Characterisation of Pressures and Impacts on the Cuiabá river

Report on visit to Brazil, 11-27th March by Andy Vinten

The purposes of the visit were:

1. To contribute to the start up workshop of PRONEX project
2. To consolidate and expand the Leverhulme Network
3. To further develop the conceptual model of the Cuiaba catchment
4. To progress preparation of a Leverhulme Research Grant
5. To discuss funding of other potential research proposals and student projects
6. To familiarise with the pressures on the Cuiaba river through a longitudinal sampling transect

The visit was co-funded by PRONEX, the Leverhulme Network, the Macaulay Development Trust , SAC and personal funds. The PRONEX project emerged following the 2nd Leverhulme Network workshop in Aberdeen in August 2009. It is funded by FAPEMAT, the Fundação de Amparo à Pesquisa do Estado de Mato Grosso, and is funded for approximately $R1m over two years (about £400k) to support Brazilian researchers at the Federal University of Matto Grosso (UFMT) (leads: Peter Zeilhofer, Eliana Dores) and Embrapa (Deborah Calheiros, Carlos Padovani). Funding for travel and expenses for 4 scottish scientists (Vinten, Dunn, Stutter (MLURI), and Ioris (Aberdeen University) to attend a start up workshop was included in the costings. The main goals of the PRONEX project are:

- *Quantification of the pollution by nutrients and pesticides in the Planalto-Depression system of the Pantanal, and identification of their impacts on on diverse sections of society.*
- *Consolidation of the database of hydro-environmental database, and techniques for remote sensing/geoprocessing for parametrisation of the basin...*
- *Development of conceptual model of processes and impacts*
- *Monitoring the water quality (nutrients and pesticides)*
- *Estimating pollutant loads*
- *Modelling the processes of transport and transformation in the rivers and dispersion of pollutants in the floodplain*
- *DIagnosing impacts and dialogue between academics and non academics about causes of environmental degradation and mitigation*

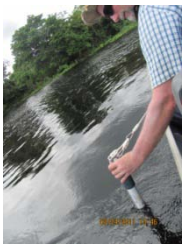
The PRONEX workshop consisted of :

A. A formal plenary session on Monday 14th March, which was attended by ca. 150 people, and reported on state TV. The morning session in Portuguese, included presentations by Peter Zeilhofer (project overview), Eliana DOres (pesticide and sediment sampling), Deborah Calheiros (nutrient dynamics) and Embrapa Corumba (working with fishery communities) and the afternoon in English (which included presentations from Sarah Dunn, Marc Stutter, Klaus Glenk and Antonio Ioris).

B. workshops on Tuesday 15th March which undertook planning of sampling strategy, developing the conceptual understanding of the Cuiaba river basin, exploring the pressures on the basin

and their impacts and mitigation, and the development of ideas for further funding. These were led by Peter Zeilhofer and Andy Vinten.

C. A field visit the research sites in the upper Cuiaba/Sao Laurenco watershed, including a site monitoring the effectiveness of riparian buffers in agricultural areas, which are required to be at least 100m under state environmental legislation, and water level and spot sampling sites on tributaries at Tenente Amaral.



D. A field visit to observe and sample the Cuiaba river within the Pantanal, at Porto Cercado, about 150km south of the city of Cuiaba. Instrumentation brought by the MLURI group to measure algal chlorophyll and turbidity was tested and samples for chemical analysis were taken. A group of about 20 MSc and PhD students from UFMT accompanied. A further purpose was to identify potential standing water sampling sites for PRONEX.

E. Networking with stakeholders in the catchment, which included a major cattle rancher from the Pocone area, a commercial fisheries organisation, a local school head to discussion plans for twinning with Lathallan school, and water companies. A list of contacts is given below.

F. Planning of longitudinal water sampling campaign on Cuiaba river Sat 18th to Thurs 23rd March. The goals of this were:

- To characterise the chemical and biological impacts of urban inputs from Cuiaba city downstream;
- To assess the pollutant processing potential (both effectiveness and mechanisms) of the river with respect to rural (sediment, nutrients, pesticides), urban (soluble organic matter, metals, PAHs) inputs from Cuiaba city, and floodplain (detritus, soluble organic matter) downstream.
- To familiarise with the flooding behaviour of the river during a high flow period;
- To familiarise with pressures associated with use of the river;
- To obtain a photographic record of the river at sampling points.

More details of this campaign, including initial results are given below.

G. Planning of informal campaign of dialogue with river users between Cuiaba city and Barao de Melgaco on Saturday 18th March . This was undertaken by Julia Martin-Ortega, Antonio Ioris, Klaus Glenk and Wagner. More details are available in a report by Julia Martin-Ortega.

Details of Longitudinal transect of the Cuiabá river.

The purpose of this transect was to obtain data to help calibrate a model of instream processing of pollutants (nutrients, organic matter, sediment) from Cuiaba city and intensive agriculture in the highlands, to observe pressures on the Cuiaba river, to identify potential standing water sampling sites for PRONEX and to familiarise with the exchange between water and floodplain during high flow period. Participants were: Carlos Padovani, Marc Stutter, Sarah Dunn, Deborah Calheiros, Andy Vinten, Julia Martin_Ortega. This campaign lasted 6 days, during which time we travelled in 3 boats (SEMA covered day 1, Pousada Mutum days 2-4, and Embrapa Corumba days 5 and 6). The transect covered the following river and floodplain stretches (see also Figure 1):

Saturday 19th March (Padovani,Vinten, Stutter, Calheiros, Dunn, George, Joao)
Above Cuiabá city to Barao de Melgaço via Saint Antonio de Leverger .
Estimated Cuiabá river distance 220km*.
*based on time records and assuming average boat speed of 30km/h

This reach was characterised by relatively intense development and use of banksides, presence of large numbers of recreational fishermen, the large urban input from Cuiaba city, as well as from other smaller sources and the floodplain river, Rio Arica.

Sunday 20th March (Padovani, Vinten, Stutter, Martin-Ortega, Dunn,Raul, Denilson)
Barao de Melgaço to Rio Mutum, via Cuiaba Mirim (riverdwellers village) and Sia Mariana (lake).
Estimated Cuiabá river distance 130km.

This reach was characterised by much less development, but canalisation of the river, especially around river communities (see above) was occurring.

Monday 21st March (Padovani, Vinten, Raul, Denilson)

Rio Mutum and Chaccorore Lake. No progress along Cuiabá river.

The main feature of this day was a longitudinal sample of Lake Chacorrore (around 10km from NE to SW), to identify the impact of the Cuiaba river, a side channel of which passes through the SW edge of the Lake as well as through Sia Mariana, a more oligotrophic lake to the south, which is strongly influenced by Rio Mutum, which runs into it from the east. Chacorrore lake is prone to drying out in the dry winter season, and a dike has been installed on the above side channel at the outlet to Sia Mariana, to try to reduce the drainage to the river in the dry period.

Tuesday 22nd March (Padovani, Vinten, Waldo)

Rio Mutum to Porto Cercado

Estimated Cuiabá river distance 190km.

There are several significant inputs to the river from floodplain rivers in this stretch of river, and the Cuiaba river braids into several smaller channels at some points, although the main channel is still dominant. There was much more marginal floating vegetation (mainly water hyacinth, *Eichornia crassipes)* both in side channels and the main channel.

Wednesday 23rd March(Padovani, Vinten, Waldo)

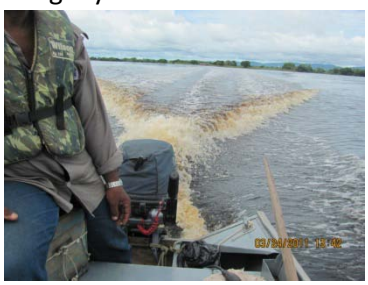
Porto Cercado to National Park (near confluence with Paraguay river)

Estimated Cuiabá river distance 330km.

Less evidence of levees, strong interchange with floodplain, many small avulsions evident.

Thursday 24th March(Vinten, Padovani, Waldo)

National Park station to confluence of Cuiaba river with Paraguay river and then onto to Corumbá. Estimated Paraguay river distance 120km.






From the National park station, the Cuiaba river soon joins the Paraguay river. Evidence of may river boats from Corumba coming into the Cuiaba river to fish (although the national park rangers said this was not allowed). The reason was clear when we reached the Paraguay river, which was exhibiting a strong dequada (oxygen depletion/carbon dioxide toxicity), with several dead fish encoutered at O_2 concentrations of 0.1-0.2 mg/L.

Measurements

We measured the Dissolved Oxygen, Electrical Conductivity and temperature with UFMT probes. We measured cyano-bacterial and green algal chlorophyll, as well as turbidity with the BBE algal torch that was brought from MLURI. In addition we took water samples for mineral and total N and P and for suspended solids analysis from Cuiaba to Porto Cercado. These samples are being analysed by UFMT (Eliana Dores). Samples of waters representing different sources were also taken for O18 and deuterium analysis for retention by UFMT, pending application for licence so they can be exported to the UK .

In addition, the GPS co-ordinates and a photographic record were taken at each sampling point. pH was only measured from Cuiaba to Mutum. Apart from regular river samples, samples of many of the major inputs to the river were taken (eg Coxipo, Little Arica, Arica, Mutum, Taruma, Tucum, Sao Laurenco, 3 brother, Piquiri rivers).

Several lakes (or Baias) and oxbows were sampled and a transect from NE to SW of Chacorrore lake was done to highlight the influence of the Cuiaba river on the SW end of the Lake.

Precise positions of these sampling points cannot be shown on a map till the GPS data is analysed. For this report we assume we can estimate distance along the river by the time of sampling, assuming a constant travel rate of 30 km/hour by the boat.

Results

The draft data are plotted on Figure 1. Inputs from several of the major rivers (and their DO measurements) are shown. The turbidity is high (40-50 NTU) before the river passes through the Cuiaba city, and remains at similar values until the entrance of Rio Taruma. From there it declines rapidly to Porto Cercado, whereafter it remains low (<10 NTU), although increasing somewhat after to Sao Laurenco input, to 10-20 NTU. The cyano-bacterial pigment concentration follows a similar trend to the turbidity, with highest concentration of around 7-10 μg/l chlorophyll. It decline at the same time/ position as turbidity, though not to the same extent. The decline is cyanobacteria is

mirrored by an increase in green algae. In the Paraguay river, both green algae and cyan-bacterai concentrations are high. The DO begins at a relatively high level (around 6 mg/L and then shows a clear sag and recovery after the input of the urban stream (Corixo). The recovery is counteracted by a gradual decline down the river, which is strongly enhanced by inputs from floodplain rivers (little Arica, Arica, Taruma etc). These introduce low DO water and also biodegradable detritus and soluble organic matter from the flood plain. There is some recovery in the DO downstream of the input of the Sao Laurenco (a tributary of comparable size to the Cuiaba river, which has a relatively high DO). At the Paraguay river, the DO drops sharply to less than 1 mg/L.
The EC declines following the input from the urban stream (Corixo) which is then counteracted by an increase after the DO sag. Thereafter it continues to decline with floodplain inputs of low EC, to a steady low value in the National Park region, until dropping further on mixing with the Paraguay river.

Discussion
They also show that during the wet season, the impact of the city on DO is relatively transient, and swamped by natural inputs of biodegradable organic matter. The strong decline in the turbidity in the taruma to Porto Cercado reach is associated with the occurrence of a floodplain which is much more interactive with the river, and the much greater abundance of marginal floating vegetation, such as water hyacinth. This suggests that filtration, dilution and sedimentation all play roles in sediment removal in this region, and also emphasises that the much more altered reaches between Cuiaba city and Barao, where there is effective river canalisation, little marginal vegetation and strong recreational pressure on banks.

This dataset gives a basis for calibration of a river processing model, for sediment and nutrients, to allow extrapolation to other flow and input conditions.

Conclusions

The team from MLURI, Aberdeen University and SAC:

1. Made contributions to the planning of sampling for the PRONEX project and developed a strong sense of teamwork with the Brazilian researchers from UFMT, CPP and Embrapa.
2. Improved the understanding and conceptual model of pressures, especially the aspects of agricultural inputs, role of drainage, morphological changes and deforestation;
3. Improved the network of stakeholders (especially with respect to fishing and ranching) for the Leverhulme project;
4. Identified several student project ideas to better quantify sources from the highlands, and improve understanding of processing in the river;
5. Noted that Everglades national park are providing a network of water level gauging in the National Park.
6. Gained an improved understanding of the kinetics and mechanisms of pollutant processing in the river and floodplain
7. Familiarised with the river-floodplain interactions.
8. Gained an improved understanding of what would be feasible and required within the Leverhulme project proposal.

Slideshows from participants are available on the website.

Andy Vinten 30.3.2011

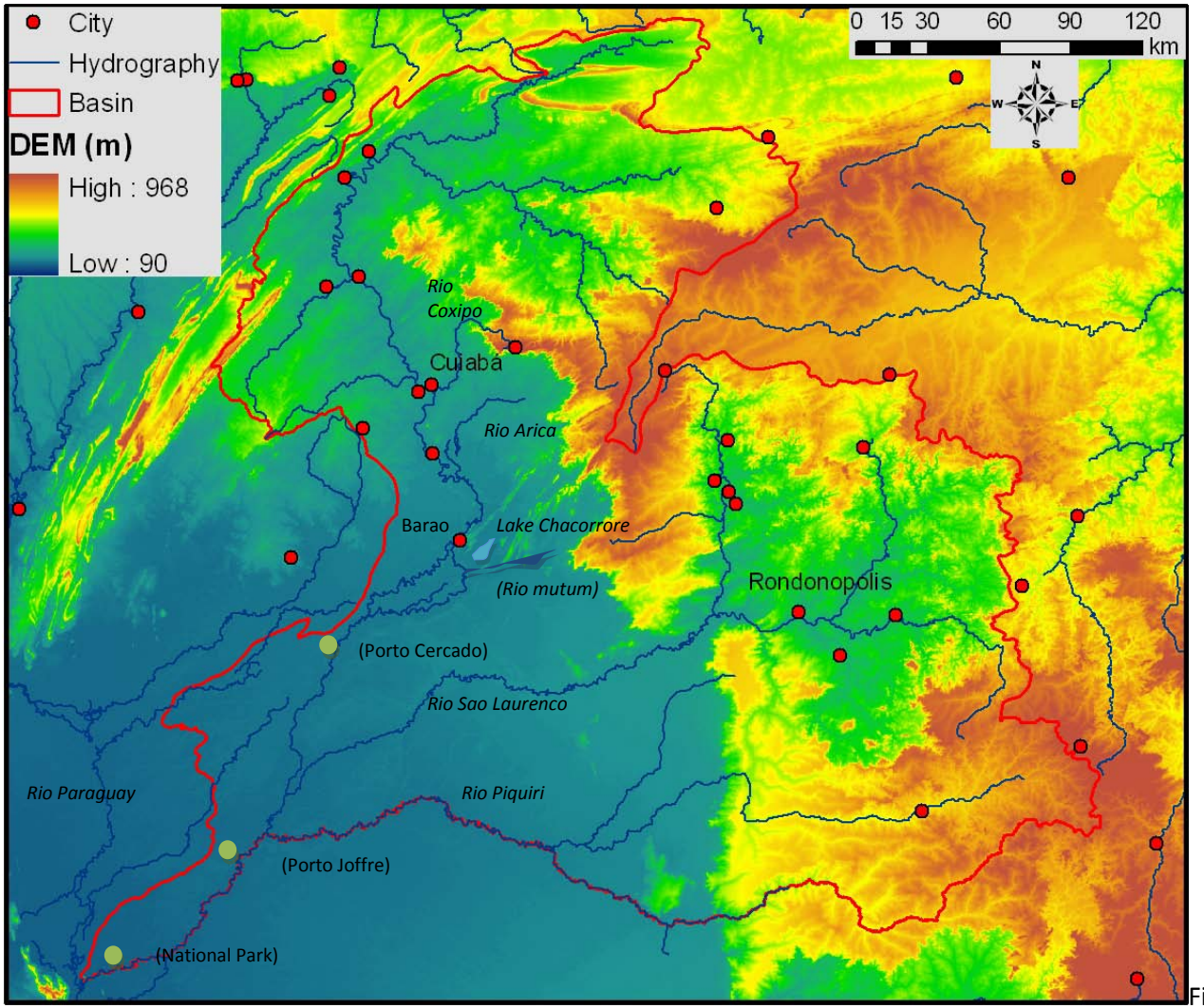


Figure 1. Cuiaba river catchment

To corumba (100km)

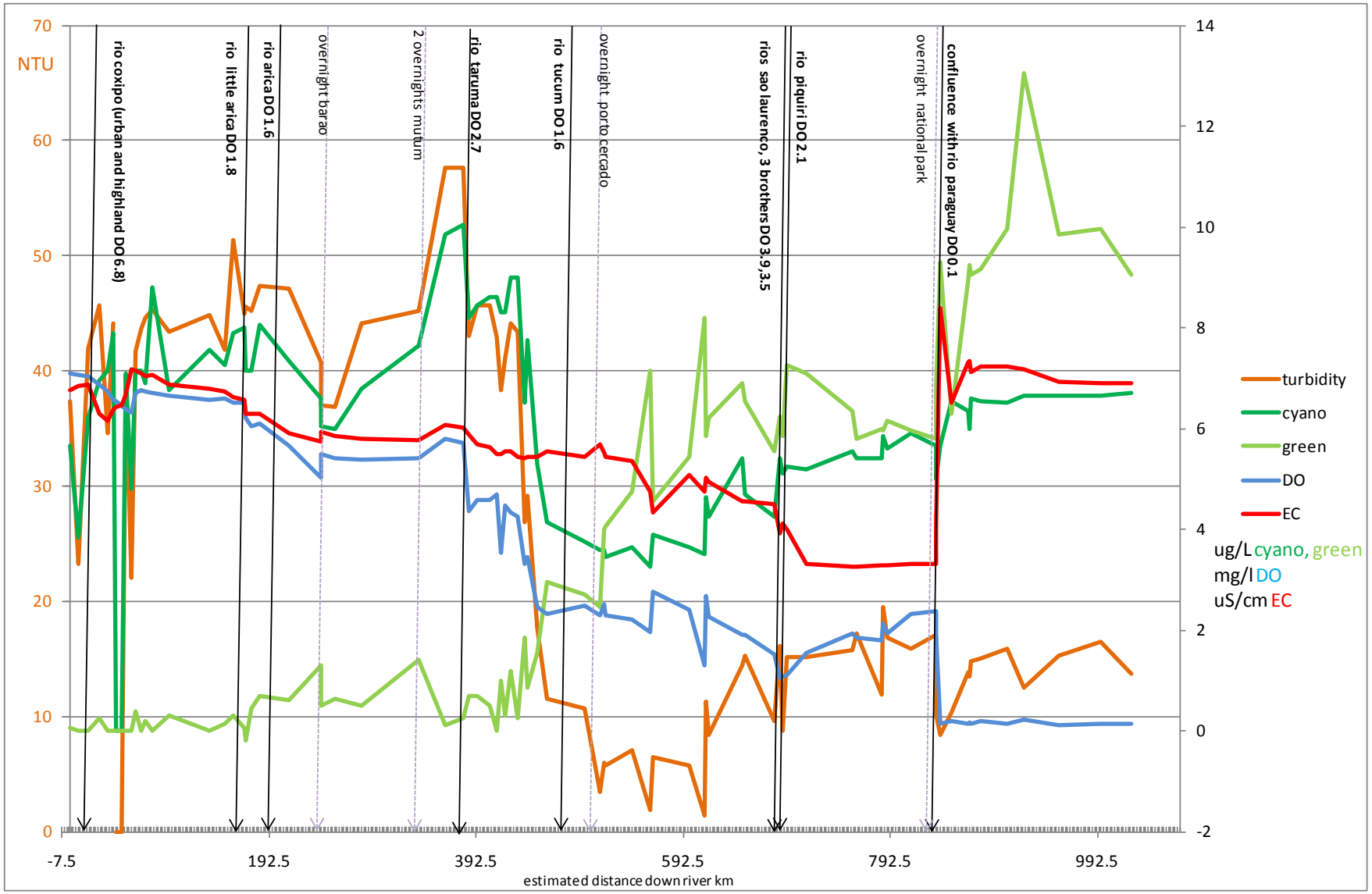


Figure 2. Preliminary plot of monitoring data on Cuiaba river (Turbidity, DO, EC, algal chlorophyll, cyanobacterial chlorophyll)