Pantanal Water Network

Second International Workshop
'Catchment Management
in the Rio Cuiabá Basin'
funded by Leverhulme Trust
18 -19 August 2009
Macaulay Land Use Research Institute
Aberdeen, UK

Welcome to the Macaulay Land Use Research Institute, who are hosting this international workshop on Catchment Management in the Rio Cuiabá Basin, South America. The Macaulay Institute is an international centre for research and consultancy on the environmental and social consequences of rural land uses. Our interdisciplinary research across the environmental and social sciences aims to support the protection of natural resources, the creation of integrated land use systems, and the development of sustainable rural communities.
We hope you enjoy your visit to the Institute, and look forward to your contribution to the discussions.

Tuesday 18 August

09.00-09.15 **Welcome to the Macaulay Land Use Research Institute**
Bob Ferrier, Catchment Management Group Science Leader

09.15-09:45 **"Review of workshop 1 and overview of aims of workshop 2",** Antonio Ioris, University of Aberdeen and Andy Vinten, Macaulay Land Use Research Institute

9:45-10:15 **"Ecological pressures and impacts in the Pantanal",** Deborah Calheiros

10:15- 10.30 *Coffee in the Conservatory*

10:30-12:30 SEMINAR
'Biogeochemistry of catchments:monitoring and modeling experience in the Pantanal and Scotland' (15 minute talks)

Hydrology
"Monitoring and modeling of flooding in Paraguay River", Carlos Padovani
"Flood management in Scotland", Tom Ball

Chemistry and ecology
"Cuiabá River chemistry and ecology", Peter Zeilhofer
"Lunan catchment chemistry and ecology", Andy Vinten, Macaulay Institute

Biogeochemical Modelling
"**Modeling sediment and P dynamics in Scottish catchments",** Martyn Futter, Macaulay Land Use Research Institute
"Modeling N dynamics in Scottish catchments", Sarah Dunn, Macaulay Land Use Research Institute
"Trend analysis for chemistry of Scottish rivers", Luigi Spezia, Macaulay Land Use Research Institute

12:30-13.30 *Lunch in the Conservatory*

13:30-16.30 **Workshop on 'Key hydrological and ecological questions for Cuiaba River'**

Facilitators: Andy Vinten, Peter Zeilhofer

1. Identification of key questions
2. Evaluation of approaches and modeling tools
3. Data availability
4. Potential projects

18.30 Workshop Dinner, The Foyer Restaurant, Aberdeen

Background

The workshop is part of the activities of the Pantanal International Network, an initiative between the Macaulay Institute and the University of Aberdeen (via the ACES partnership) and Brazilian scientists of the Pantanal Research Centre (CPP, Federal University of Mato Grosso, Cuiabá, Brazil). The network is funded by The Leverhulme Trust and more information can be obtained at www.aces.ac.uk/PantanalInternationalNetwork.htm. The activities of the network started in 2008 with the first workshop held in Cuiabá on 25-27th March 2009. It was jointly organised by Pierre Girard of CPP, Antonio Ioris of ACES Aberdeen, UK and Andy Vinten of Macaulay Institute, Aberdeen, UK. The aim of the workshop was to bring together Brazilian stakeholders and academics, to discuss the problems of the Cuiabá River Basin and to start to develop a conceptual model of the catchment. The river drains sewage from about 800,000 people, with only 20% treatment, and soil and agrochemicals from areas of intensive agricultural production on the surrounding plateau, into the Pantanal - a vast wetland area world renowned for its biodiversity and ecology. The workshop was attended by over 20 people, including the Brazilian environmental protection, nature conservation and agricultural support agencies and universities of Mato Grosso and Mato Grosso do Sul.

The main outcomes of the first workshop were:

- The development of a network of agencies, academic researchers and government bodies with interest in, data on, and responsibility for, the management of the Cuiaba River.
- The identification of key features, and drafting of a conceptual model of the river catchment
- The identification of sources of data for developing a model of the pollutant hydrology of the catchment, in the context of local stakeholder needs.

Aims of second workshop

The aims of the second workshop in Aberdeen, Scotland, UK are to

a) Summarise the ecological, economic and human health impacts of water pollution from diffuse and urban sources in the Cuiabá and Miranda River Basins.

b) Carry out a model evaluation exercise to appraise suitability of modelling approaches for application to the Cuiabá catchment

c) Further develop the conceptual model and begin identification of scenario themes

d) Progress data collation and identify gaps
e) Identify sources of further finance and prepare concept notes and proposals to submit to these sources.
f) Consolidate and enhance the existing network with the identification of additional areas of common research interest.

Reporting

We wish to produce a short booklet summarising the outputs of the workshop, and to this end, if you are presenting, provision of your slides with a short (500 word maximum) summary of your talk when you come to the meeting, would be helpful. Those designated for facilitation will prepare a short summary of these workshop sessions for the booklet.

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13:30-16.30 **Workshop on 'Key hydrological and ecological questions for Cuiaba River'**

Facilitators: Andy Vinten, Peter Zeilhofer

5. Identification of key questions
6. Evaluation of approaches and modeling tools
7. Data availability
8. Potential projects

18.30 Workshop Dinner, The Foyer Restaurant, Aberdeen

Wednesday 19th August

08.30 Taxi from Guest House

09:15-09.30 Summary of Day 1 and introduction to day 2, Peter Zeilhofer/Antonio Ioris, University of Aberdeen

9.30 -10:45 SEMINAR

'Socio-economics, governance and regulation of catchments – experience in the Pantanal and Scotland' (15 minute talks)

Catchment planning and regulation

"Water Governance and the Regulation of Water Use in Brazil and in the Pantanal" Antonio Ioris

"EU Aquarius project, Dee catchment" Simon Langan

Water costs and values

"Attitudes to flood risk ", Klaus Glenk

"Assessing costs and benefits of diffuse pollution mitigation", Andy Vinten

10:45-11.00 Coffee in the Conservatory

11:00-11:45 **"Experience of integrated catchment management in Taquari River, Pantanal",** Rob Jongman, Alterra.

11:45-12:30 **"Strategy for diffuse pollution mitigation in Scotland",** Jannette MacDonald, Scottish Environmental Protection Agency (SEPA)

12:30-13.30 Lunch in the Conservatory

13:30-15.00 **Workshop on ' Key socio-economic and governance questions for Cuiaba River'** (facilitators Rob Jongman and Robert Ferrier)

1. Identification of key questions
2. Evaluation of approaches and modeling tools
3. Data availability
4. Potential projects

15:00-17:00 **Workshop on "Integration of biogeochemical and socio-economic aspects of catchment management"**(facilitators Andy Vinten/Antonio Ioris)

1. Agreeing key questions
2. Conceptual model and scenarios
3. Potential projects and Funding sources
4. Workshop report

Evening Arrangements- Delegates free to explore Aberdeen

Thursday 20th August (Core project group)
08.30 Taxi from Guest House
9.00–12:00 Model developments: concepts, data and calibration
13:00-17:00 Project proposal development

Evening Arrangements- Delegates free to explore Aberdeen

Friday 21st August Field trip to Lunan (optional)
08.30 Taxi from Guest House
09.00 Depart Macaulay Land Use Research Institute for Field trip to Lunan
10:00 Catchment viewpoint, Turin Hill – diffuse pollution mitigation
10:30 Wemyss: monitoring of pollutant loads
11:00 Rescobie Loch – restoration targets and water values
11:30 Balgavies Loch – outlet ecology
12.15 Lunch at Kookaburras, Forfar
13:15 Friockheim pond : Stream ecology/morphology
13:45 Boysack Weir – barriers to migration, invasive species
14:15 Inverkeilor bridge viewpoint – Lunan Water & River Basin Planning
15:00 exercise on priorities
16:00 Refreshments at North Lodge, Johnshaven
17.00 approx. Return to Guest House

Evening Arrangements- Delegates free to explore Aberdeen

Delegates

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Pen pictures of speakers

Mr Albano Araújo is a senior officer at The Nature Conservancy in the Brazilian headquarters in Brasília. He is currently coordinating various projects, in partnership with Brazilian and international universities and government authorities at different levels, in the areas of ecosystem services, water management and decision support systems. Previously, Albano was a policy officer at the National Water Authority (ANA) in Brasília.

Dr. Débora Fernandes Calheiros has a degree in Biological Sciences by the University of São Paulo (1983), master's in Hydraulic Engineering and Sanitation by the University of São Paulo (1989) and Ph.D. in Sciences (Nuclear Energy and Agriculture) by the University of São Paulo & Michigan University (2003). Currently she is a senior scientist at the Pantanal centre of the Brazilian Agricultural Research Corporation (EMBRAPA) and editor of the journal Oecologia Brasiliensis. Débora has extensive experience in the area of Ecology, with emphasis on ecosystem ecology. Publications have focused, mainly, in the subjects: river ecology, food chain, stable isotopes (carbon and nitrogen), aquatic biota and rivers of the Pantanal.

Dr Sarah Dunn has 15 years' experience in hydrological and water quality modelling. She specialises in the development and application of catchment-scale models as a tool to facilitate the interpretation of physical processes operating at catchment scales and their implications for catchment hydrology and hydrochemistry.
Sarah has worked on a broad range of projects related to the prediction of impacts of land use on stream flows and hydrochemistry, and has undertaken a number of contracts carrying out modelling studies to support new policy development for implementation of the Water Framework Directive. Recently she has been carrying out research on the integration of natural tracers within hydrological modelling as a means of better understanding catchment scale processes.

Dr Bob Ferrier leads the Catchment Management Research Programme. This Programme focuses on the hydrological, hydrochemical and ecological consequences of environmental change; in particular land use and management, and climate change. His own research interests centre on the potential role of policy and land use change on water resources and the development of systems based models and frameworks for sustainable management. He has been a champion for research addressing the global challenge of diffuse pollution. Bob is a current member of the CEH Programme Development Group which advises on the CEH Science Strategy and progress against NERC objectives. In 2006 he was the first International Flagship Fellow for CSIRO's Water for a Healthy Country Programme advising on national research capability in relation to the protection of the Great Barrier Reef. He is an

Honorary Research Fellow in the College of Physical Science, University of Aberdeen, and a member of the UK NERC-BBRSC Soils Research Advisory Committee, and acts as an Evaluator for National, North American and European funding programmes.

Dr Martyn Futter is a catchment biogeochemist. His research is focused on understanding the consequences of human activity on the environment, and how these consequences will affect society in the future. His interests combine hydrology, geochemistry and ecology to understand the movement of water, nutrients and pollutants through a watershed. He is interested in the response of natural and semi-natural ecosystems to the effects of anthropogenic stressors including climate change, land management and atmospheric deposition. He uses process-based watershed-scale models of the movement of water, sediment, nutrients and contaminants through the landscape; GIS modelling of watershed dynamics; advanced statistical techniques including multivariate and time series analysis; and public engagement.

Dr Antonio Ioris is a lecturer in human geography at Aberdeen University and research fellow at the Aberdeen Centre for Environmental Sustainability (ACES), which is a partnership between the University of Aberdeen and The Macaulay Institute. His main areas of research are related to water policy and institutional reforms in the water sector, with current research in Portugal, Brazil, Peru and Scotland. Previous work included the assessment of water sustainability, agriculture irrigation and river basin development. Ioris was a co-editor of the 2003 publication "The Pantanal: Scientific and Institutional Challenges in Management of a Large and Complex Wetland Ecosystem" (available at http://el.erdc.usace.army.mil/elpubs/pdf/sr04-1.pdf).

Dr Rob Jongman is a landscape ecologist with long experience in river ecology, nature conservation planning and environmental monitoring. His PhD project was on ecology, planning and policy in river systems. From 1995 until 2007 he worked on modelling river landscapes and water processes in the Orinoco (Venezuela) and Pantanal (Brazil).
In 1987 he published a handbook on multivariate analysis in (landscape) ecology based on a post graduate course on statistics for practitioners. This handbook has been published through Cambridge University Press since 1995 and is still one of the leading student text books.
Since 1990 he developed the concept of ecological networks at the European level as a new strategy for nature conservation planning. He has been involved in a large number of projects on development of ecological networks in Europe. As part of this he was seconded for four years at the European Centre for Nature Conservation (ECNC 1994-1997) focusing on the Pan European Ecological network.

As a result of this work he published in July 2004 the book "Ecological networks and Greenways" on the development and implementation of ecological networks in the Cambridge University Press Landscape Ecology Series..
His present interest is the implementation of academic ecological knowledge into real world problems and the interaction between science and practice. His present projects are focusing on this in the field of biodiversity monitoring and ecological networks. With Diversitas International and NASA he is co-lead in the GEO biodiversity Community of Practice GEO-BON (http://www.earthobservations.org/cop_bi_geobon.shtml) and leader of the European pilot project on biodiversity monitoring EBONE (http://www.ebone.wur.nll).

Dr. Simon Langan has a background in research related to soil and water quality. Much of his early research career focused on the impacts of acid rain on upland waters and soils. More recently his research has concerned with water quality in relation to diffuse pollution and its alleviation through the implementation of best management practice. Throughout all of his research a strong component has been how scientific knowledge and can be presented so that wider society and non specialist can understood and appreciate the issues involved.
Research Interests
Simon's research currently centres on issues related to catchment management. This work has involved working extensively on the River Dee catchment and its tributaries. Within the catchment there are a number of issues relating to the river and its ecology from such issues as: acid deposition impacts, changing climate and land management. Recently he has been working on the understanding of the impact of adopting best management practices to reduce diffuse pollution and increase biodiversity within and along stream margins.

Dr Jannette MacDonald has worked for SEPA for 10 years on a range of soil and diffuse pollution issues. Currently based in SEPA's Land Policy Unit as policy lead for diffuse pollution she has been involved in the development of a wide range of measures to mitigate diffuse pollution and is particularly interested in the realisation of multiple benefits at the catchment scale. Prior to SEPA Jannette worked at the Centre for Ecology and Hydrology in Edinburgh, completing a PhD on the impacts of land management on greenhouse gas emissions, and at the Open University where she worked on the development of soil quality indicators for impacts of nitrogen deposition in forest soils.

Mr. Carlos Roberto Padovani has a degree in Biological Sciences by the Federal University of Santa Catarina, Brazil (1986) and MSc in Biology (Ecology) by the National Research Institute of the Amazon (INPA), in 1992. Carlos is currently senior scientist at the Pantanal centre of the Brazilian Agricultural Research

Corporation (EMBRAPA) with work in the areas of ecology and GIS. Publications included work in applied ecology, Pantanal flooding, and environmental impact assessment. He is currently finishing his doctoral thesis at the University of São Paulo, campus of Piracicaba.

Dr. Luigi Spezia received an MA in Economics from UCSC Milano in 1994 and a Ph.D. in Methodological Statistics from Università degli Studi di Trento in 1999. He spent two years as a Postdoctoral fellow at Athens University of Economics and Business and worked at Università degli Studi del Piemonte Orientale, Novara, and Università Ca' Foscari , Venezia.
His research interests include Bayesian modelling in time and space; computational statistics; environmental and ecological statistics.
He has been working for Biomathematics & Statistics Scotland since February 2008.

Dr. Andy Vinten is a senior scientist in the Catchment Management Group at Macaulay Institute. He is a soil and water management specialist with over 20 years experience in research on impacts of land use on water quality, including nitrates, salinity, phosphates, pesticides and faecal indicators. His current research concerns the evaluation of Best Management Practices for diffuse pollution control in a farm context, and the quantification of the agricultural loads of faecal indicator bacteria to water at field and catchment scale. He manages a Research work package entitled "Management to Enhance water quality" which aims to provide research that will support effective policy and guidance on the management and enhancement of water resources and water quality, under present and future environmental conditions, focussed by an understanding of stakeholder needs and economic cost. He is investigating the cost:effectiveness of measures to mitigate diffuse pollution using national scale diffuse pollution models and literature data on cost:effectiveness along with local scale validation of effectiveness in monitored catchments.

Dr. Peter Zeilhofer is geographer and received his doctoral degree in forestry from the Ludwig-Maximilians University, Munique (Germany). Actually he is professor at the Department of Geography at the Federal University of Mato Grosso – UFMT (Brazil). His research interests focus on the utilization and development of GIS applications for water resource monitoring and management and vector habitat mapping.

NOTES FROM FIRST WORKSHOP ON THE CUIABA RIVER

25-27 March, 2009, Cuiaba, Brazil

Prior to the workshop, Andy Vinten spent 2 days visiting one of the headwater areas of the catchment at Chapada dos Guiamares (Rio Coxipo, Rio Arica), and Antonio Ioris and Andy Vinten spent 2 days visiting key stakeholders and academics at UFMT and SEMA (the Brazilian Environment Agency) and familiarising with the River catchment downstream of Cuiaba, as far as Barao de Melgaco. This also enabled plans for the field visit of the workshop to be drawn up.

The workshop timetable was as follows:

Day 1 – Water management pressures and demands

- Stakeholder workshops
- Presentations by Luiz Noquelli and Leandro Maraschin of SEMA (Catchment Management) and Carlos Padovani and Deborah Calheiros of Embrapa, Corumba (long term ecology)

Day 2 field visit – rapid catchment appraisal

Field visit – rapid catchment appraisal, covering:

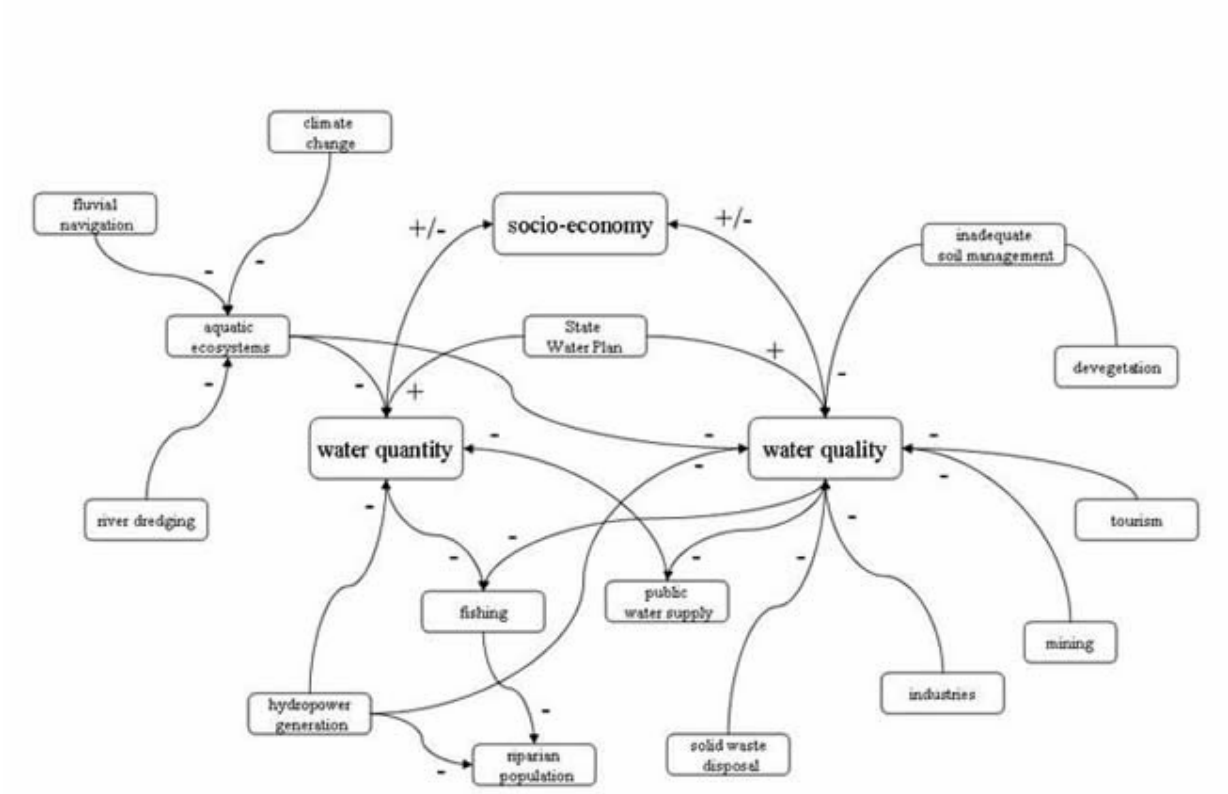
- River headwater hydrology and hydro-ecology
- Cuiaba sewage treatment works, hosted by …
- Interaction with local river users at San Antonio de Leverger, ca. 50 km. downstream of Cuiaba

Day 3- causal relationships and future research opportunities

- Presentation by Andy Vinten on Catchment Management and Planning in Scotland
- Presentation by Albano Araujo on Water for tomorrow, a strategic ecological flows project in the Sao Laurenco Basin.
- Presentation on integrated catchment management by Norman Brunet, University of Quebec, Canada
- Stakeholder workshop to formulate causal loop diagram of qualitative interactions in the catchment, led by Antonio Ioris
- Stakeholder workshop to identify biophysical catchment model concepts, data sources and draft scenario themes led by Andy Vinten

Summary of workshop session to formulate causal loop diagram of qualitative interactions in the catchment, led by Antonio Ioris

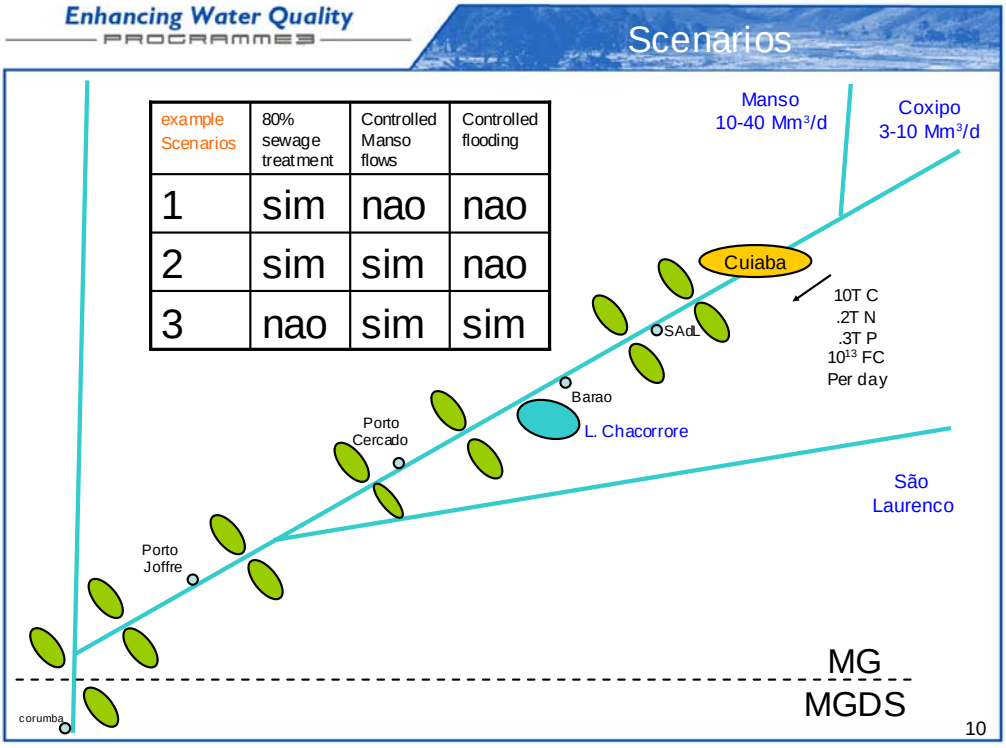
The outcome of this session was the diagram below:



Causal Loop Diagram: Overview of water issues in the Cuiaba River Basin (summary of working group exercise)

Summary of workshop session to identify catchment model concepts, data sources and draft scenario themes, led by Andy Vinten

The workshop session was intiated by a presentation by Andy Vinten on Catchment and Planning in Scotland, followed by a simple draft conceptual view of what a Cuiaba River model might be attempting to deliver (Figure 1) . This was based on perceptions of the catchment from pre-visits and meetings and previous workshop sessions, including the field trip.



Conceptual biophysical model of Cuiaba River catchment and its links with the Pantanal. This was used as a simple tool to initiate discussion, and was based on inputs from participants on the field trip. Green areas represent zones of potential flooding, estimates of nutrient loads and flows from verbal discussions and exercise during field visit. MG = Mato Grosso state, MGDS = Mato Grosso do Sul state. Figure covers about 200km x 150km.

Comments made on the conceptual model were as follows:

1. The flow from Manso whould be split about 60%: 40% between the Manso Dam and Cuiabazinho catchments.
2. Chemical data for Porto Cercado exists for C,N and P over at least 10 years.
3. In the headwaters the soluble P content is around 0.05 mg/L
4. During flooding, there is potential for the N (and P) content of the water in the flooded areas to increase, before the waters discharge back to the main channel.
5. The end of the dry season there is a large peak in nutrient concentrations in the river
6. Solid waste flushed from the urban stream channels is a major problem during flood events
7. The river shows quick flood dynamics
8. Manso Dam flows improve water quality in the dry season
9. The resolution of DigitalTerrain modelling in the catchment is about 90m(horizontal) x 50m(vertical). This limits the potentially for identifying potentially flooded areas by modelling.
10. Remote Sensing Data is easy to get for all of Pantanal (eg Adriano Paz, Sao Paulo University)
11. The vertical elevation needs on the ground survey
12. Its important to include fish farms (ca. 300) in the catchment model
13. Sao Laurenco and Cuiaba rivers are similar hydrologically
14. About 30% of pollution loads come from diffuse sources upstream of Cuiaba.

Comments made on the scenarios were as follows:

1. Controlled flooding might be done at end of season to flush urban streams
2. Controlled flooding may not be feasible or desirable.
3. The Manso dam licence requires a minimum of 90cm water in the river
4. The is a flood risk to housing upstream
5. Urban stormwater detention may be an option (some experience of SUDS)
6. Its important to have scenarios in relation to fishing
7. Important to discuss scenarios with stakeholders

Summary of workshop session on sources of data

The responses on sources of data were as follows:

1. There are 20 met stations with Rain and PET run by SEMA, and 3 at Manso Dam and others run by UFMT. The data are mainly held by Peter Zeilhofer at UFMT.
2. The land cover has been characterised in 2002, data held by Peter Zeilhofer
3. There are soil series data at 1:250,000 from which soil moisture estimates may be feasible
4. There is little data on groundwater – only a few boreholes and some typologies (from the state plan)
5. Vegetation data is available from the SEMA catchment plan
6. http://www.sema.mt.gov.br/PERH/
7. There are 6 stations + Manso dam with consistent hydrometric data
8. There are 12 stations from 1995, plus geostatistical interpolation, for monthly water chemistry in the Pantanal (? Or was it the Cuiaba river?)
9. There are only soil physical data, no chemistry
10. No data on fertiliser inputs, though these could be estimated from the state plan.
11. There is no heavy metal or pesticide data.
12. There may be some data on discharge licences from SEMA
13. There is an MSc thesis on Agriculture on the MANSO watershed
14. EMBRAPA (Deborah) has data on sediment PSA, OM and P content
15. No atmospheric input data
16. There is ecological data on the state of water bodies: chlorophyll a, zooplankton, phytoplankton, every (or for) two years (?).
17. There is a longitudinal study on the Miranda River
18. About 60-80cm amplitude in water levels (Pierre Girrard outside workshop)

Possible project emerging from workshops on biophysical model of catchment and data sources: Set up multipollutant model to simulate transport of sewage pollutants downstream of Cuiaba under conditions of a range of flows, but no flooding. Then introduce scenarios of increased potential for flooding (removal of floodwaters from model), and improving sewage treatment. Calibration using longitudinal sampling of river at high and low flow conditions (or microbial data of Edna Hardoim at UFMT), and validate using long term datasets from 12 stations along river.

Notes from the field trip along the Cuaiba River and discussions held.




Example comments of river community dwellers at San Antonio de Leverger

A) The flow regime seems to be changing - this year the Cuiabá river height did not reach the maximum level as in other years (my consideration: it's true, but this year La Niña phenom was delayed, and now it's raining a lot in Cuiabá and likely the river will reach the maximum level)

B) More pollution is being seen in the river year after year. Tourism is prejudiced.

C) Water quality worsen and now they need to treat the water to drink it, despite several people in the city still use water directly from the river (water treatment is not available for everyone).

D) Fishery break time (piracema), when registered fishermen cannot fish in the river, is creating the opposite effect. During this time, illegal fishermen fish and take big ammounts of small fish, affecting the biodiversity. My comment: if it's true, it'll be more difficult to relate fish reduction or extinction to water quality or ecological changes in the river environment. In any situation, Pantanal ecosystem will be in peril.

Possible project: community perceptions of changes in water quality/flows as a function of distance downstream of Cuiaba city, and time relative to Dam and city development

After the workshop, Andy Vinten and Deborah Calheiros (Embrapa Corumba) visited the headwaters of Cuiabazinho river at Azur Azul, (limestone hills ca. 100km north of Cuiaba) from 27th -29th March. These waters feed into the Manso Dam, which supplies hydropower, irrigation water and Cuiaba city municipal water.