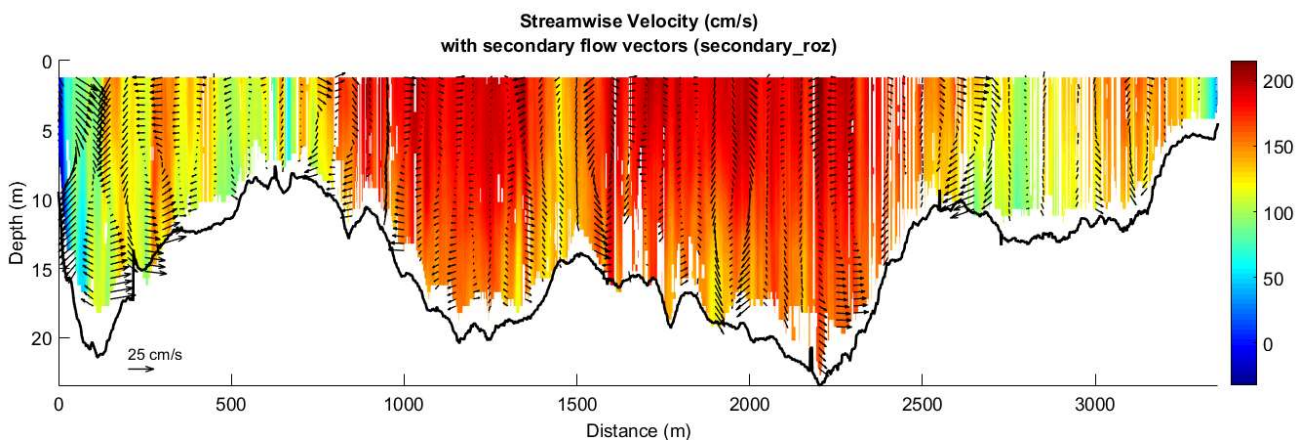
The ADCP data were also analyzed using the VMT code. Figures 3 and 4 show the cross-sectional distribution of the streamwise velocity with the secondary flow vectors calculated by Rozovsky's method for the transects BRA-KIN-L1 and BRA-KIN-H3, respectively, both located at the outlet of the Malebo Pool. Each plot represents the results by averaging 2 transects. These transects were collected in low flow and high flow conditions, respectively, in which large differences in velocity and water depth were observed. Additionally, the central part of the cross-section, where the velocity was quite uniform during high flow conditions, during low flow conditions was divided in two regions with the appearance of sandbanks. This is consistent with the observations from Laraque et al. (2022). In both cases, intense secondary flow was found in the central part of the river. Figure 5 presents the cross-sectional distribution of the streamwise velocity with the secondary flow at the Maluku station



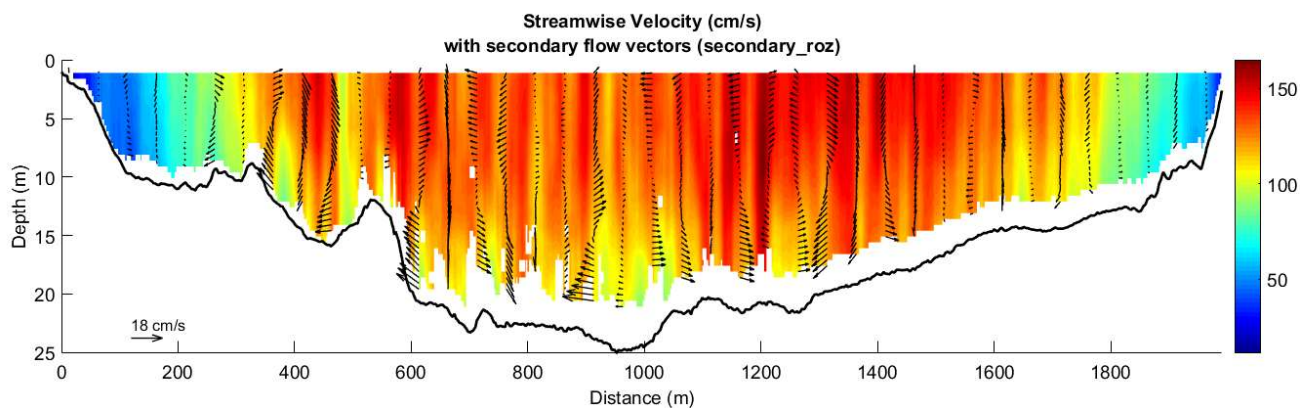
in July 2010 under low flow conditions. Velocities in the order of 1-1.5 m/s and 0.1-0.6 m/s were observed in the central region of the river and at the banks, respectively.



**Figure 3.** Cross-sectional distribution of velocity magnitude with secondary flow vectors – BRA-KIN-L1



**Figure 4.** Cross-sectional distribution of velocity magnitude with secondary flow vectors – BRA-KIN-H3



**Figure 5.** Cross-sectional distribution of velocity magnitude with secondary flow vectors – MAL-L1

**Table 5.** Coriolis and Boussinesq coefficients in Brazzaville-Kinshasa reach during the 2010/2019 field studies

Name	Date		Q (m <sup>3</sup> /s)	$\alpha$	$\beta$
BRA-KIN-L1	14/07/2011	Low flow	24822	1.70	1.36
BRA-KIN-H1	28/11/2012	High flow	49757	1.83	1.59
BRA-KIN-L2	28/03/2013	Low flow	37627	1.94	1.49
BRA-KIN-L3	10/06/2013	Low flow	36124	1.76	1.39
BRA-KIN-H2	19/12/2014	High flow	60080	---	---
BRA-KIN-H3	23/12/2019	High flow	65710	1.72	1.49

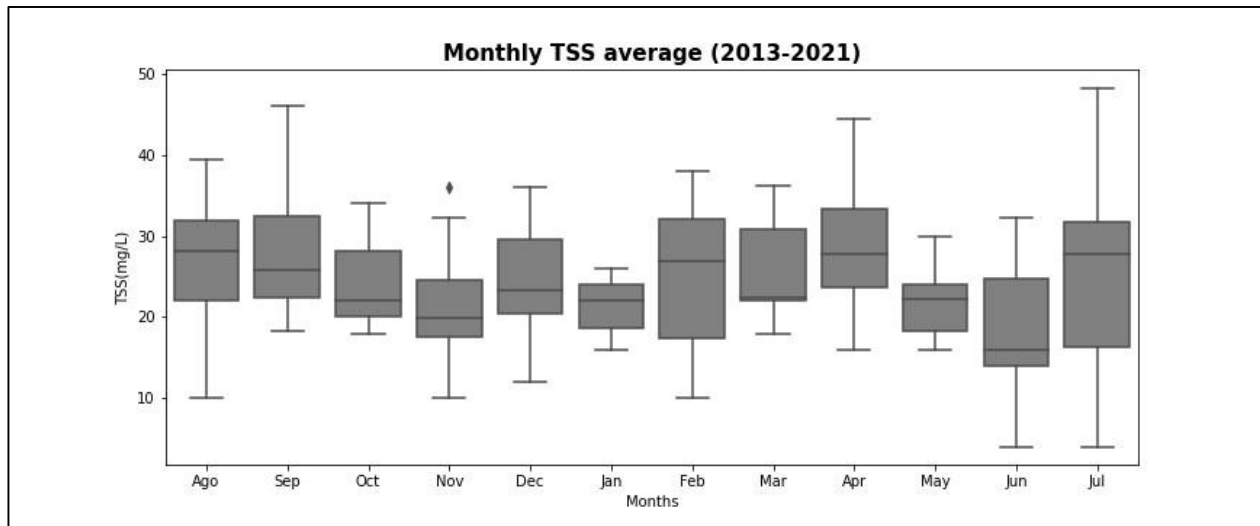
Legend: Q = discharge;  $\alpha$  = Coriolis coefficient;  $\beta$  = Boussinesq coefficient

Table 5 lists the Coriolis and Boussinesq coefficients for the Brazzaville-Kinshasa reach during the field studies from 2010 to 2019. The coefficients  $\alpha$  and  $\beta$  were in the range from 1.72 to 1.94 and from 1.36 to 1.59,

respectively. Those values were consistent with those found in the lower reach of the Orinoco River with comparable discharge and flow velocities (Gualtieri et al. 2022).

### 3.2 Sediment transport parameters

Figure 6 shows box plots of the monthly-averaged TSS concentration collected in situ at the Brazzaville/Kinshasa station from 2013 to 2021. Such concentration had an average and minimum value of 24 and 4 mg/L, respectively. Large variations in TSS concentration were found in from June to September with a peak of almost 50 mg/L in July and September, perhaps related to a backwater effect in the main tributaries and floodplain upstream of the station.



**Figure 6.** Monthly-averaged TSS concentration at the Brazzaville/Kinshasa station from 2013 to 2021

One of the objectives of the field campaigns was to study the interaction between hydrodynamics and sediment transport in the Congo River. This transport is possible as the intensity of the water flow is strong enough to move the finer particles away from the bed and to carry them along the current, while heavier particles are harder to be moved and either remain on the bed, move close to the bed, sliding or rolling, or deposit once moved, i.e. saltation (Bombardelli and Moreno, 2012).

**Table 6.** Main sediment transport properties measured in the Brazzaville-Kinshasa reach during the 2010/2019 field studies.

Name	Date		Q (m <sup>3</sup> /s)	$\tau'_b$ (Pa)	$u^*$ (m/s)	Ro	$d_{ss}$ (mm)
BRA-KIN-L1	14/07/2011	Low flow	24822	1.75	0.042	1.85	0.186
BRA-KIN-H1	28/11/2012	High flow	49757	2.97	0.055	1.40	0.211
BRA-KIN-L2	28/03/2013	Low flow	37627	1.59	0.040	1.91	0.179
BRA-KIN-L3	10/06/2013	Low flow	36124	1.52	0.039	1.95	0.178
BRA-KIN-H2	19/12/2014	High flow	60080	2.04	0.045	1.69	0.192
BRA-KIN-H3	23/12/2019	High flow	65710	3.35	0.058	1.32	0.217

Legend: Q = discharge;  $\tau'_b$  = bed shear stress;  $u^*$  = shear velocity; Ro = Rouse number;  $d_{ss}$  = maximum suspended grain size

**Table 7.** Main sediment transport properties measured in the Maluku reach during the 2010/2018 field studies.

Name	Date		Q (m <sup>3</sup> /s)	$\tau'_b$ (Pa)	$u^*$ (m/s)	Ro	$d_{ss}$ (mm)
MAL-L1	03/07/2010	Low flow	36574	1.60	0.040	1.91	0.181
MAL-L2	15/07/2011	Low flow	25361	0.89	0.030	2.56	0.158
MAL-L3	01/08/2011	Low flow	23967	0.83	0.029	2.66	0.155
MAL-L4	05/09/2013	Low flow	33158	1.40	0.037	2.04	0.176
MAL-L5	22/07/2017	Low flow	28835	1.35	0.037	2.08	0.174
MAL-L6	23/08/2018	Low flow	30268	1.21	0.035	2.19	0.169

Legend: Q = discharge;  $\tau'_b$  = bed shear stress;  $u^*$  = shear velocity; Ro = Rouse number;  $d_{ss}$  = maximum suspended grain size

Tables 6 and 7 list the median values for each transect of the main sediment transport parameters in Brazzaville-Kinshasa and Maluku, respectively. In Brazzaville-Kinshasa a large variation in bed shear stresses



from the low flow to the high flow conditions was observed. The median shear stress was from 1.52 to 3.35 Pa in low and high flow conditions, respectively. In Muluku, the median shear stress was in the range from 0.83 to 1.60. The Rouse number indicated that in Brazzaville-Kinshasa and Muluku, in both low and high flow conditions, the dominant mode for  $d_{84}$  was the *suspended load* mode. The maximum suspended grain size  $d_{ss}$  was in the order of fine sands for each flow conditions and field site. Note that these values of  $Ro$  and  $d_{ss}$  should be considered as an upper and lower boundary, respectively, because they were based only upon the skin friction shear stress and not upon the total stress  $\tau_b$  in the Equation [4].

Comprehensive studies about hydrodynamics and sediment transport in the Congo River, which is the second largest river in the world in terms of basin area and discharge, are completely lacking. The present study summarizes the results from a series of field studies conducted using ADCP profiling and water sampling for TSS measurement from 2010 to 2019 in low and high flow conditions in the reach located at the outlet of Malebo Pool between Brazzaville and Kinshasa and in the reach at the city of Maluku. Large differences in discharge and flow velocities were observed in each survey according to the hydrological cycle. The flow discharge was in the range from 24000 to 66000 m<sup>3</sup>/s. Channel width was from 3.0 to 3.7 Km at the outlet of Malebo Pool and from 1.2 to 2.0 Km in Maluku. Large velocities up to almost 2 m/s and 3 m/s were observed in Maluku and Brazzaville-Kinshasa, respectively, while water depth was in the range from 9 to 23 m from low to high flow conditions at the outlet of the Malebo Pool and from 15 to 23 m in Maluku. The analysis of the cross-sectional distribution of the velocity revealed intense secondary flow in each flow conditions and in both field sites.

Coriolis and Boussinesq coefficients were consistent with those found in the Orinoco River for comparable discharge and velocities. Finally, at Brazzaville-Kinshasa station monthly-averaged TSS concentration from 2013 to 2021 was in range from 20 to 30 mg/L, while grain-related bed shear stress distribution identified dominant transport mode and maximum suspended grain size, being in the range order of fine sands for each flow condition and field site.

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