Draft

Prepared for:

Partners for Water

Pantanal / Taquari project

River Survey

Report

November, 2004

Q3335.00

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List of Symbols

Symbol	Units	Meaning
C	$m^{1/2}/s$	Chèzy roughness coefficient
d_i	m	Grain size
Dm	m	Mean grain size diameter
D35	m	Grain size diameter of which 35% of the sediment is smaller
D50	m	Median grain size diameter (Grain size diameter of which 50% of the sediment is smaller)
D90	m	Grain size diameter of which 90% of the sediment is smaller
g	m/s^2	Acceleration of gravity
h	m	Water depth
p_i	-	Fraction with grain size d_i
U	m/s	Average flow velocity
U_{wl}	m/s	Flow velocity at the water surface
u	m/s	Flow velocity
u_*	m/s	Shear flow velocity
Re	-	Reynold number
x	-	Coordinate in flow direction
y	-	Coordinate in lateral direction
z	m	Vertical coordinate
z_0	m	Level above the bed of zero velocity or discharge
δ	m	Thickness of the viscous sub layer at the bottom
κ	-	Von Kármán constant
ν	m^2/s	Kinematic viscosity

1 Introduction

This report presents the findings of a field mission in the Pantanal and in particular in the Taquari area (March 30th to April 4th) within the framework of the Pantanal–Taquari project. One of the key topics of this project concerns the sedimentation and flooding problems of the Río Taquarí in the Pantanal. The report records the river data and information obtained during the river survey. A second, separate report elaborates the actual assessment of sedimentation and flooding problems of the Río Taquarí in the Pantanal.

Measurements of the following river aspects between Coxim and Corumba were carried out during the river survey:

1. Sonar measurements of the water depth in the vicinity of the river thalweg (e.g. the deepest locations along the river).
2. Grab samples of the channel sediment.
3. Sonar measurements of 26 cross-sections (including sketches of the banks above the water level).
4. DGPS point measurements of the water level at 9 locations along the Rio Taquari, the Caronal and the Paraguai River and at one geographical known position in Corumba;
5. GPS flow velocity measurements in the thalweg.

These data have been worked out into:

- the longitudinal profiles of the thalweg depth, the bed level and the water level (Chapter 2);
- the longitudinal profile of the characteristic grain sizes of the river bed sediment (Chapter 3);
- the longitudinal profile of the approximated flow velocities in the vicinity of the thalweg (Chapter 4);
- a total of 26 cross-sections in the Rio Taquari and the New Caronal (Chapter 5).

Also pictures were taken during the river survey. They can be found in Appendix C of this report, although no separate chapter has been dedicated to the pictures.

The report has been written by mr. C. Stolker. Arc-View assistance was provided by mr. G. Groenveld (Alterra) and mr. M. Ververs (WL | Delft Hydraulics).

2 Longitudinal profiles of water level, bed level and thalweg depth

2.1 Introduction

The field-trip was carried out with a small open boat using an outboard motor. An acoustic sonar device was placed 0.3 m below the water surface and was attached to the boat. During the first two days of the trip, the distance between the sonar and the river bed was measured with a frequency of 0.1 Hz and during the following days with a frequency of 0.5 Hz. Both the measured depth and the geographical position of the boat in X,Y co-ordinates were stored on a disk.

2.2 Water depth and water level

All data has been imported in ArcView. A fluent sailing path was drawn through the measured depth points, and redundant points were removed. Due to shallow water depths in the Rio Taquari the boat was continuously following the deepest sections of the river. Therefore, this sailing path can more or less be seen as the river thalweg (e.g. the deepest locations along the river stretch). The cumulative distance between the various depth points enables the production of a longitudinal profile of the water depth in the Rio Taquari (Figure 2-1) and in the upstream part of the New Caronal (Figure 2-2).

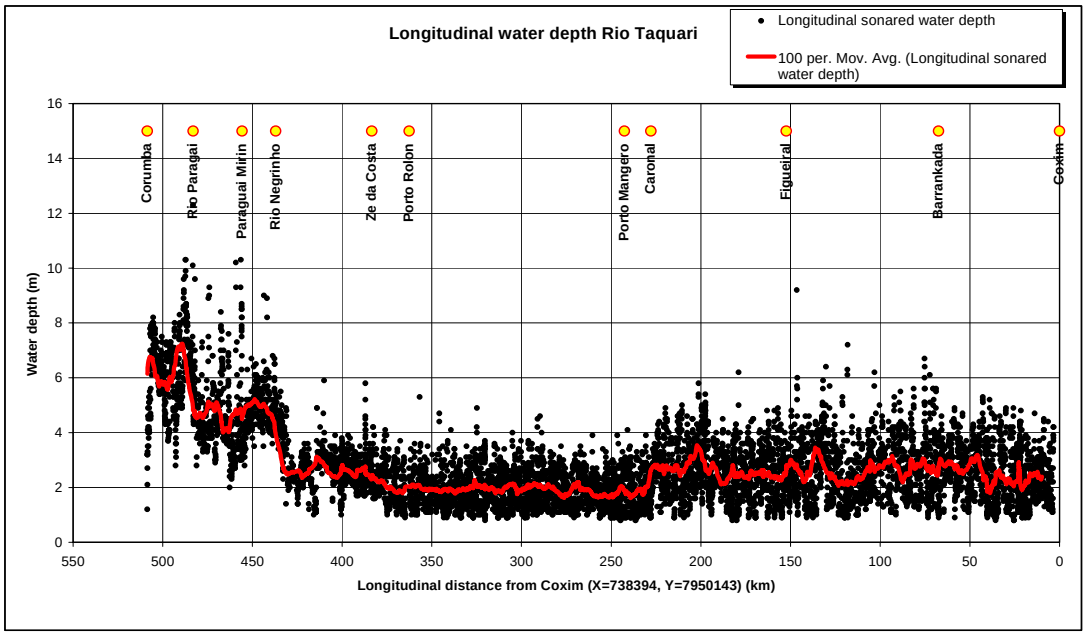


Figure 2-1 Longitudinal profile of the water depth along the thalweg in the Rio Taquari (March 30th to April 4th)

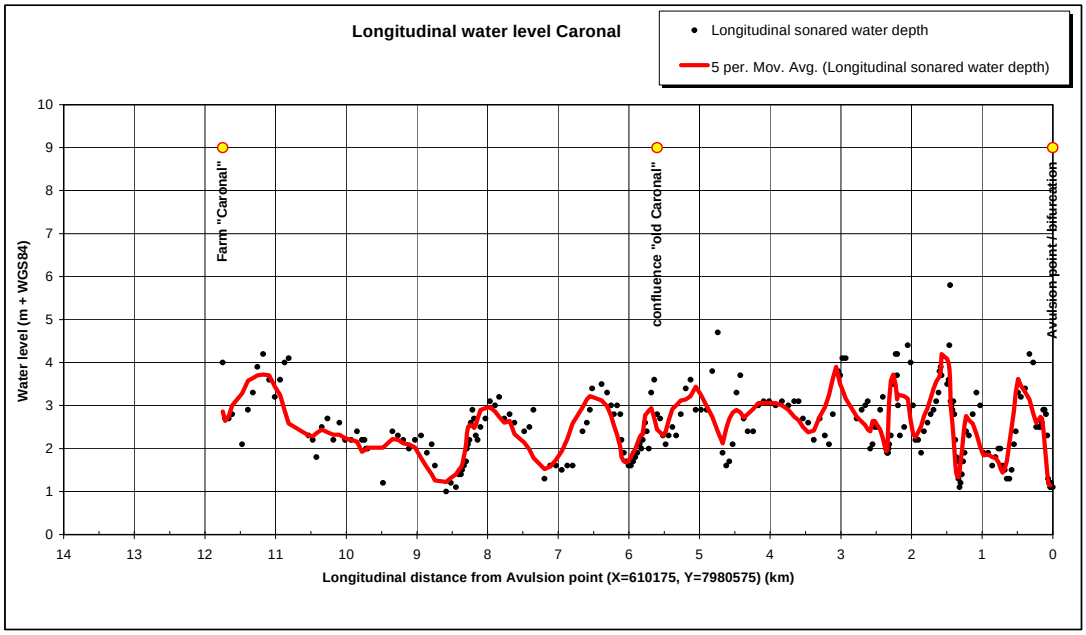


Figure 2-2 Longitudinal profile of the water depth along the thalweg in the New Caronal (March 30th to April 4th)

Although, the presented longitude (X) and latitude (Y) geographical position of a common GPS is quite accurate, the delivered altitude (Z) is very unreliable (> 10 m). However, an accurate altitude level of the water surface along the river was important to determine the actual bed level. That is why DGPS measurements of the water level have been carried out at 9 locations along the river. One DGPS-measurement of a geographical known point in Corumba showed an accuracy of the DGPS measurements within 0.1 m. The DGPS levels show a rather constant gradient in water lever in a large part of the Taquari. Therefore, a linear interpolation between the various DGPS measurements seems to be allowed. The observed water depths have been related to this obtained water level and are presented for the Rio Taquari in Figure 2-3 and for the upstream part of the New Caronal in Figure 2-4. The corresponding discharge of this period has still to be requested at the administrating organization.

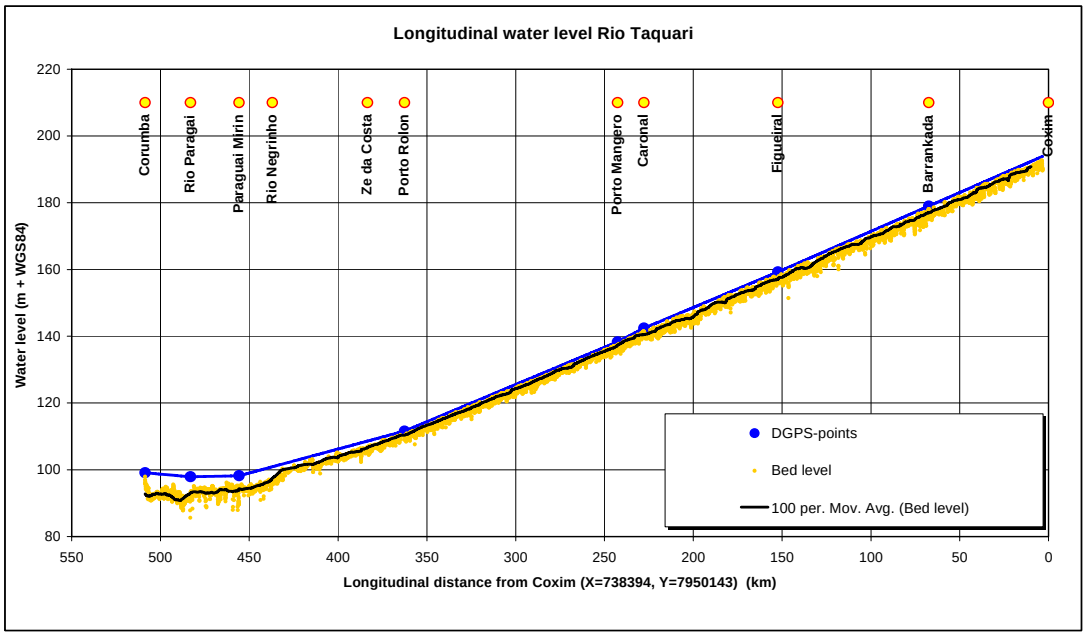


Figure 2-3 Longitudinal profile of the water level and the bed level along the thalweg in the Rio Taquari (March 30th to April 4th)

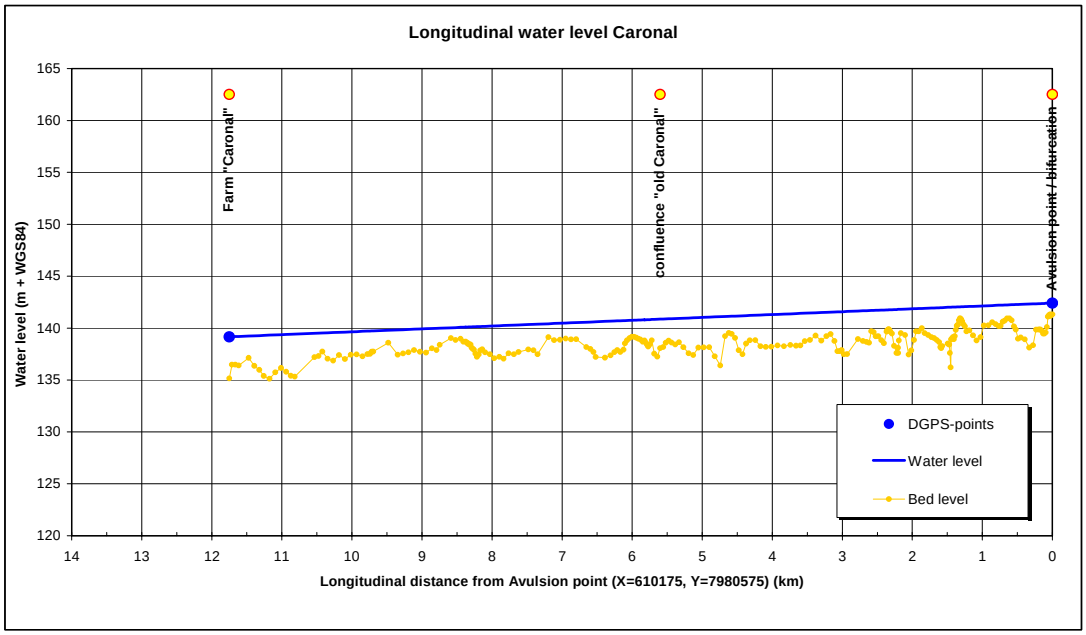


Figure 2-4 Longitudinal profile of the water level and the bed level along the thalweg in the New Caronal (March 30th to April 4th)

2.3 Conclusions

The previous figures together with field observations lead to the following conclusions:

- In the major part of the Taquari the water depth varied between a few dm and 5 m (except for some points and downstream of the Rio Negrinho).
- The average water depth in the lower Taquari downstream of the New Caronal avulsion (rkm 225 – 425) is approximately 1 m lower than the upper part of the Taquari.
- Downstream of rkm 425 the water depth increases considerably (up to 200%) and varies between 2 and 10 m.
- The water depth in the 12 km long upstream part of the New Caronal varies between 1 and 4 m.
- The following water slopes have been observed:

River	Section	rkm in figures	water level slope (m/km)
Rio Taquari	Coxim – Caronal	0 – 228	0.229
	Caronal bif. – Porto Rolon	228 – 363	0.229
	Porto Rolon – Paragai Mirin	363 – 456	0.144
	Paraguai Mirin – Rio Paraguai	456 – 483	0.011
Caronal	bifurcation – Farm :"Caronal"	0 – 12	0.277
Rio Paragai	Corumba – Rio Taquari	456 – 483	0.017

Table 2-1 Water level slope (measurements March 30th to April 4th)

- The slope in water level between Coxim and Ze da Costa is very constant.
- The slope in water level in the upper part of the New Caronal is slightly steeper than the slope of the lower Taquari.

3 Longitudinal distribution of characteristic grain sizes of the river bed sediment

3.1 Grab samples

Along the river stretch 17 samples of the river bed material have been obtained, using a Van Veen grabber of approximately 5 litre (see Figure 3-1).

Figure 3-1 Van Veen grabber used for taking the grab samples during the River Survey

The sediment samples were sieved in the laboratory of Embrapa. From this analysis accumulated sieve curves have been developed, which are presented in Figure 3-2. The actual sieve diameter of the particles was determined as follows: if a particle falls through sieve D_A and remains on the next sieve D_B then the actual sieve diameter $D = (D_A * D_B)^{1/2}$.

Table 3-1 provides for each sample the characteristic grain sizes: D35 (35% of the sediment is smaller), D50 (50% of the sediment is smaller, median grain size), the mean grain size diameter Dm and D90 (90% of the sediment is smaller), in which Dm is defined as:

$$Dm = \frac{\sum (p_i \cdot d_i)}{\sum p_i} \qquad (3.1)$$

Table 3-1 also provides the geographical location (X and Y) of the samples obtained.

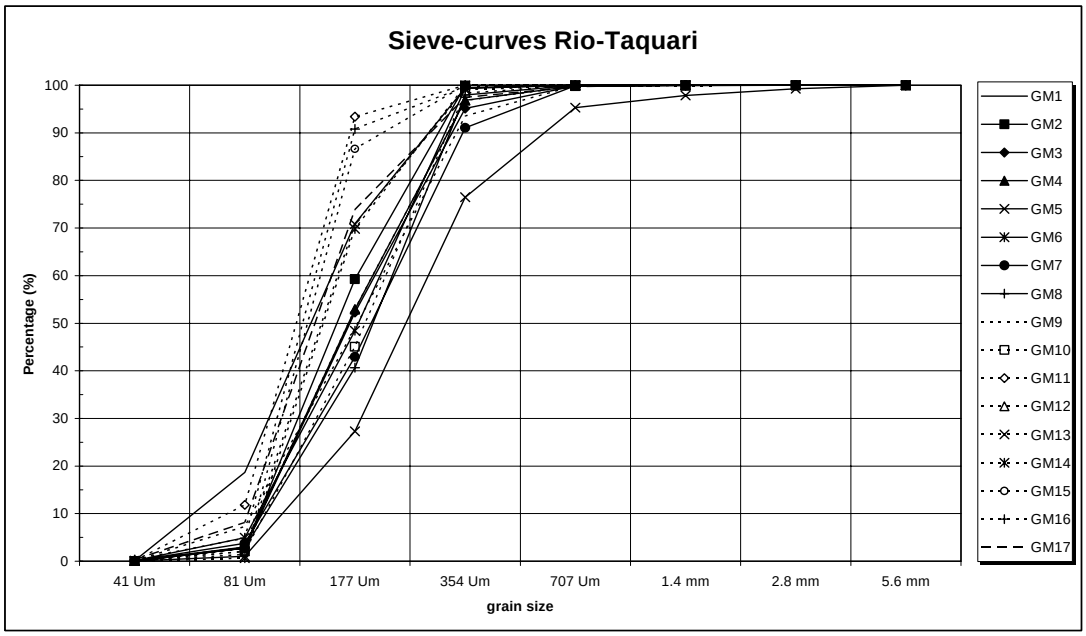


Figure 3-2 Accumulated sieve curves of the river bed samples

Sample	X (m)	Y (m)	Location	rkm	D35 (mm)	D50 (mm)	Dm (mm)	D90 (mm)
GM1	725918	7960601		22.9	0.111	0.139	0.212	0.295
GM2	715167	7963669		40.3	0.136	0.161	0.246	0.310
GM3	707229	7973740		67.4	0.144	0.172	0.276	0.333
GM4	692064	7983131	Cross-section TK5	105.5	0.143	0.171	0.269	0.326
GM5	665750	7984055	Figureial	152.4	0.204	0.258	0.554	0.608
GM6	632303	7984084	Cross-section TK6	197.4	0.147	0.182	0.266	0.321
GM7	617485	7982093	Cross-section TK9	218.3	0.157	0.203	0.307	0.350
GM8	599183	7979075	Cross-section TK10	241.7	0.162	0.206	0.286	0.329
GM9	610483	7980605	upstream Caronal bifurcation	227.5	0.145	0.181	0.283	0.340
GM10	600631	7981404	Caronal avulsion		0.154	0.193	0.278	0.326
GM11	579837	7974744		268.1	0.108	0.126	0.177	0.173
GM12	556887	7966060	Cross-section TK11	302.5	0.143	0.171	0.269	0.326
GM13	518037	7942817	Porto Rolon	362.6	0.127	0.148	0.230	0.297
GM14	502615	7930932	Zeda Costa	387.1	0.129	0.149	0.230	0.295
GM15	493109	7928593	Bifurcation point	400.1	0.119	0.136	0.199	0.221
GM16	466581	7917417	Rio Negrinho	437.5	0.115	0.131	0.190	0.176
GM17	453752	7913038	Paragai Mirin	463.2	0.120	0.142	0.226	0.298

Table 3-1 Characteristic grain sizes (in mm)

3.2 Characteristic grain sizes along the river

The sediment can be characterized as fine sand, which indicates that the dominant transport mechanism of the sediment is suspended load transport (transport of particles moving in the fluid and kept in suspension by turbulent diffusion).
The grain sizes do not vary strongly in downstream direction, as can be seen in **Error! Not a valid bookmark self-reference.**, which presents the longitudinal distribution of the characteristic grain sizes, although minor downstream fining can be noticed.

The critical flow velocity for this sediment mixture is approximately 0.35 m/s, which is the point of initiation of motion of the sediment particles.

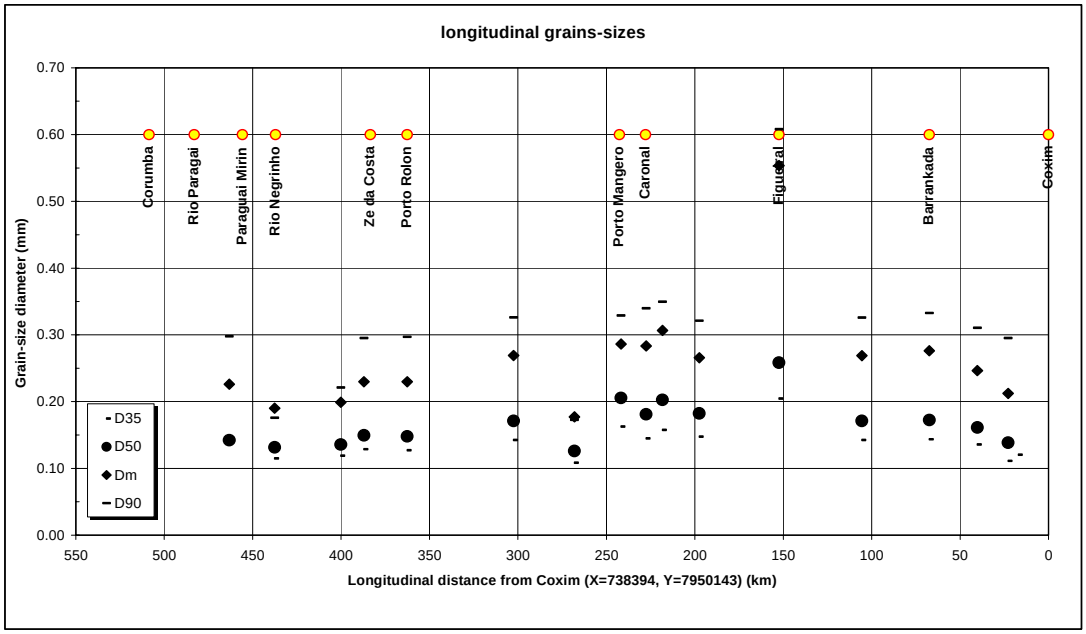


Figure 3-3 Longitudinal distribution of the grain sizes

4 Flow velocities

4.1 GPS flow measuring

Although a sophisticated flow velocity measuring device was not available during the field trip, the flow velocity at the water surface (U_{wl}) has been determined in a straightforward way. The engine of the boat was turned off and the boat drifted with the speed of the water, approximately along the river thalweg. The corresponding speed was read from the GPS and was corrected upwards or downwards if floating particles on the water surface were traveling faster of less fast than the drifting boat. This technique was repeated at various locations along the river.

4.2 Determination of the depth-averaged flow velocity

The flow velocity at the water surface has been re-calculated to the depth average flow velocity *U*, using the following equation:

$$U = \frac{U_{wl}}{\ln\left(\frac{h}{z_0}\right)}\left[\ln\left(\frac{h}{z_0}\right)-1\right] \qquad (4.1)$$

The measured values of flow velocity, flow depth and gradient result in a remarkably low hydraulic roughness. Therefore, the depth-averaged flow velocity is calculated using theoretical relations for hydraulically smooth beds. Parameter z_o is the level of zero velocity or discharge, which, in case of a hydraulically smooth surface can be determined by the following equation:

$$z_0 \approx \frac{\delta}{117} \qquad (4.2)$$

where δ denotes the viscous sub-layer at the bottom defined by:

$$\delta = 11,6\frac{\nu}{u_*} = 1.6\frac{C}{\mathrm{Re}\sqrt{g}}h \qquad (4.3)$$

The other symbols are explained in the list of symbols on page I-ii.

The basis of equation (4.1) is the assumption that the water velocity in vertical or depth direction can be described by a logarithmic velocity distribution, with:

$$u(z) = \frac{u_*}{\kappa} \ln\left(\frac{z}{z_0}\right) \qquad (4.4)$$

Equating the integral along the water depth of equation (4.4) to the depth-averaged flow velocity U times the water depth h, and the flow velocity at the water surface $u(z) = U_{wl} = u(h)$ and assuming z_0/h<<1, equation (4.4) can be rewritten into equation (4.1). This equation enables us to calculate the depth-averaged flow velocity with the flow velocity at the water surface U_{wl} as input.

4.3 Depth-averaged flow velocities along the river

The following figures show the distribution of the depth-averaged flow velocity U along the Rio Taquari (Figure 4-1) and along the upper part of the New Caronal (Figure 4-2). The depth-averaged flow velocity in the Rio Taquari varies between 0.3 m/s and 1.4 m/s. The flow velocity decreases in downstream direction. The flow velocity in the upper part of the Caronal is more ore less constant.

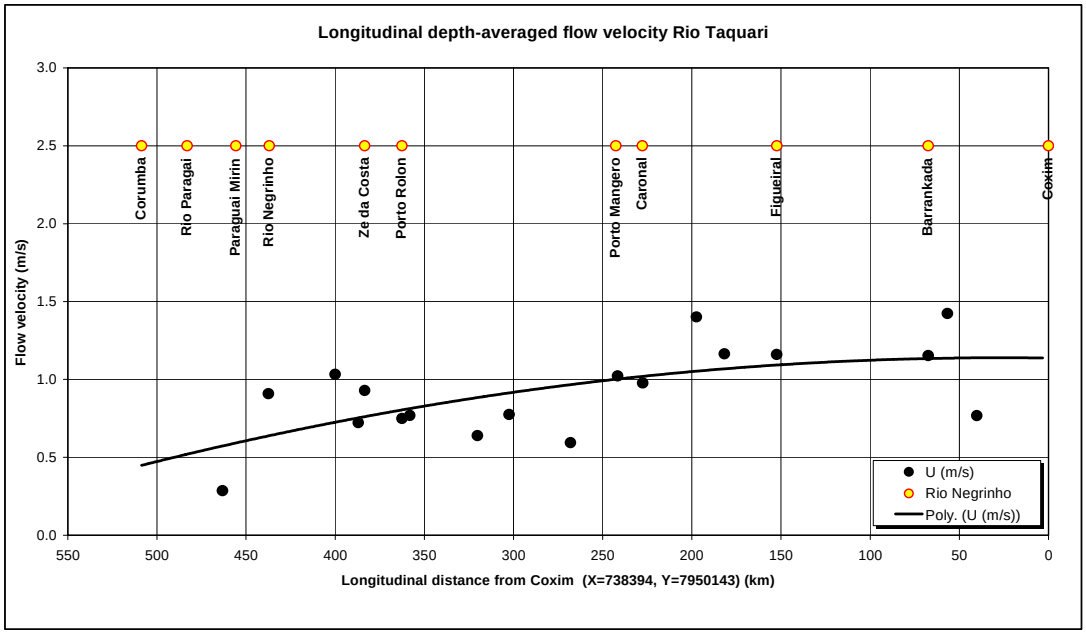


Figure 4-1 Longitudinal distribution of the depth-averaged flow velocity along the thalweg in the Rio Taquari (March 30th to April 4th)

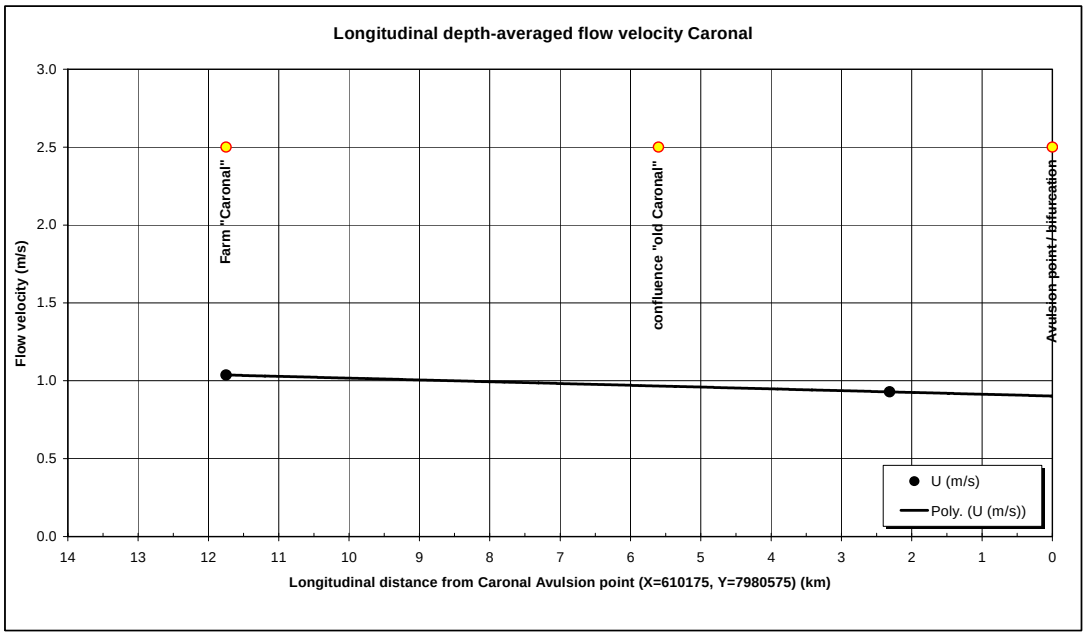


Figure 4-2 Longitudinal distribution of the depth-averaged flow velocity along the thalweg in the New Caronal (March 30th to April 4th)

5 Cross-sections

5.1 Introduction

Besides the longitudinal measurements of the water depth, at 26 locations in the Rio Taquari and the Caronal the water depth was measured in sections perpendicular to the river axis in order to obtain representative cross-sections. Due to local circumstances the boat with the sonar was able to reach the river banks within one or a few metres. Therefore, for each cross-section a rough sketch was made of the left and right banks above the present water level. The dimensions of the banks were estimated.

Among other purposes, the newly measured cross-sections can be used for the following:

- record of the present local river width and river depth;
- examination of the morphological changes after the previous cross-sections surveys;
- record of the differences between cross-sections at bifurcations.

Between 1995 and 1997 also a set of cross-sections was measured in the Rio Taquari. During the field survey almost all of these cross-sections have been re-measured. The locations of the previous cross-sections are given in Table 5-1.

Name	X (m)	Y (m)	Altitude Z (m)	Date	Re-measured
TK3	721083	7959585	-	17-09-1995	no
TK4	710461	7970312	-	18-09-1995	yes
TK5	692084	7982830	-	19-09-1995	yes
TK7	655966	7984369	-	21-09-1995	yes
TK8	632299	7984080	-	23-09-1995	yes
TK9	617563	7981976	-	24-09-1995	yes
TK10	599183	7979075	-	25-09-1995	yes
TK11	556928	7965986	-	26-09-1995	yes
TK12	7942753.69	518086.62	-	1995	yes
Figueiral	665741.26991	7983813.42499	154.2	Jan 1997	yes
Pte. Velha - coxim	739203.82288	7951022.82050	-	Jan 1997	no
Zé da Costa	505566.88841	7931723.79364	87,9	Jan 1997	yes
Pto. Rio Negrinho	466581.67160	7917487.92688	80,35	Jan 1997	yes
P. Mirim Faz. S. Bened.	453918.54138	7912946.51475	101,2	Jan 1997	yes
Figueiral	665741.26991	7983813.42499	154,2	Jan 1997	yes

Table 5-1 Previously measured cross-sections

The cross-sections have to be used with a certain reservation. They account only for the local situation and only for the date they were measured on. The Rio Taquari is characterized by strong cross-sectional variations (river width and depth) in longitudinal and perpendicular direction. The river and the cross-sections also vary strongly in time, due to all kinds of morphological processes.

5.2 Morphological development

The 26 measured cross-sections have been plotted in separate figures and can be found in Appendix A (Cross-sections in the Rio Taquari) and in Appendix B (Cross-sections in the Caronal). The morphological development at certain cross-section locations is tried to determine by comparing the previous and present measured cross-section at a corresponding location. Twelve cross-sections have been re-measured after they were first measured 7 – 9 years ago (1995 - 1997).
Table 5-2 presents an analysis of the differences in corresponding cross-sections. For these profiles the new as well as the previous cross-section were appended to the respective figures in appendix A, which facilitates the comparison and the finding of mutual differences. The vertical change in bed level is almost impossible to determine as it seems that the altitude between the '95-'97 cross-sections and the present ones differ eminently. However, the shapes of the cross-sections have often remained similar, which also indicates that the correct locations were sonared. By shifting the '95 – '97 cross-sections to the present ones (the new cross-sections are probably more reliable), the horizontal differences could be assessed.

Name	Figure	Vertical change		Transversal change			
	App.dix. A	Sediment-ation (m)	Erosion (m)	Shifted Left > 10 m	Shifted Right > 10 m	Widened (m)	Narrowed (m)
TK4	A-1	unknown[1]	unknown[1]	yes[2]	no	no	no
TK5	A-3	Probably	unknown[1]	yes	no	no	15
Figueiral	A-1	unknown[1]	unknown[1]	no	no	25	no
TK7	A-6	unknown[1]	unknown[1]	yes	no	10	no
TK8	A-7	unknown[1]	unknown[1]	yes	no	no	40
TK9	A-8	unknown[1]	unknown[1]	yes	no	20	no
TK10	A-11	unknown[1]	unknown[1]	no	no	15	no
TK11	A-13	unknown[1]	unknown[1]	no	no	15	no
TK12	A-15	unknown[1]	unknown[1]	yes[2]	no	no	40
Zé da Costa	A-16	unknown[1]	unknown[1]	no	no	15	no
Rio Negrinho	A-20	unknown[1]	unknown[1]	no	no	15	no
Para. Mirim	A-21	unknown[1]	unknown[1]	no	no	no	no

Table 5-2 Indication of morphological changes at cross-section locations

1. All the re-measured cross-sections lay on a higher level than the previous measured cross-sections. The most straightforward explanation is a difference in reference-level. The altitude of the present cross-sections has been determined with a DGPS, of which the coordinates are referred to the WGS84 geoide. The altitude of the 1995 – 1997 cross-sections has probably been referred to an older or other system. Unless the difference between these systems is discovered, conclusions about sedimentation and erosion of the cross-sections are almost impossible to make.
2. This is a typical bend cross-section, with a shallow inner bend and a deep outer bend. According to the measurements the cross-sections are shifted in the direction of the inner bend. This is unusual and probably not right because rivers mainly displace by enlarging their outer bend, unless there has been a matter of cut-off.

6 Conclusions

Between March 30th to April 4th a field survey of the Rio Taquari downstream of Coxim has been carried out, in which the following river aspects were measured:

- Sonar measurements of the water depth in the vicinity of the river thalweg (e.g. the deepest locations along the river).
- Grab samples of the channel sediment.
- Sonar measurements of 26 perpendicular cross-sections (including sketches of the river banks above the water level).
- DGPS point measurements of the water level at 9 locations along the Rio Taquari, the Caronal and the Paraguai River and at one geographical known position in Corumba;
- GPS flow velocity measurements in the thalweg.

The measurements have been worked out in more detail and are presented in this report. Some observations concerning these river aspects are:

- The slope in water level between Coxim and Zeda Costa is very constant. The average water depth in the lower Taquari downstream of the New Caronal avulsion (rkm 225 – 425) is approximately 1 m lower than the upper part of the Taquari. The slope in water level in the upper part of the New Caronal is slightly steeper than the slope of the lower Taquari. The water depth in the 12 km long upstream part of the New Caronal varies between 1 and 4 m.
- The sediment in de Rio Taquari and the Caronal can be characterized as fine to very fine sand, which indicates that the dominant transport mechanism of the sediment is suspended load transport. The grain sizes do not vary strongly in downstream direction. The critical flow velocity for this sediment mixture is approximately 0.3 m/s.
- The depth average flow velocity in the Rio Taquari varies between 0.3 m/s and 1.4 m/s. The flow velocity decreases in downstream direction. The flow velocity in the upper part of the Caronal is more ore less constant.

26 Cross-sections were measured of which 12 has been measured already 7 – 9 years ago. The vertical change in bed level is almost impossible to determine from these cross-sections, as it seems that the altitude between the ‘95-’97 cross-sections and the present ones differ eminently. Seven cross-sections seem to have been widened with 10 – 25 m in the last 7 – 9 years, three cross-sections seem to have been narrowed with 15 – 40 m and 2 cross-sections do not show strong signs of widening or narrowing. Four to six cross-sections seem to have been shifted in horizontal direction.

A Cross-sections in the Rio Taquari

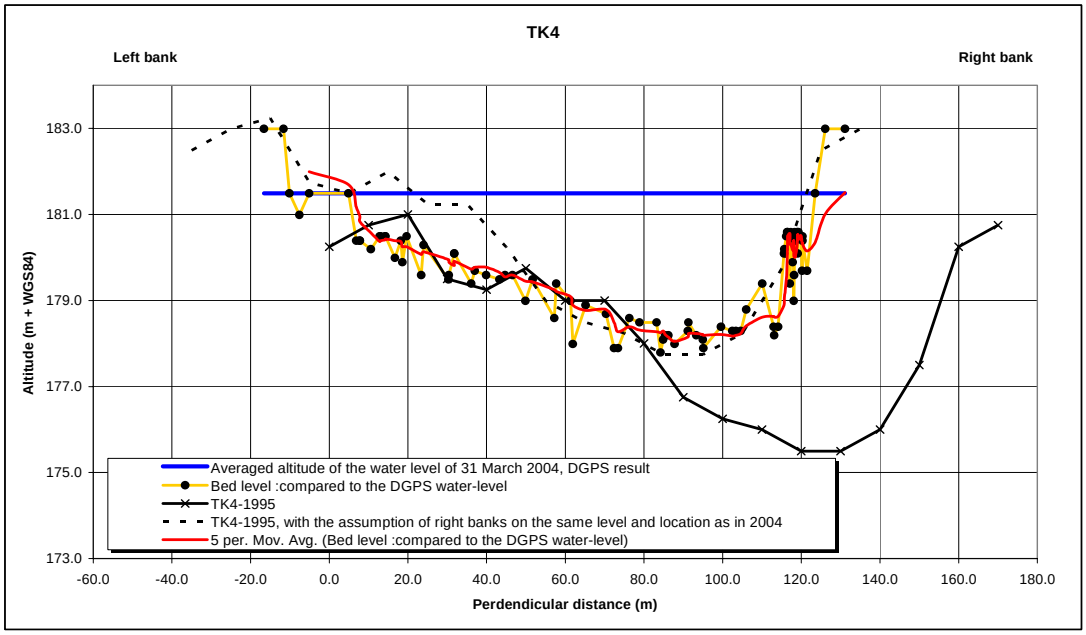


Figure A-1 Measured cross-section TK4 (distance rkm 56.70)

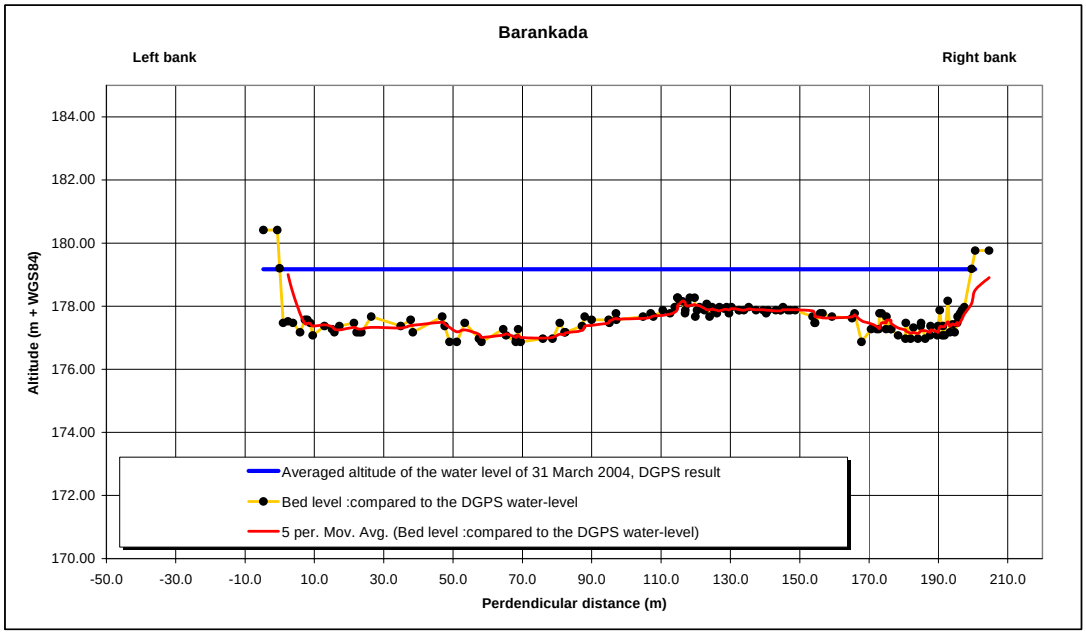


Figure A-2 Measured cross-section at Barankada (distance rkm 67.43)

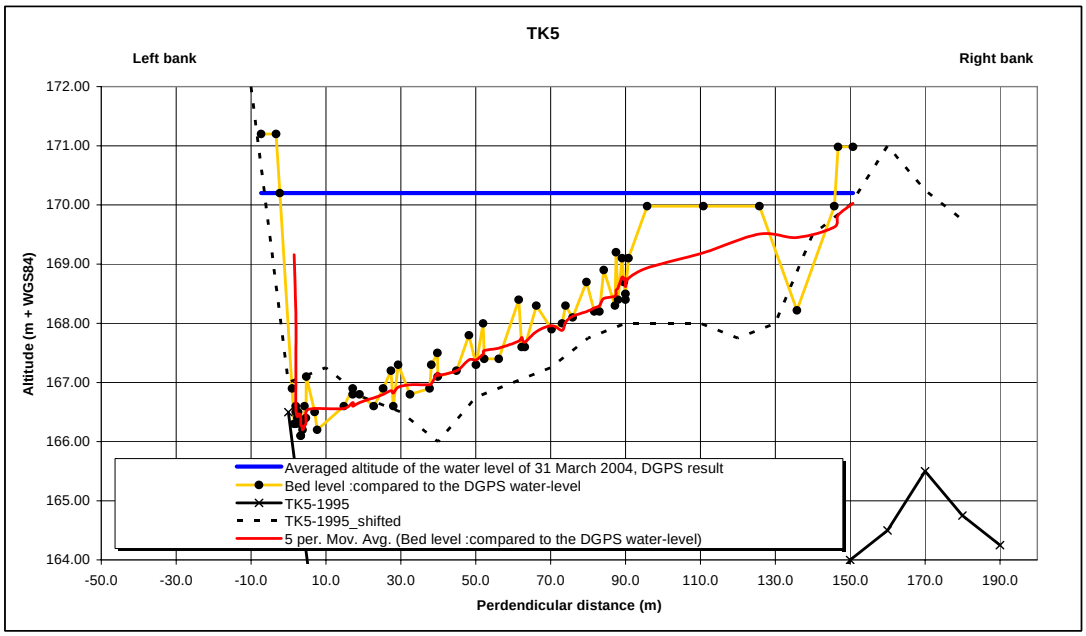


Figure A-3 Measured cross-section TK5 (distance rkm 105.28)

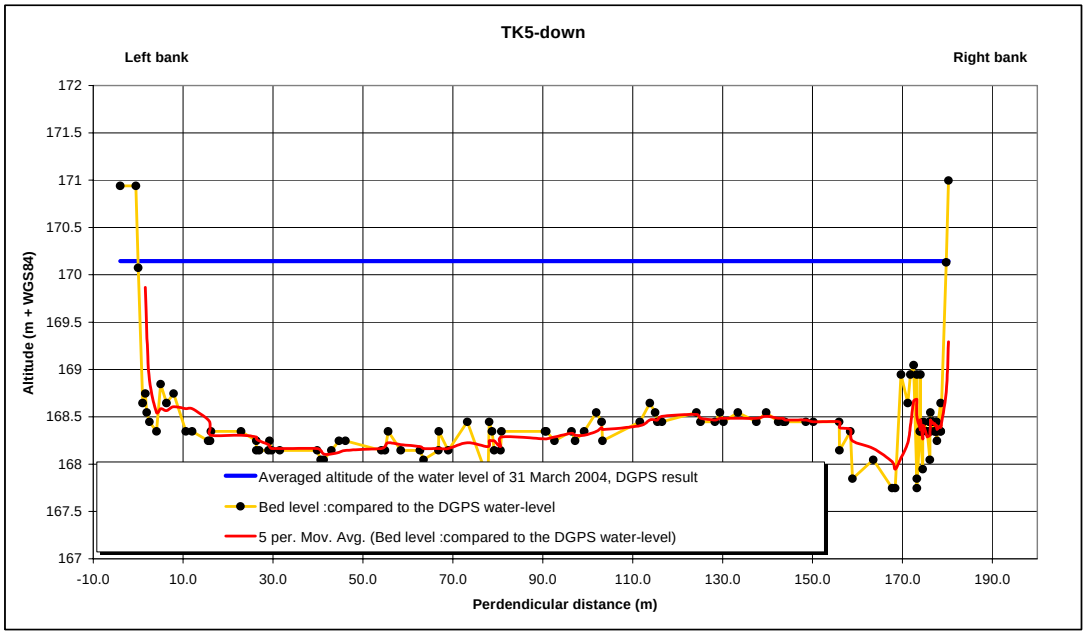


Figure A-4 Measured cross-section 250 m downstream of TK5 (rkm 105.51)

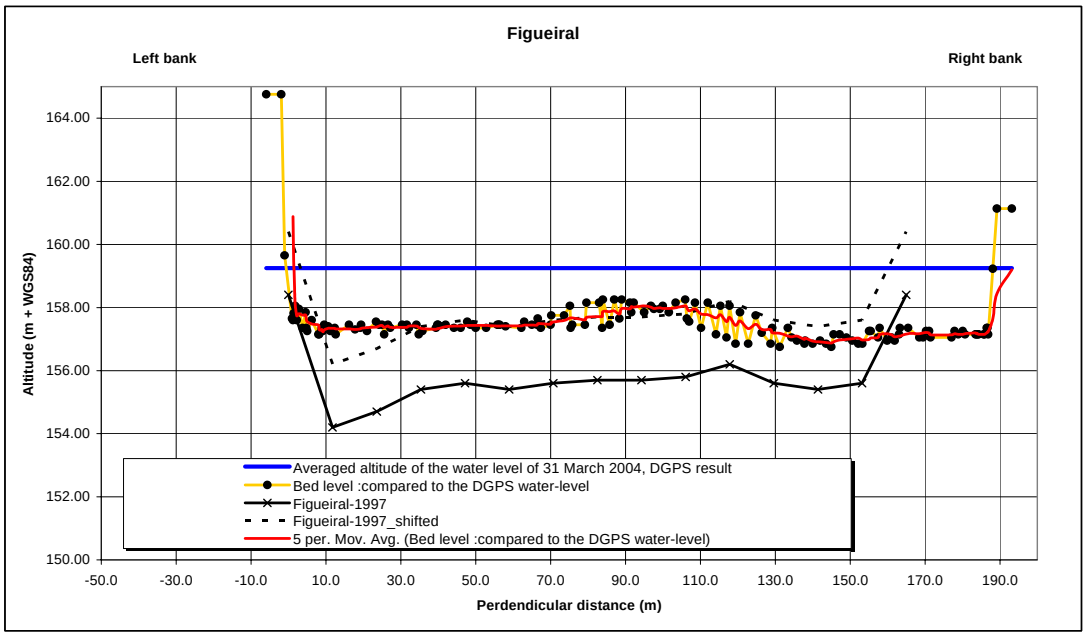


Figure A-5 Measured cross-section at Figueiral (rkm 152.37)

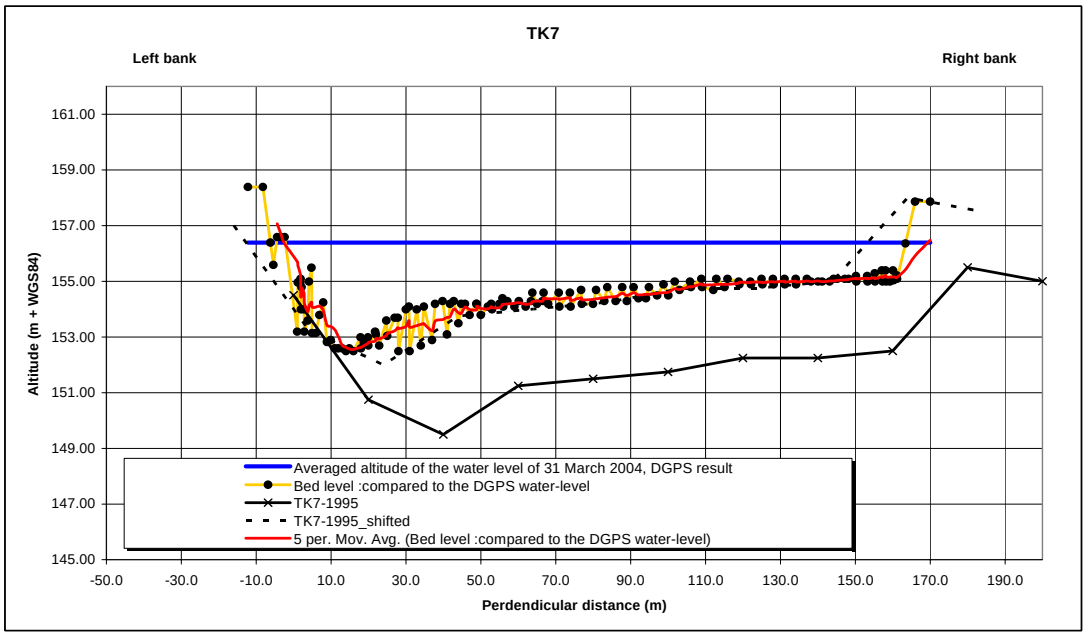


Figure A-6 Measured cross-section TK7 (rkm 165.19)

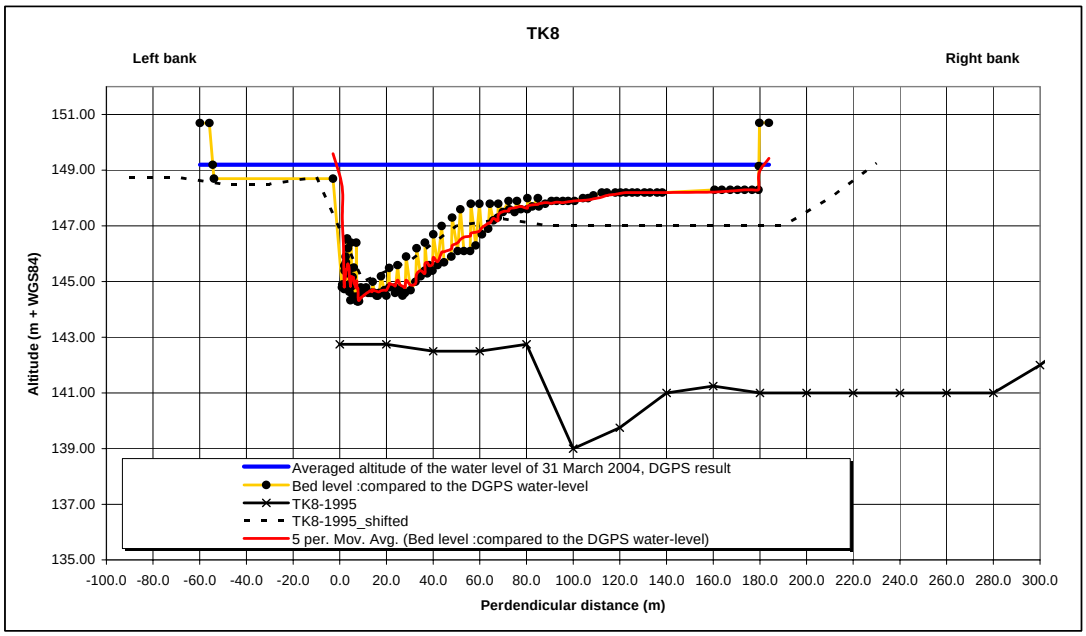


Figure A-7 Measured cross-section TK8 (rkm 197.43)

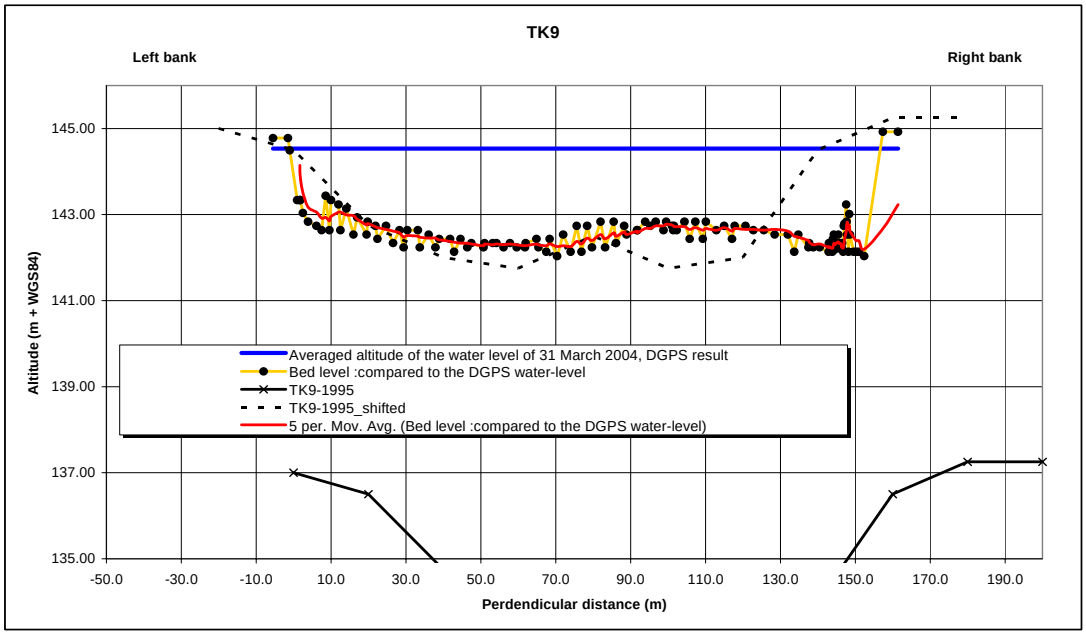


Figure A-8 Measured cross-section TK9 (rkm 218.28)

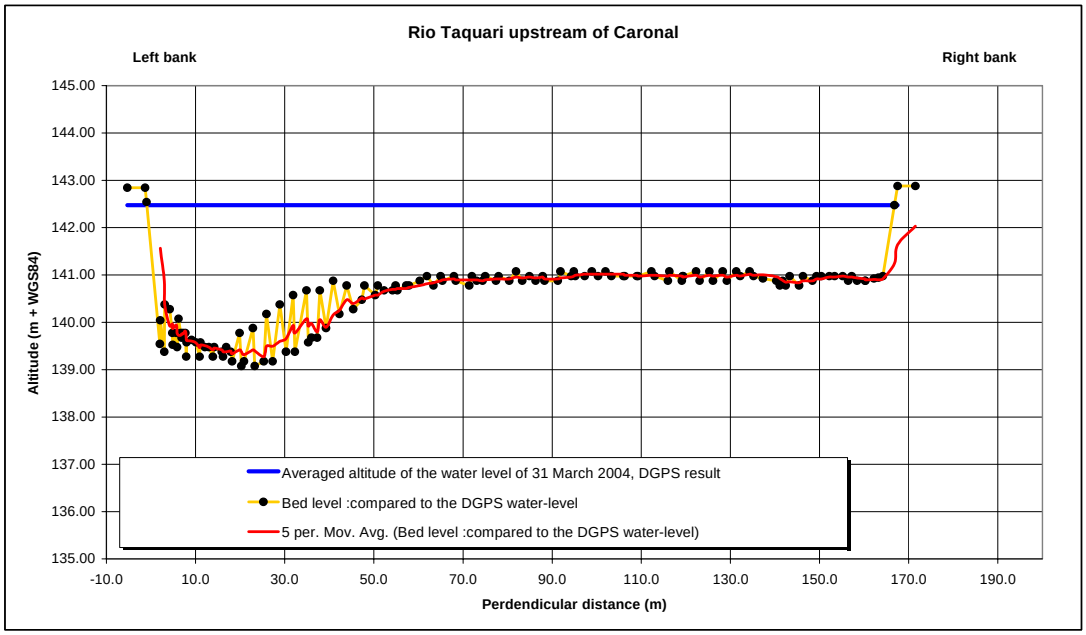


Figure A-9 Measured cross-section Taq_Car_up (rkm 227.51)

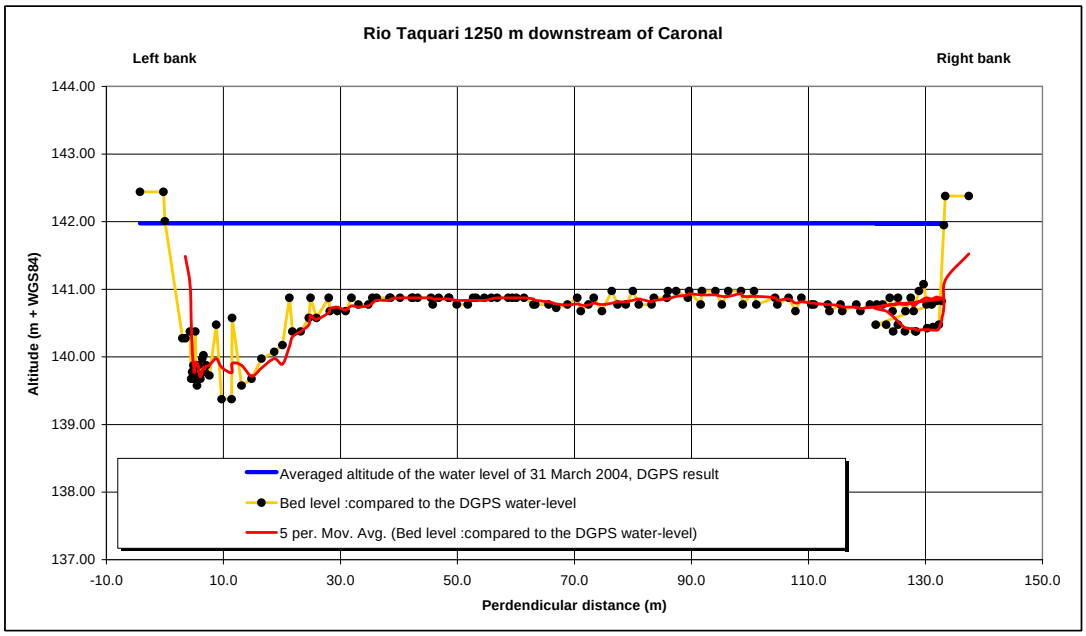


Figure A-10 Measured cross-section Taq_Car_down (rkm 229.39)

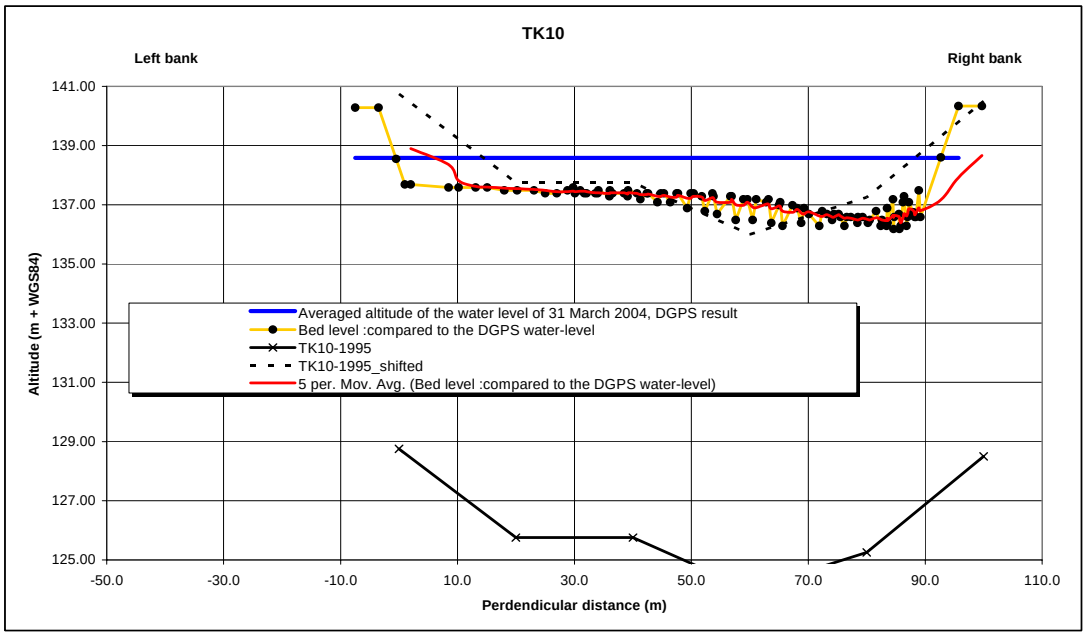


Figure A-11 Measured cross-section TK10 (rkm 241.71)

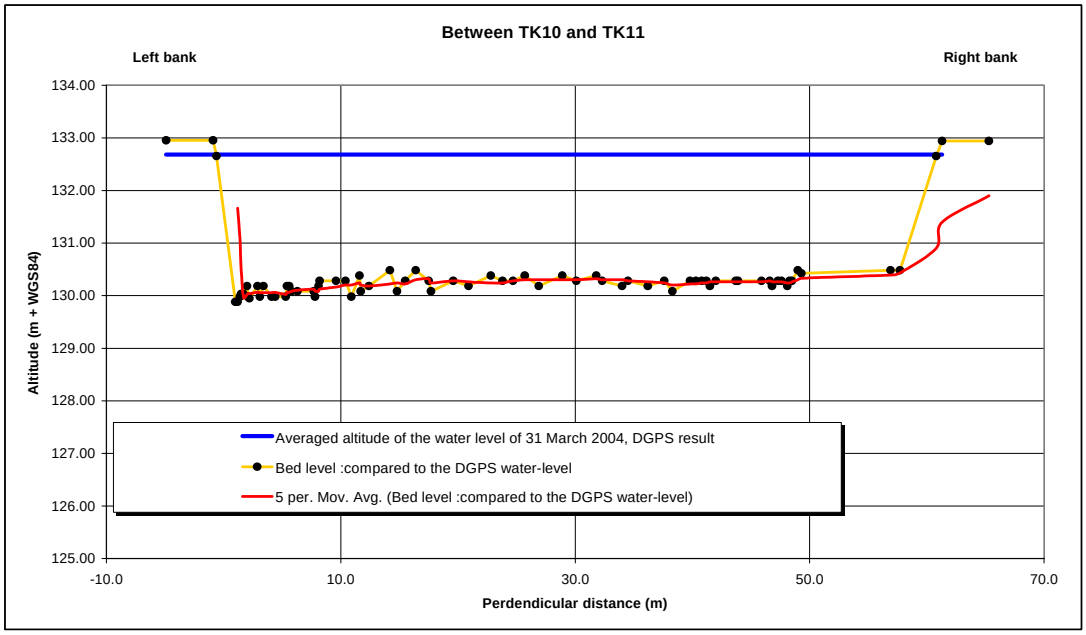


Figure A-12 Measured cross-section Between TK10 and TK11 (rkm 267.96)

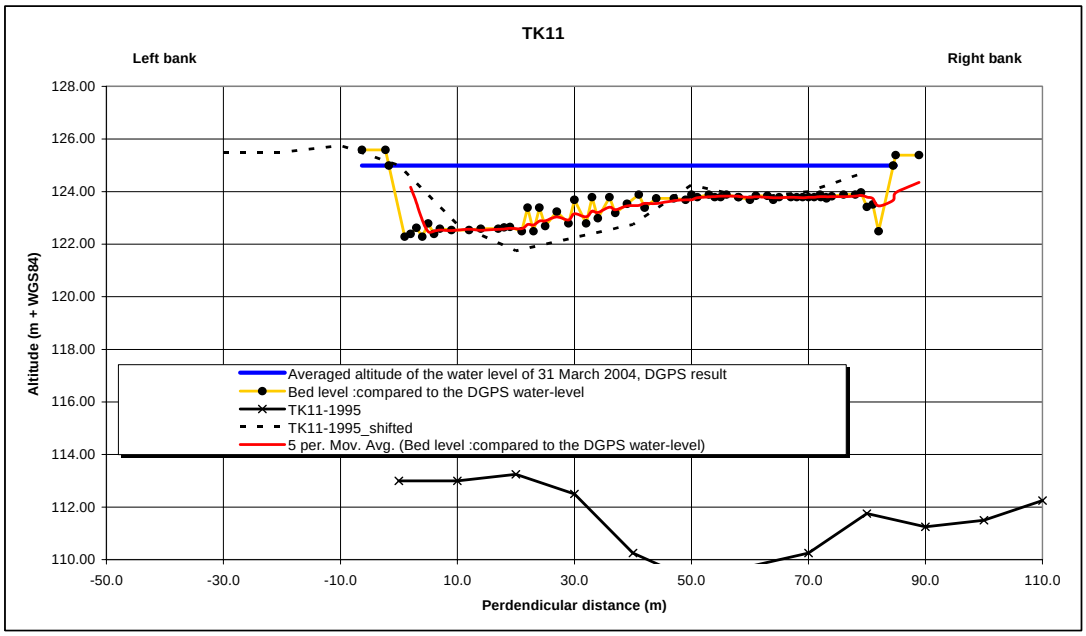


Figure A-13 Measured cross-section TK11 (rkm 302.49)

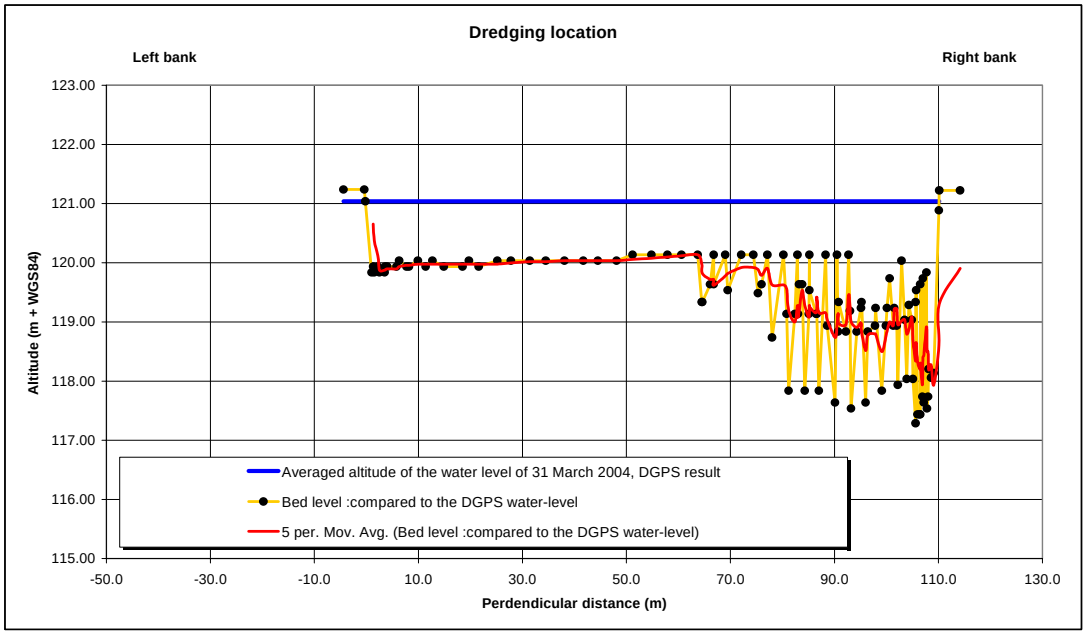


Figure A-14 Measured cross-section at the Dredging Location (rkm 320.21)

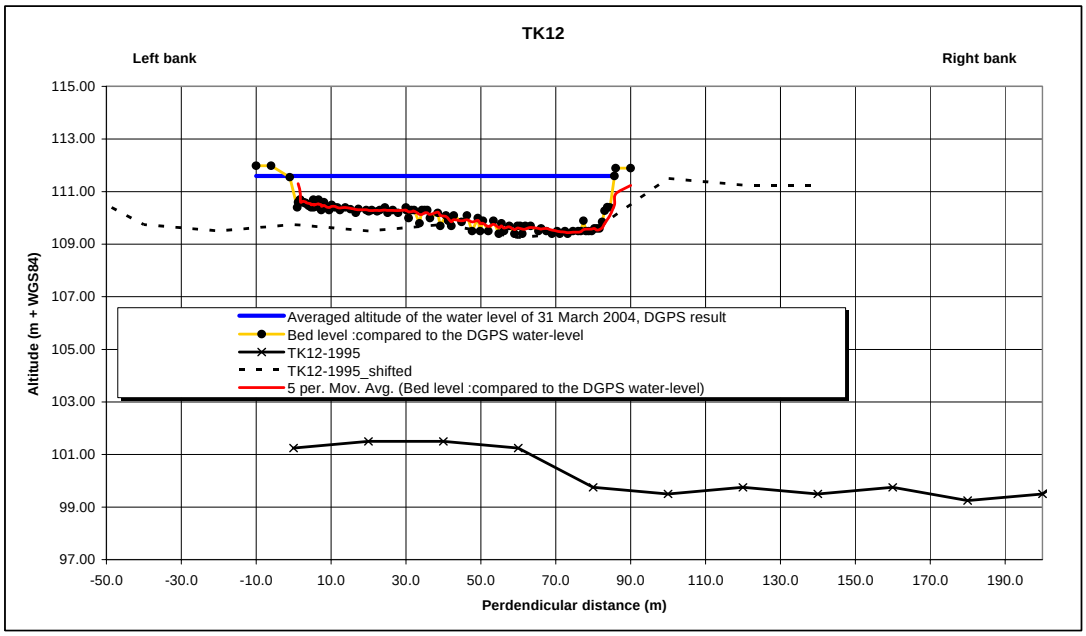


Figure A-15 Measured cross-section TK12 (Porto Rolon) (rkm 362.59)

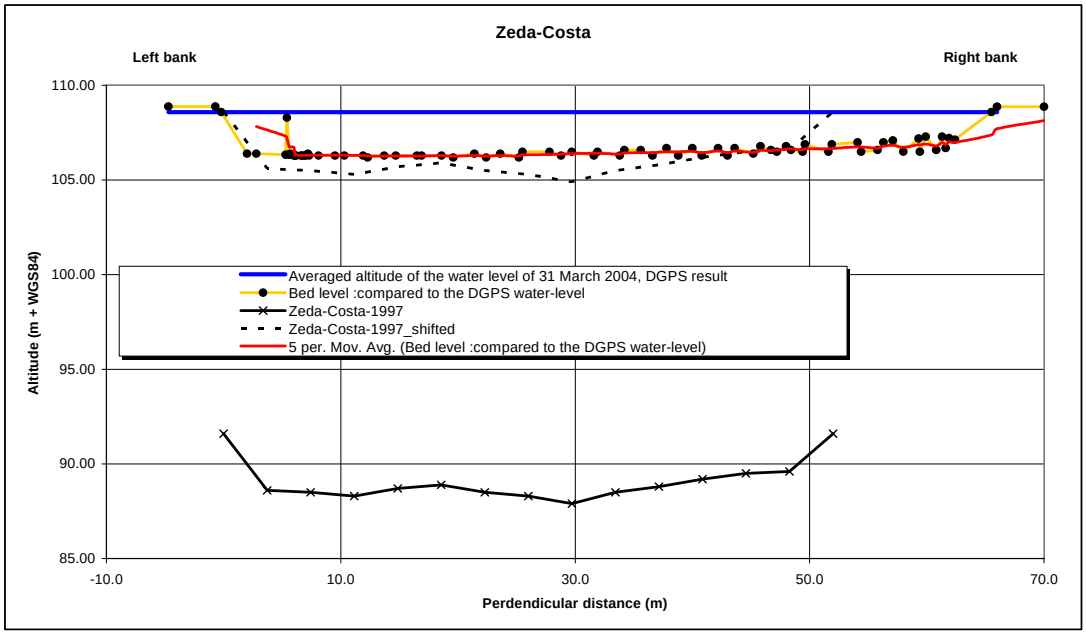


Figure A-16 Measured cross-section at Zeda Costa (rkm 383.53)

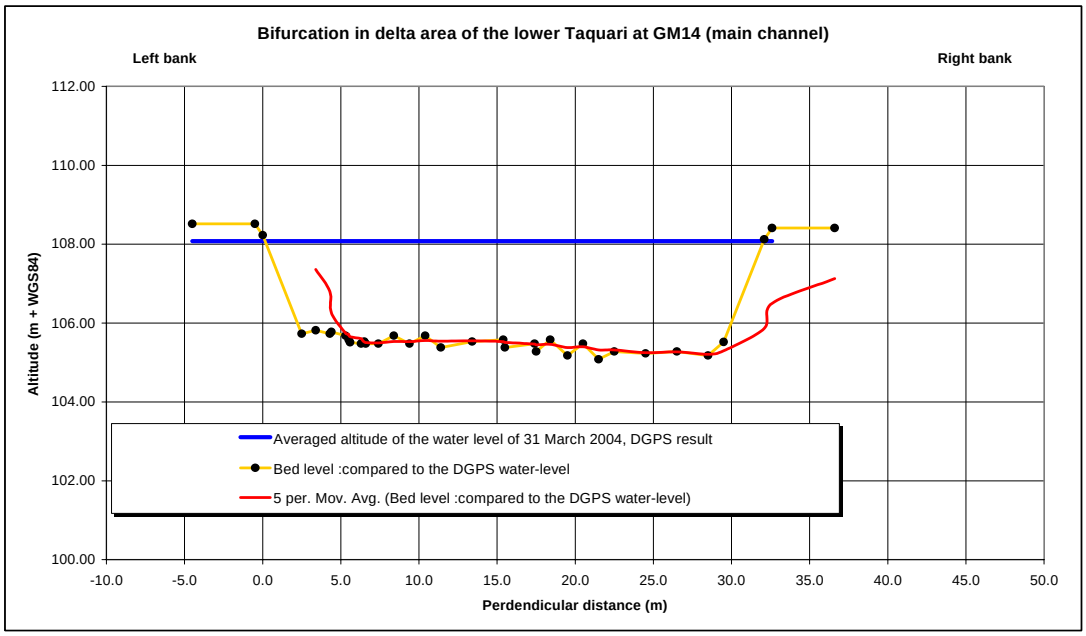


Figure A-17 Measured cross-section at Bifurcation at Grab Sample location GM14 (rkm 387.06)

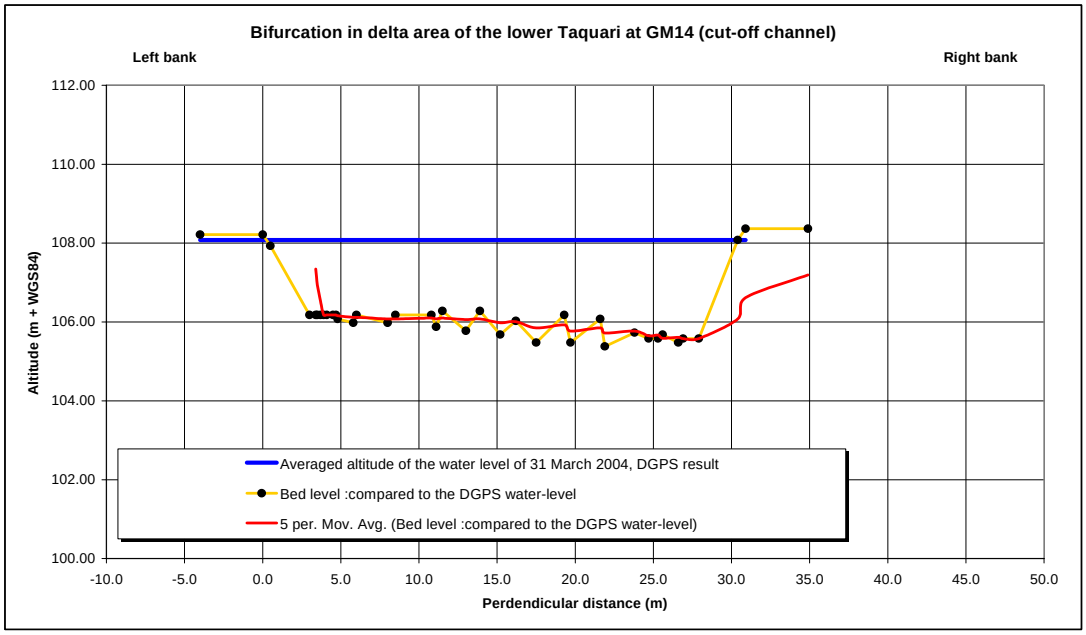


Figure A-18 Measured cross-section at Bifurcation at Grab Sample location GM14 (lateral branch) (rkm 387.06)

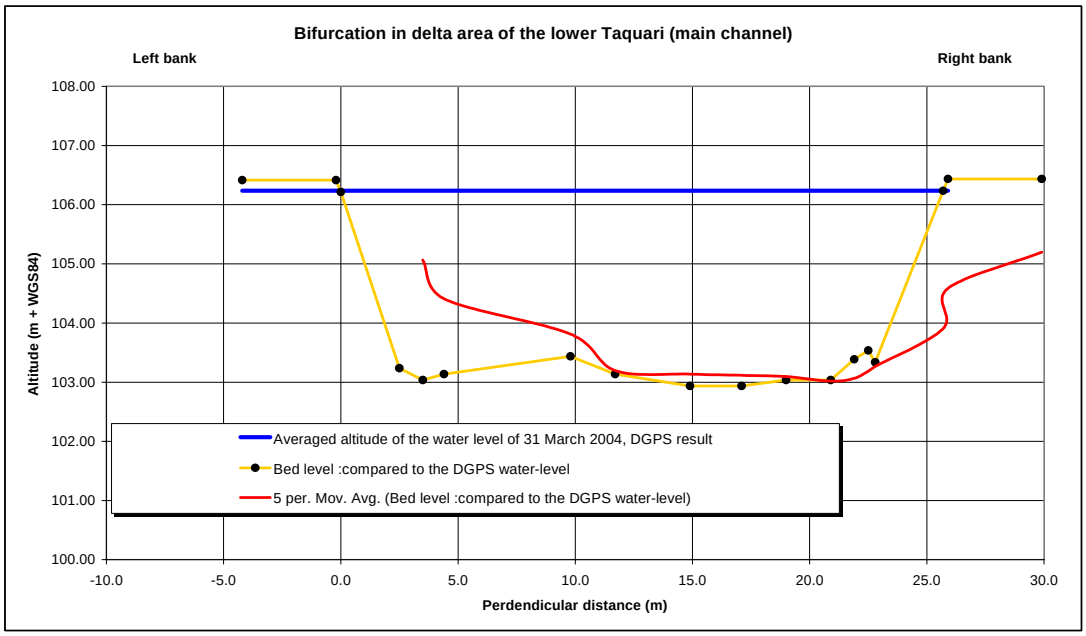


Figure A-19 Measured cross-section at a Bifurcation (rkm 399.88)

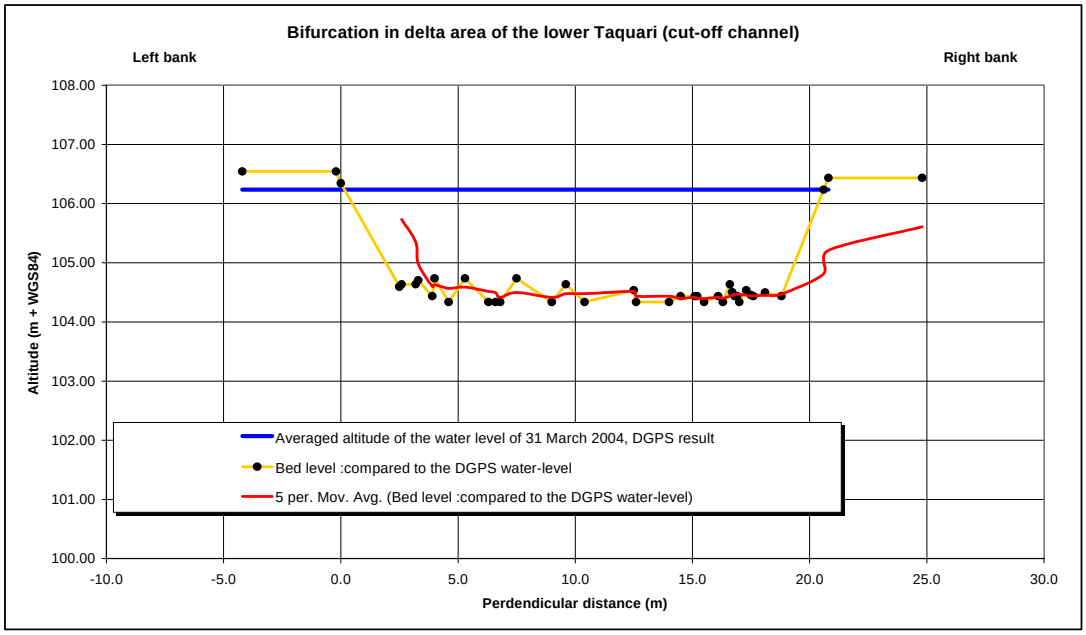


Figure A-20 Measured cross-section at a Bifurcation – lateral branch (rkm 399.88)

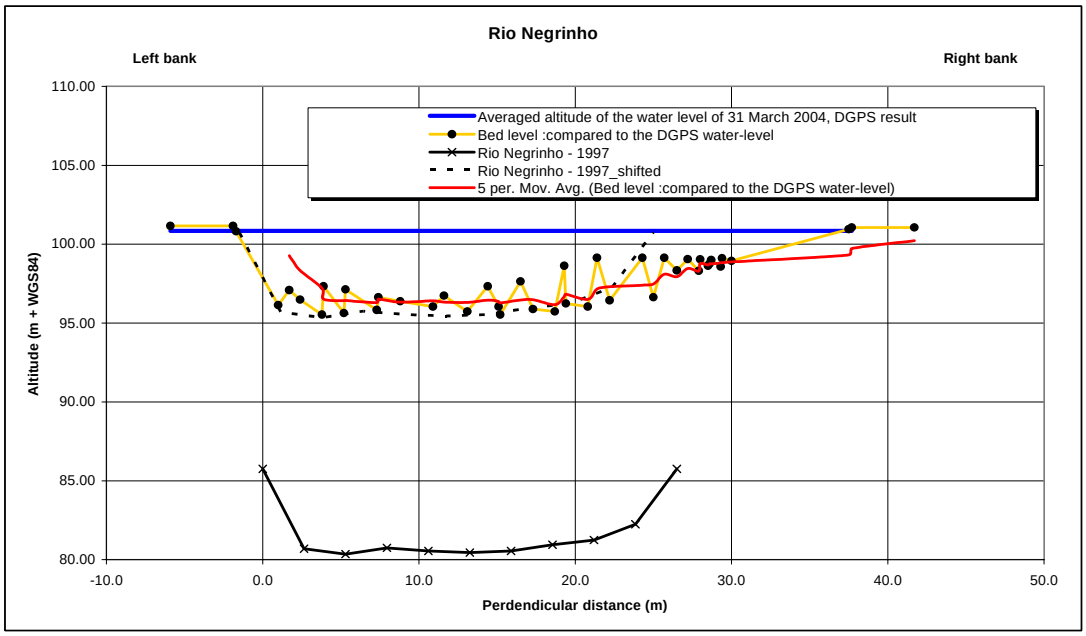


Figure A-20 Measured cross-section Rio Negrinho (rkm 437.48)

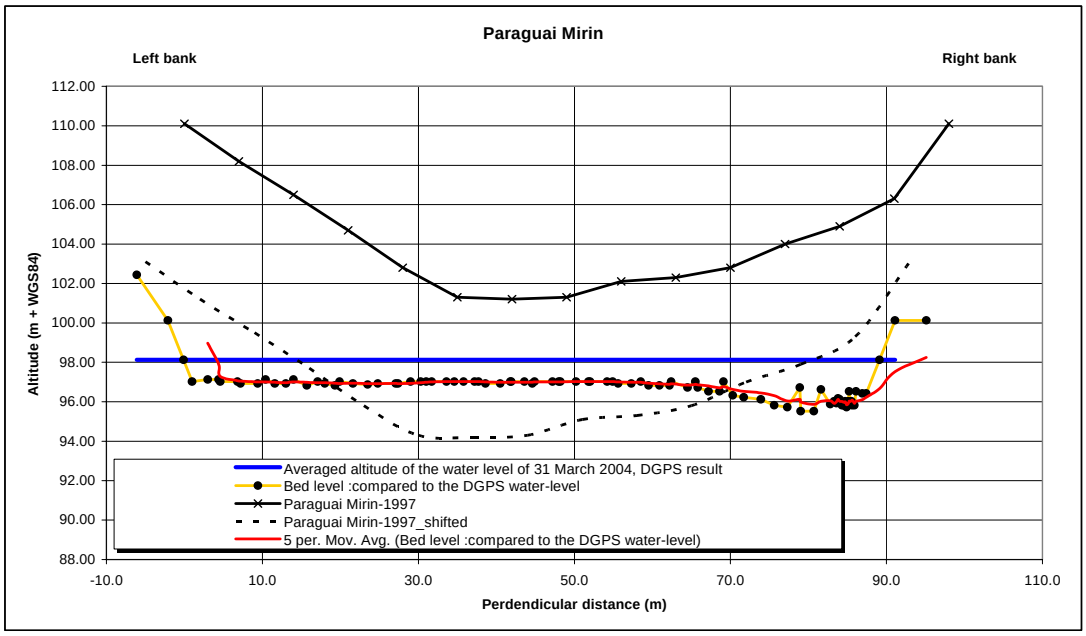


Figure A-21 Measured cross-section at the Paraguai Mirin (rkm 463.24)

B Cross-sections in the New Caronal

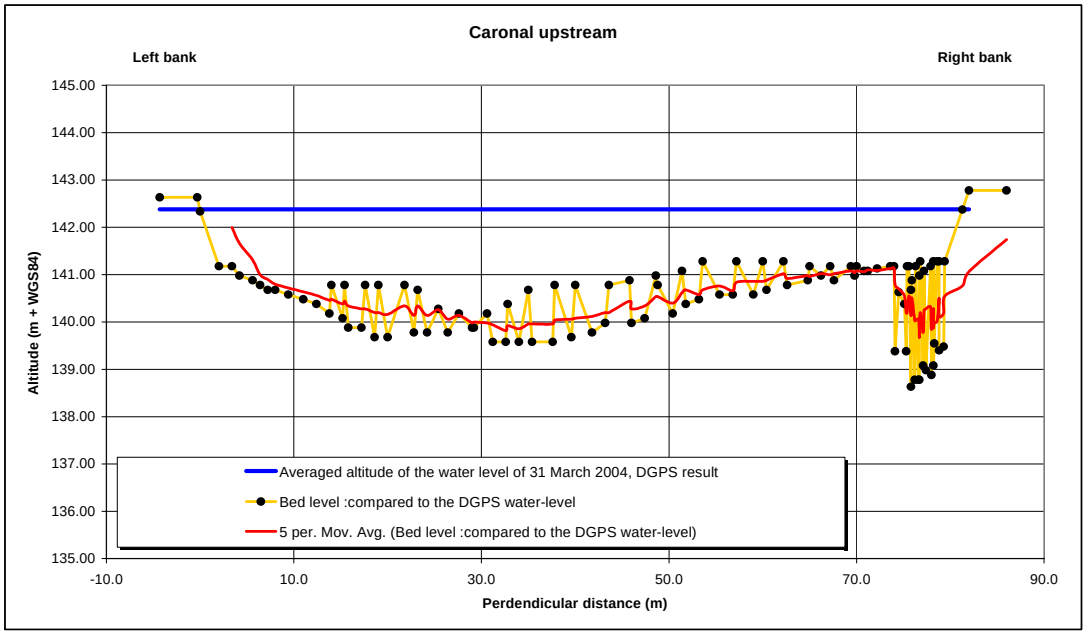


Figure B-1 Measured cross-section upstream in de Caronal (rkm 0.11)

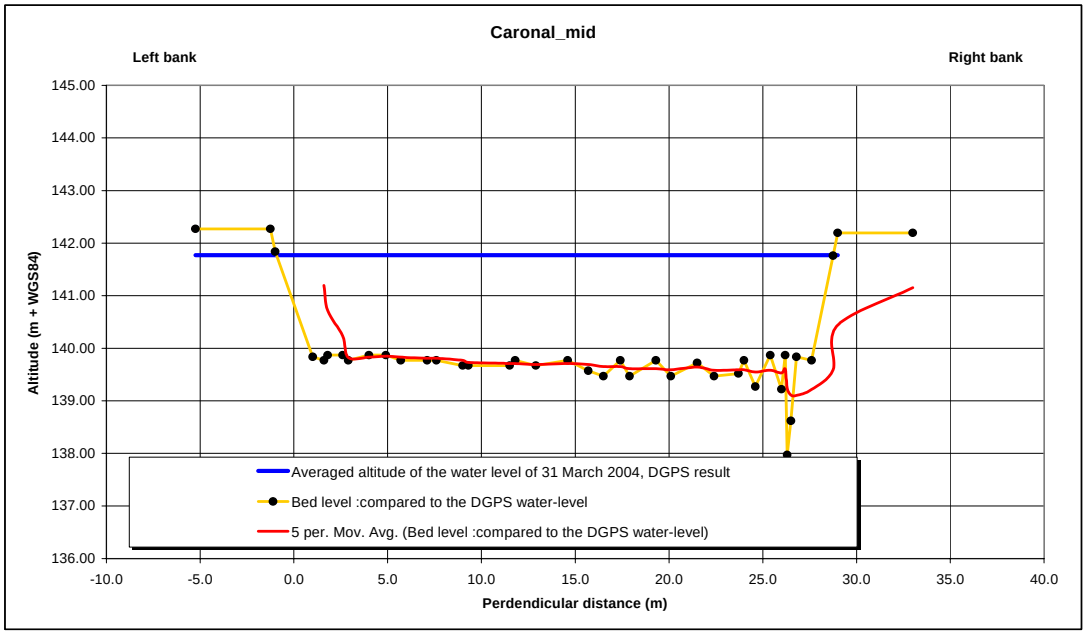


Figure B-2 Measured cross-section approx. 2.5 rkm in de Caronal (rkm 2.32)

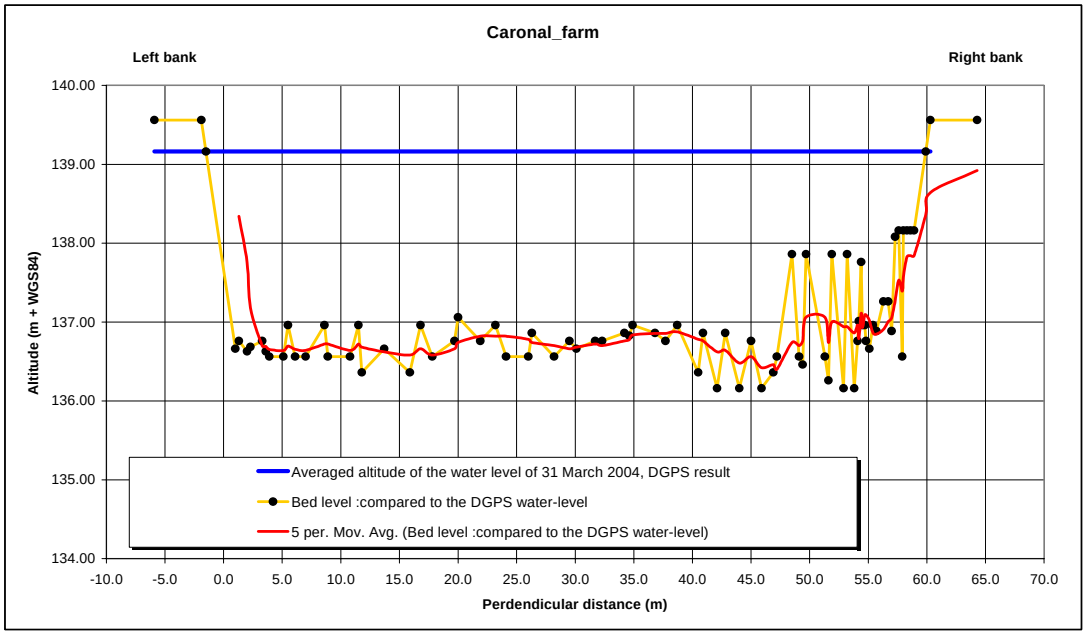


Figure B-3 Measured cross-section near the Caronal Farm (rkm 11.75)

C Pictures

C.1 Roll 1

nr. *14*	*Roll 1*
Description: *Taquari in upstream direction near Coxim*	
X: *≈731363*	Y: *≈7959206*

nr. *15*	*Roll 1*
Description: *Taquari in downstream direction near Coxim*	
X: *≈731363*	Y: *≈7959206*

nr. *16*	*Roll 1*
Description: *Coxim, steep river banks / bank erosion*	
X: *0731491*	Y: *7957749*

nr. *17*	*Roll 1*
Description: *Steep slopes of the right river bank at the place we stayed the first day. Bird holes in the banks, probably just above the highest flood level.*	
X: *0707240*	Y: *7973782*

nr. *18*	*Roll 1*
Description: *Major bank withdrawal, outside bend* *(see left-side of this picture. The picture doesn't show it adequately)*	
X:	Y:

	0707369	*7976835*

nr. *19*	*Roll 1*
Description: *Inside bend, same location as photo 18.*	
X: *0707369*	Y: *7976835*

nr. *20*	*Roll 1*
Description: *Major bank erosion, just downstream of the previous picture*	
X:	Y:

nr. *21*	*Roll 1*
Description: *Banks composed of iron material*	
X:	Y:

	0692064	*7983131*

nr. *22*	*Roll 1*
Description: *Figueiral. Taquari, seen in upstream direction. Taken at the location of overnight stay 1th april.*	
X: *0665733*	Y: *7983813*

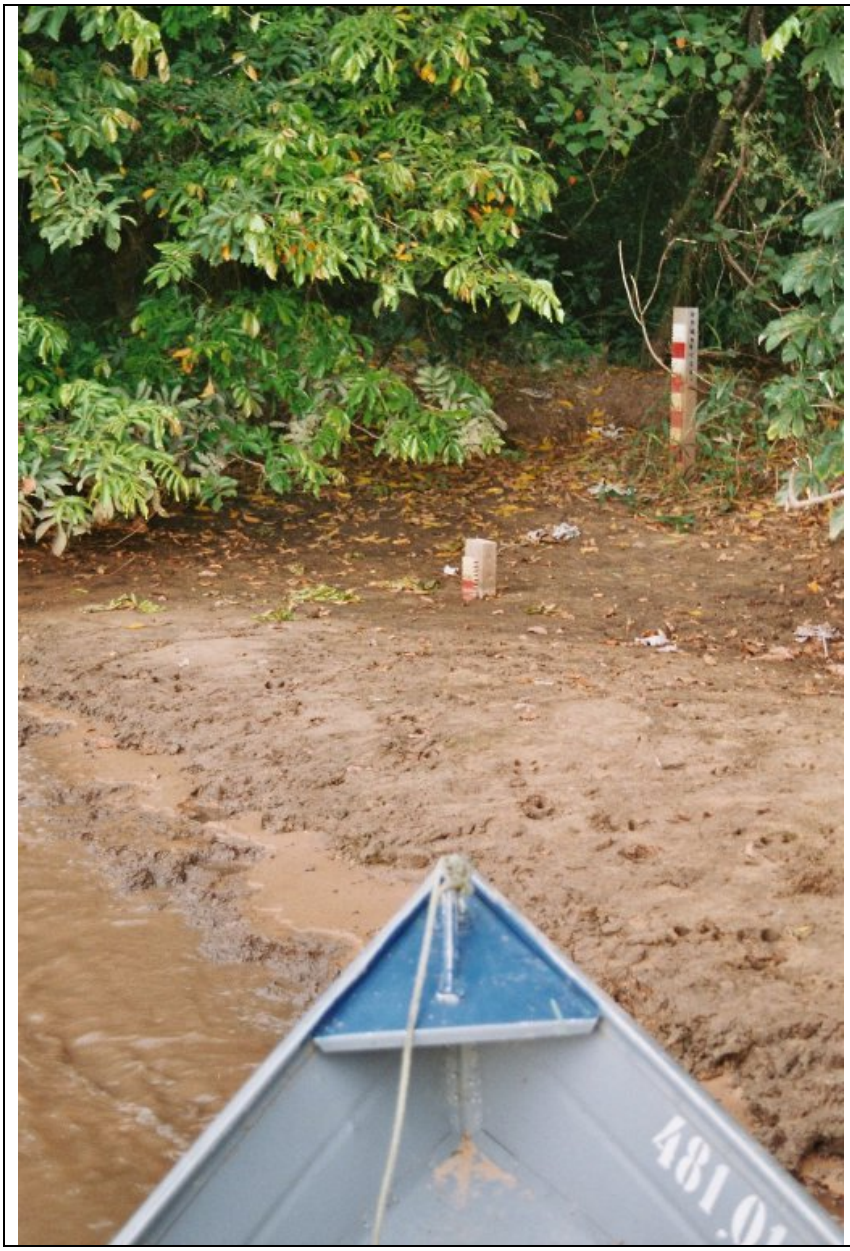
nr. *23*	*Roll 1*
Description: *Figueiral. Same location as 22, but picture taken of the hinterland*	
X:	Y:

nr. *24*	*Roll 1*
Description: *Figueiral (left bank). April 1 (day 3), the house we stayed that night.*	
X:	Y:

	nr. *25*	*Roll 1*
	Description: *Figureial. Bank material (right bank. Opposite site of the previous three pictures*	
	X: *0665733*	Y: *7983813*

	nr. *26*	*Roll 1*
	Description: *Figureial (right bank). Bart Makaske is taking a drilling sample at the opposite side of 23.*	
	X: *0665733*	Y: *7983813*

nr. *32*	*Roll 1*
Description: *Several sand banks and shallow sections in the Taquari*	
X:	Y:



nr. *34*	*Roll 1*
Description: *A water level gauge in the Taquari. Water level approx. 0.70 – 0.60 m (reference level not known at this moment)*	
X: *632523*	Y: *7984070*

nr. *36*	*Roll 1*
Description: *One of the boats at full speed*	
X:	Y:

nr. *37*	*Roll 1*
Description: *Empty bottles used for illigal fishing*	
X:	Y:

nr. *38*	*Roll 1*
Description: *Taquari, downstream direction* *Less bank erosion here.*	
X: *0627132*	Y: *7985306*

C.2 Roll 2

nr. *7*	*Roll 2*
Description: Rio Taquari	
X:	Y:

nr. *8*	*Roll 2*
Description: Vegetated banks	
X:	Y:

nr. *9*	*Roll 2*
Description: *Taquari, downstream direction. dark sky.*	
X: *0617716*	Y: *7982318*

nr. *10*	*Roll 2*
Description: *Rising sun at the location of overnight stay at Porto ("harbor") Mangero..*	
X:	Y:

nr. *11*	*Roll 2*
Description: *Location of overnight stay, april 2th and 3th.*	
X:	Y:

nr. *12*	*Roll 2*
Description: *Location of overnight stay, april 2th and 3th.*	
X:	Y:

nr. *13*	*Roll 2*
Description: *Left side the harbor master of Porto Mangero*	
X:	Y:

nr. *14*	*Roll 2*
Description: *Avulsion point. Sandbags placed by local inhabitants to close it.*	
X: *0616911*	Y: *7980425*

nr. *15*	*Roll 2*
Description: *Picture taken in upstream direction from this avulsion point*	
X: *0616911*	Y: *7980425*

nr. *16*	*Roll 2*
Description: *Avulsion width approx. 10 m*	
X: *0616911*	Y: *7980425*

nr. *17*	*Roll 2*
Description: *(illegal) fishery / fishing rod (often seen)*	
X: *0616911*	Y: *7980425*

nr. *18*	*Roll 2*
Description: *The same avulsion*	
X: *0616911*	Y: *7980425*

nr. *21*	*Roll 2*
Description: *A number of km's into the avulsion The width is increasing and the depth is decreasing. Depth at a width of 12 m approx. 1.0 m. Depth at the width of 25 m approx. 50 cm,*	
X:	Y:

nr. *25*	*Roll 2*
Description: *The bifurcation at Caronal. Right hand the Caronal, Left hand the Lower Taquari*	
X:	Y:

nr. *26*	*Roll 2*
Description: *Sailing towards the Caronal avulsion*	
X:	Y:

nr. *27*	
Description: *In the Caronal avulsion*	
X:	Y:

nr. *28*	*Roll 2*
Description: *Sandbank just downstream of the bifuracton in the Lower Taquari*	
X:	Y:

C.3 Roll 3

X:0604023, Y:7981220
Upper Taquari
New Caronal
Lower Taquari

X: 0606076, Y: 7980816
Taquari
Old Caronal

nr. *9*	*Roll 3*
Description: *Transition between the sand bank and vegetation at Caronal*	
X: *0604023*	Y: *7981220*

nr. *10*	*Roll 3*
Description: *In the Caronal*	
X: *0604023*	Y: *7981220*

nr. *11*	*Roll 3*
Description: *Caronal river stretch. Dead forrest; the effect of too much water.*	
X: *0602217*	Y: *7981063*

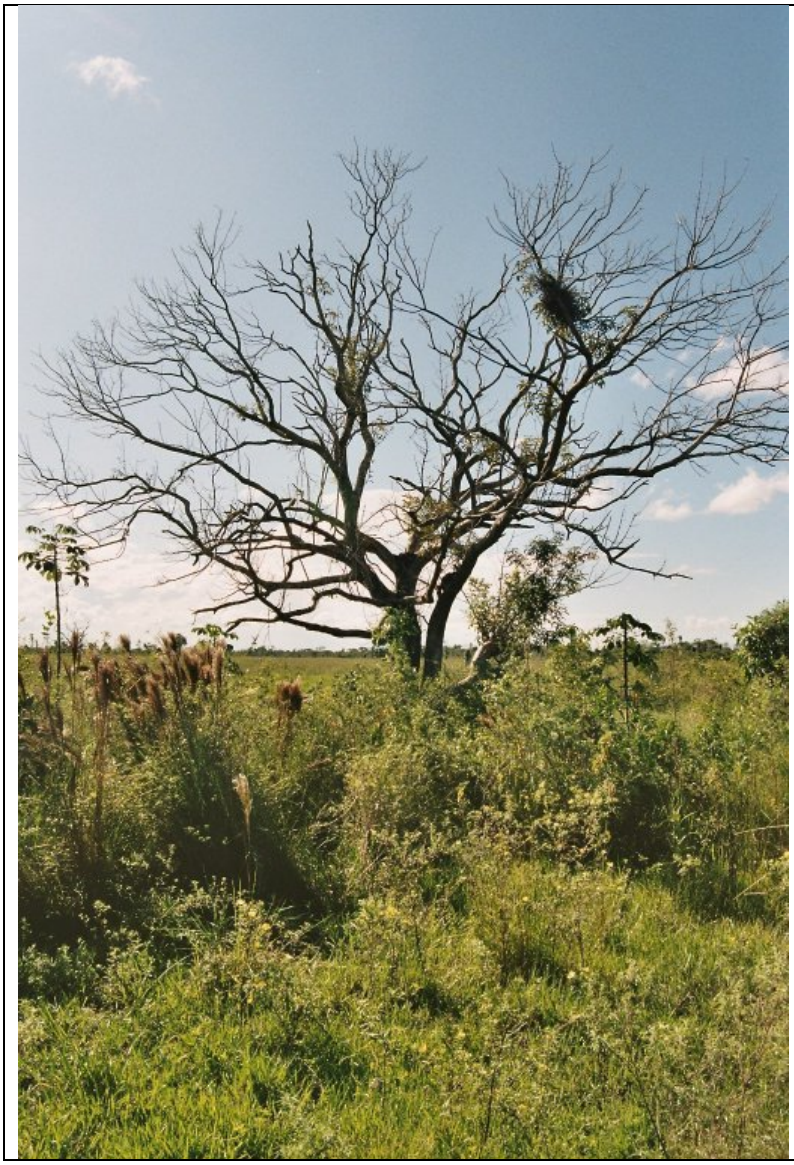
nr. *12*	*Roll 3*
Description: *Caronal river stretch. Dead forrest; the effect of too much water. (Location approx. 0.5 km downstream of previous picture)*	
X:	Y:

nr. *13*	*Roll 3*
Description: *Farmhouse "Caronal". Abandoned because of raised water levels. Water level equal to or above bottom level.*	
X: *0600853*	Y: *7981270*

nr. *14*	*Roll 3*
Description: *The present occupants of farm "Caronal"*	
X: *0600853*	Y: *7981270*

nr. *18*	*Roll 3*
Description:	
X: *0600853*	Y: *7981270*

nr. *16*	*Roll 3*
Description: *Swampy*	
X: *0600853*	Y: *7981270*



nr. *17*	*Roll 3*
Description: *This tree did not survive*	
X: *0600853*	Y: *7981270*

nr. *19*	*Roll 3*
Description: *Piranha*	
X: *0600853*	Y: *7981270*

nr. *20*	*Roll 3*
Description: *Piranha*	
X: *0600853*	Y: *7981270*

nr. *21*	*Roll 3*
Description:	
X: *0600853*	Y: *7981270*

nr. *22*	*Roll 3*
Description: *A "Capibara" (a big guinea pig / "Cavia")*	
X: *0616911*	Y: *7980425*

nr. *27*	*Roll 3*
Description: *Artificial channel by-pass, dug by a local farmer (of Santa ….) to protect his land against eroding*	
X: *0564430*	Y: *7969911*

C.4 Roll 4

nr. *1*	*Roll 4*
Description: *Dredging works (carried by local farmers).* *Water level almost equals bottom level here (approx. 20 cm difference). Left bank. picture approx. 500 m after dredging works started. It continues several km's (sediment deposits on left and right banks)*	
X: *0544888*	Y: *7962296*

nr. *2*	*Roll 4*
Description: *Dredging barge owned by the local farmer, which is often used*	
X: *0537175*	Y: *7959166*

nr. *3*	*Roll 4*
Description: *Dredging barge*	
X: *0537175*	Y: *7959166*

nr. *4*	*Roll 4*
Description: *Porto Rolon* *Taquari in upstream direction*	
X: *0518037*	Y: *7942817*

nr. *5*	*Roll 4*
Description: *Porto Rolon, Location of overnight stay.*	
X: *0518037*	Y: *7942817*

nr. *6*	*Roll 4*
Description: *Local Pantero's*	
X: *0518037*	Y: *7942817*

nr. *7*	*Roll 4*
Description:	
X: *0518037*	Y: *7942817*

nr. *9*	*Roll 4*
Description:	
X: *0518037*	Y: *7942817*

nr. *10*	*Roll 4*
Description:	
X: *0518037*	Y: *7942817*

nr. *11*	*Roll 4*
Description: *DGPS measurement*	
X: *0518037*	Y: *7942817*

nr. *12*	*Roll 4*
Description: *Taquari, low land area, picture taken in downstream direction*	
X: *0499462*	Y: *7929820*

nr. *13*	*Roll 4*
Description: *Same as previous but picture taken in upstream direction*	
X: *0480309*	Y: *7929820*

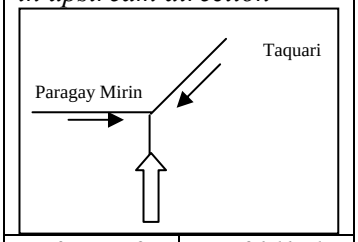
nr. *14*	*Roll 4*
Description: *Downstream. Al lot of surface water, Delta area(?), braided.*	
X: *0480309*	Y: *7929820*

nr. *15*	*Roll 4*
Description: *Grab sample with a Van Veen Grabber in the Rio Negrinho (cross section location)*	
X:	Y:

nr. *16*	*Roll 4*

Description:

Paraguai Mirini. Higher banks again. Picture taken in upstream direction



X: *0454752*	Y: *7916156*

nr. *17*	*Roll 4*

Description:

Paraguai Mirin or Rio Negrinho, sailing a cross-section, higher surrounding terrain

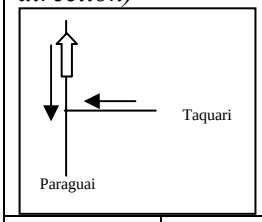
X:	Y:

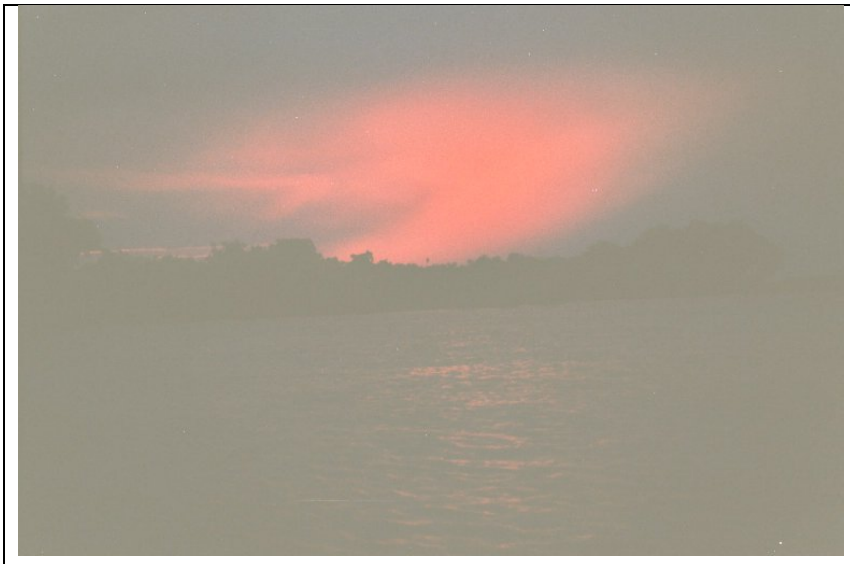
nr. *18*	*Roll 4*

Description:

Somewhat downstream of the previous picture. The mountains near Corumba

X:	Y:

nr. *19*	*Roll 4*
Description: *Paraguai river, just after inflow of the Taquari (upstream direction)*  	
X:	Y:



nr. *20*	*Roll 4*
Description: *Setting sun. Purple sky. Paraguai river*	
X:	Y: