



# Research and Monitoring Action Plan



For the Okavango Delta Management Plan  
Research and Data Management Component

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# Research and Monitoring Action Plan for the Okavango Delta Management Plan (ODMP), Research and Data Management Component

By

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## Executive Summary

The purpose of this Research and Monitoring Action Plan (RMAP) is to assist in putting the ODMP's Research Strategy (RS) into practice. It does this by providing a more specific overview of the currently ongoing research and monitoring (R&M) efforts, specifying the activities that need to be initiated and topics that need to be investigated to address current problems and needs, as well as outlining some specific tasks and responsibilities to get these started. It was developed from January to March 2007, involving a series of interviews with ODMP stakeholders as well as two stakeholder workshops, during which the overviews were obtained, R&M needs and priorities identified and activities and responsibilities discussed and decided upon.

In general the research needs identified in the RS were endorsed. However, the RMAP involved specifying and adapting these and as far as possible translating them into concrete research topics and questions. The subdivision in three research categories was maintained, resulting in specific priorities for research in ecology, socio-economy and physical processes (with an emphasis on hydrology). Cross-cutting issues were integrated into the three main research sectors.

In the hydrology sector the need to complete, fine-tune and adapt the hydrological model to be able to answer interdisciplinary questions was stressed. It was agreed that more information on long term flooding patterns, sediment transport, salinisation, water quality and surface-groundwater interaction was required. At the same time the validity of the existing model versus other or new models should be further investigated. Additional priorities in hydrological research should address cross-cutting research questions in relation to vegetation feedback on changing hydrological conditions and resource use problems such as channel blockages, aquatic weed control and the sustainability of water off take.

In the socio-economic sector it was found that not much research had addressed the key land use issue, the human elephant conflict in the past. However, the findings and recommendations of this specific ODMP component output provided good baseline information. More focus should be put on the regional aspect of the human elephant conflict. Even though tourism had received a lot of research attention in the recent past it should remain a research priority to investigate issues related to the sustainability, diversification and economic benefit of this fast growing sector. A lot of new research questions in the socio-economic sector are related to resource governance and the impact of management interventions.

In the ecological sector research has to provide more information on the population dynamics of important keystone and indicator species (mammals, birds, aquatic invertebrates and vertebrates and vegetation) in relation to human impact (resource exploitation) and changing natural conditions (climatic change).

The priorities and research questions identified in this way provide an overview of the current research needs for the ODMP. Their implementation into concrete activities is likely to require further choices and compromises. In this process, it will be crucial to maintain a certain balance in order to cover all relevant dimensions of the ODRS. The research categories outlined in the Ramsar Guidelines can provide useful direction in this respect.

Monitoring plays a crucial role by providing both research and management with up-to-date information, increasing knowledge on the current status of the Delta, helping in making informed decisions and providing a basis for adapting management to the ever-changing situation in and around the Delta. The drafting of the RMAP involved getting an overview of currently ongoing monitoring activities and summarising them in a table. Here, too, the three thematic categories of the RS were adhered to. This process provided stakeholders with the opportunity to inform each other about and discuss the different ongoing monitoring activities, highlighting both opportunities and current weaknesses and information gaps. Taking this overview as a starting point, effective co-ordination of monitoring activities within the ODMP will very much be a matter of keeping all stakeholders informed on the ongoing activities and guiding efforts to address any information needs and shortcomings.

The RMAP covers the institutional structures required for an effective co-ordination and implementation of R&M activities. Taking the existing ODMP research- and communication strategies as starting point, three

'levels' were identified in which information exchange within ODMP implementation can be structured. The central level consists of the HOORC library, ODIS and in the near future probably also HOORC's Environmental Monitoring Unit. Their role is to gather information at a central point, structure where required and make it available and distribute it to all ODMP partners. The second level consists of information exchange between the partners themselves. It highlights the need for them to further strengthen and promote active communication and information exchange between them. This will very much be a matter of creating a kind of 'culture' of information-seeking and –exchange within the ODMP. The third level, finally, consists of the Research Advisory Group (RAG), a group of representatives from the different R&M stakeholders within the ODRS, whose task will be to co-ordinate and guide R&M efforts.

In this area the development of the RMAP involved outlining and deciding upon specific activities to establish and strengthen the structures and processes described above. They consists of a series of 'communication processes' addressing the first and second levels, as well as a proposed set-up of the RAG and a list of tasks that it will need to fulfil.

The fourth chapter of the RMAP gives an overview of the 'funding landscape' for the R&M activities of the ODMP. Funding opportunities have changed significantly in the recent past, mainly due to the current withdrawal of the major bilateral donors from Botswana. Nevertheless, a range of opportunities remain available, including international agencies such as the EU and UNDP, South African research funds as well as national sources of funding provided through line ministries and the University of Botswana. Special emphasis is made on the need to be pro-active in the search for funding in order to ensure that the ODMP's needs are explicitly addressed by any activities funded through these channels.

The RMAP's annexes, finally, contain an overview of the research results and ongoing in the priority area specified by the Research Strategy. Furthermore a synopsis of the ongoing sectorial monitoring activities in the ODRS is provided as well as an outline of the communication process between stakeholder to exchange research and monitoring results.

## Table of Contents

<b>Acknowledgements</b> .....	<b>i</b>
<b>Executive Summary</b> .....	<b>ii</b>
<b>Table of Contents</b> .....	<b>iv</b>
<b>List of Tables</b> .....	<b>v</b>
<b>List of Figures</b> .....	<b>v</b>
<b>List of Annexes</b> .....	<b>v</b>
<b>List of Abbreviations</b> .....	<b>vi</b>
<b>Introduction</b> .....	<b>1</b>
<b>ToR for the development of a Research Action Plan for the ODRS</b> .....	<b>2</b>
<b>Team structure</b> .....	<b>3</b>
<b>Methodology</b> .....	<b>3</b>
<b>Chapter 1 - Prioritisation of Research Topics</b> .....	<b>5</b>
Priority research related to ecological processes.....	6
Socio-economic Research .....	12
Physical and chemical processes and features (mainly hydrology) .....	15
Way Forward: Maintaining an Adequate Balance in Research .....	21
<b>Chapter 2 - Monitoring the ODRS</b> .....	<b>23</b>
Ecology.....	23
Physical Processes and Hydrology.....	24
Socio-economy .....	24
Steps to Take .....	25
<b>Chapter 3 - Institutional Structures (working title)</b> .....	<b>26</b>
Overall Structure .....	26
Gathering and Systematising Information.....	27
Information Sharing and Exchange between Stakeholders .....	27
Overall Co-ordination through the Research Advisory Group .....	28
<b>Chapter 4 - Funding</b> .....	<b>30</b>

## List of Tables

Table 1: Research Outputs related to ODMP Priority Areas in Ecological Research .....	6
Table 2: Priority topics for focused ecological research in the Okavango Delta .....	9
Table 3: Priority topics for focused socio-economic research in the Okavango Delta .....	13
Table 4: Research Outputs related to ODMP Priority Areas in Socio-economic Research.....	14
Table 5: High priority topics for research on physical and chemical processes and features (mainly hydrology) in the ODRS .....	16
Table 6: Medium priority topics for research on physical and chemical processes and features (mainly hydrology) in the ODRS.....	18
Table 7: Low priority topics for research on physical and chemical processes and features (mainly hydrology) in the ODRS .....	19
Table 8: Research Outputs related to ODMP Priority Areas in Hydrological Research.....	20
Table 9: Research Outputs and Activities in the different priority research areas .....	21

## List of Figures

Figure 1: Research Outputs related to ODMP Priority Areas in Ecological Research.....	6
Figure 2: Research Outputs related to ODMP Priority Areas in Socio-economic Research.....	14
Figure 3: Research Outputs related to ODMP Priority Areas in Hydrological Research .....	20
Figure 4: Research Outputs and Activities in the different priority research areas .....	21
Figure 5: Institutional Structures.....	26

## List of Annexes

Annex 1: Research Action Plan Publications and Projects .....	32
Annex 2: Monitoring Overview.....	76
Annex 3: Communication Processes Overview .....	86
Annex 4: Timetable of the Main Communication Processes.....	88
Annex 5: List of Participants RMAP Meeting with HOORC Staff (12.03.2007).....	89
Annex 6: Individual Meetings with ODMP Partners on the RMAP .....	90
Annex 7: RMAP Workshop Participants (19.03.2007) .....	92
Annex 8: List of Reference Material .....	94
Annex 9: Suggestion for topics to be covered during the first Research Advisory Group Meeting .....	97

## List of Abbreviations

AIDS	Acquired Immune Deficiency Syndrome
BNRSTP	Botswana National Research, Science and Technology Plan
CBNRM	Community-Based Natural Resource Management
CBO	Community Based Organization
DAHP	Department of Animal Health and Production
DANIDA	Danish International Agency for Development
DEA	Department of Environment Affairs
DFRR	Department of Forestry and Range Resources
DHT	District Health Team
DoT	Department of Tourism
DTRP	Department of Town and Regional Planning
DWA	Department of Water Affairs
DWNP	Department of Wildlife and National Parks
EDDI	Education, Democracy and Development Initiative
EHD	Environmental Health Department
EMU	Environmental Monitoring Unit
EU	European Union
GTZ	Gesellschaft für Technische Zusammenarbeit
HATAB	Hotel and Tourism Association of Botswana
HIV	Human Immuno-deficiency Virus
HOORC	Harry Oppenheimer Okavango Research Centre
IBA	Important Birding Area
IFR	In-stream Flow Requirements
MEWT	Ministry of Environment, Wildlife and Tourism
MoA	Ministry of Agriculture
NFS	National Foundation of Science
NGO	Non-Government Organization
NORAD	Norwegian Agency for Development
NWDC	North West District Council
ODIS	Okavango Delta Information System
ODMP	Okavango Delta Management Plan
ODRS	Okavango Delta Ramsar Site
ORD	Office of Research and Development
P	Pula
R&M	Research and Monitoring
RAG	Research Advisory Group
RMAP	Research and Monitoring Action Plan
RS	Research Strategy
SA	South Africa
SIDA	Swedish International Development Agency
TLB	Tawana Land Board
UB	University of Botswana
UNDP	United Nations Development Programme
USAID	United States Agency for International Development
VW	Volkswagen
WHC	Wildlife Human Conflict



## Introduction

Research and Monitoring (R&M) is a crucial element of the ODMP implementation process. It was first addressed through the ODMP Research Strategy, which gave a general overview of the Plan's needs and priorities in this respect. However, in order to translate the Strategy's recommendations into practice it was decided that further specifications and concrete activities would need to be identified in collaboration with all ODMP partners.

The present report summarises the outcomes of this process, being the ODMP Research and Monitoring Action Plan (RMAP). The purpose of the RMAP is to provide a more specific overview of the current R&M situation, the activities and initiatives that are required to address current problems and clear tasks and responsibilities for the relevant stakeholders to get the process started.

The report is structured as follows:

**Chapter 1** addresses ongoing research within the ODRS, outlines specifications of the research priorities and identifies research gaps that still need to be covered.

**Chapter 2** gives a similar outline of the monitoring activities within the ODRS, summarising the ongoing activities and highlighting existing weaknesses and gaps.

Both research and monitoring require effective co-operation between the ODMP stakeholders. **Chapter 3** addresses this issue by outlining a framework for institutional collaboration within R&M, and describing several mechanisms through which collaboration and information exchange should take place, as well as indicating the organisations responsible to implement them.

**Chapter 4** finally gives a short synopsis of the changing funding landscape for Botswana in general and the ODMP specifically, and mentions some of the sources for funding that might be approached for R&M-related activities.

The Annexes, finally, contain the working documents that are part of the RMAP as well as relevant background information on the drafting process.

## ToR for the development of a Research Action Plan for the ODRS

Building on the ODMP Research Strategy which identified specific priority research areas, the Research Action Plan (RAP) has to define specific research topics or projects that will answer specific management questions and or contribute to the deeper understanding of physical, chemical, ecological processes and socio-economic and political factors that influence the conditions in the ODRS. **The main aim of the research action plan is to make the ODMP Research Strategy more specific and operational.**

### Key activities:

- **Prioritisation of immediate specific research needs** involving all ODMP institutions and other relevant stakeholders, to monitor the ecological and socio-economic conditions of the Delta to guide the periodic revision of the ODMP.
- Facilitation of discussions among HOORC research units to **categorize the specific research needs** for management planning in the Okavango Delta Ramsar Site.
- Establishment of procedures and an appropriate **forum for research collaboration** among all ODMP components to contribute solving multi-disciplinary problems in the Okavango Delta Ramsar Site.
- **Determination of responsible institutions** to carry out the particular monitoring and research activities and definition of the role of each player.
- Identification of **cooperation and communication requirements between management, monitoring and research institutions.**
- **Production of a Research Action Plan** that will determine which processes and results of interventions need research and monitoring to provide information on the changing conditions in the Ramsar Site. This will form the basis for adapting the management plan over time.
- **Workshop** involving representatives from ODMP partner institutions and interested stakeholders to discuss preliminary sectoral research agenda and cooperation requirements.
- Facilitation of the formation of a **Research Advisory Group (RAG)** for the Okavango Delta Ramsar Site to ensure that research and monitoring activities linked to the Okavango Delta Ramsar Site should contribute to inform the planning process, should be well coordinated. The results have to provide feedback to all stakeholders involved in using or managing the site or interested in its conservation.
- **Dissemination of the content of the Research Action Plan** to all parties involved.

### **Changes in the original ToR**

Research and monitoring are inseparable. Both activities play a key role in informing the ODMP planning and resource management decision making process. It has been decided, therefore to expand the perspective of the Research Action Plan (RAP) to include monitoring.

## Team structure

The Director of HOORC coordinated the Research and Monitoring Action Plan work.

HOORC researchers were responsible for compiling a research catalogue describing ongoing research activities and research results.

Mrs. Bendsen, a land use planner, who has worked closely with the research strategy team and all the ODMP components and their consultants, compiled the immediate research priorities of all ODMP components and HOORC researchers and compared them with research outputs. She worked jointly with Dr. K. Mfundisi, Research Fellow Wetland Ecology, to guide the RMAP process.

Mr. Federik Oberthür, a Niras/Scanagri consultant, compiled the results of the various inputs and took the lead in formulating the Research and Monitoring Action Plan.

## Methodology

To get an overview of the specific information needs and research gaps to inform the ODMP planning process, the findings of all project components were collected and analysed for specific research and monitoring recommendations.

The Research and Monitoring Action Plan presented here is based on a wide range of stakeholder consultations with ODMP partner institutions, selected representatives from NGOs and the private sector. Stakeholders involved in monitoring and research were interviewed individually to identify their research requirements and to collect information on all the ongoing monitoring activities in the ODRS. Cooperation requirements among management, monitoring and research institutions and appropriate forums for research collaboration were discussed with the partners.

For a quick overview about all ongoing research projects and related research outputs the HOORC team designed a research project database to be filled by all researchers. Furthermore, the HOORC library catalogue was searched for publications related to the ODMP research priorities.

All research priority areas identified in the ODMP Research Strategy were related to existing research outputs and ongoing research activities. The results were compiled (see Annex 1: Research projects and publications related to ODMP priority research areas). Graphics were used illustrated which topics were more frequently addressed and which were not covered adequately.

Immediate research needs in the three thematic areas: hydrology and physical processes, ecology and socio-economy, were discussed with ODMP stakeholders in a workshop held on the 19<sup>th</sup> March at HOORC. Information about the ongoing activities to monitor the state of environment and socio-economic conditions in the Okavango Delta Ramsar Site (monitoring activity, lead

institution, monitoring partners, timing, data storage, obstacles) were compiled in a monitoring table (see Annex 2).

Cooperation requirements between management, monitoring and research institutions and appropriate forums for research collaboration were discussed with all the partners as well as means and ways of appropriate knowledge management.

Meetings were held with staff from the DEA headquarters and the DEA district representatives to discuss the setting up a Research Advisory Group for the ODRS and its role, composition and inter-institutional linkages.

The draft Research and Monitoring Action Plan was submitted and discussed with the DEA. Suggestions were included in the final version.

## Chapter 1 - Prioritisation of Research Topics

The Research Strategy endorsed by stakeholders gave an overview of the broad priority research areas to be investigated to inform the ODMP planning process. Several of these research areas were however too broad to be workable and required further specification. In addition, with several of the stakeholders involved in parallel research activities, it was also necessary to get an overview over the areas already covered before decisions on further research needs could be taken.

In a first step, a compilation and an extensive analysis were made of the existing research outputs and the ongoing research activities and projects from HOORC, UB and other international research institutions collaborating with HOORC, as well as from the research units of the respective line ministries and from individual researchers (see Annex 1: Research outputs and ongoing research projects in research areas prioritised in the ODMP Research Strategy).

In a second step, these priority areas were revisited and discussed in detail individually and jointly with a wide range of ODMP stakeholders (See Annex 6: List of stakeholder interviewed and Annexes 5 and 7: List of HOORC staff workshop and ODMP workshop participants). The objective was to identify detailed priority topics that could inform the ODMP planning process by fulfilling the following functions:

- Analysing resource use issues (applied research) to inform the conflict resolution process.
- Providing guidance to the adaptive management planning process in the ODRS (applied research).
- Provide information on the state of environment and the biodiversity of the ODRS.
- Analysing the impacts of management interventions (applied research).
- Providing more information to get a better understanding of the hydrological and ecological functioning of the Okavango Delta and the socio-economic and political factors that influence human and ecosystem interactions (basic and applied research).

Based on these discussions, this Research and Monitoring Action Plan contains further specified information needs and research topics of interest to resource managers, planners and researchers. They are subdivided according to the Research Strategy's three research categories, i.e.:

- Ecological processes linking habitats to populations of species.
- Physical and chemical processes and features (mainly hydrology).
- Social and economic processes that exploit or derive benefits from the ecosystem.

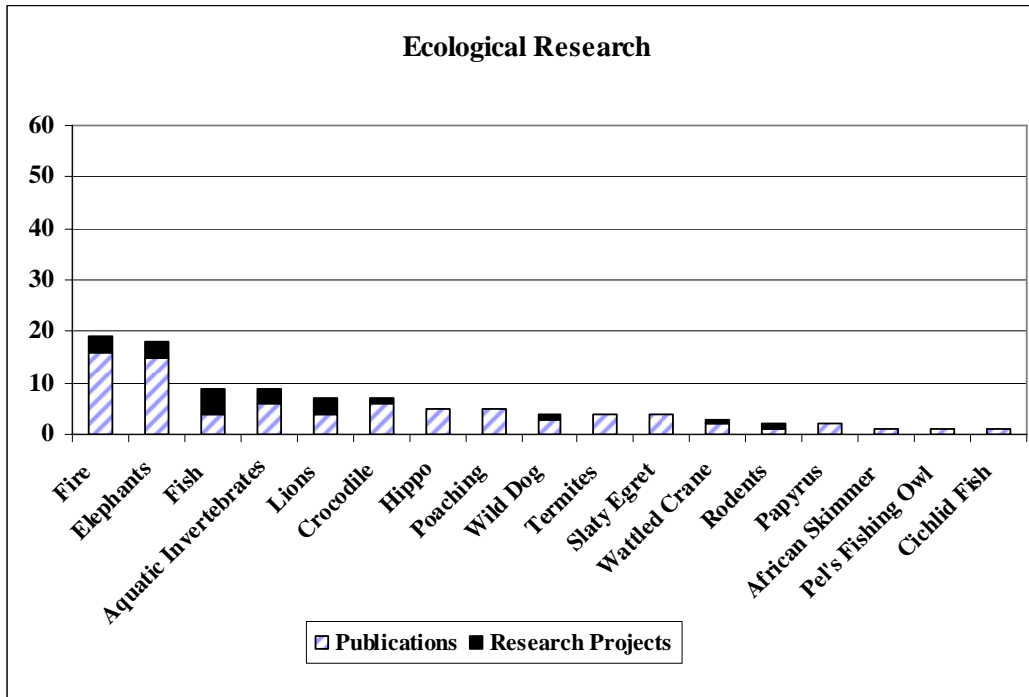
Cross-cutting issues were not separated, but built into the categories.

The following sections describe the outcomes of the discussions for each of the categories. This is followed by a section providing some considerations on the future of research within the ODRS.

## Priority research related to ecological processes

The Table 1 and Figure 1 below give an overview of the ongoing and available research related to ecological processes.

**Figure 1: Research Outputs related to ODMP Priority Areas in Ecological Research**



**Table 1: Research Outputs related to ODMP Priority Areas in Ecological Research**

Ecological Research Area				
Research Topic	Total of Publications	Total of Research Projects	DWNP Research Projects	HOORC Research Projects
Fire	16	3	2	1
Elephants	15	3	3	0
Fish	4	5	1	4
Aquatic Invertebrates	6	3	2	1
Lions	4	3	3	0
Crocodile	6	1	1	0
Hippo	5	0	0	0
Poaching	5	0	0	0
Wild Dog	3	1	1	0
Termites	4	0	0	0
Slaty Egret	4	0	0	0
Wattled Crane	2	1	1	0
Rodents	1	1	0	1
Papyrus	2	0	0	0
African Skimmer	1	0	0	0
Pel's Fishing Owl	1	0	0	0
Cichlid Fish	1	0	0	0

With this overview in mind, the priorities outlined in the Research Strategy were amended, resulting in Table 2. The comments below describe the rationale behind the changes:

- Some of the priority research topics of the research strategy grouped under ecological processes are **related to the conflict hot spots** identified by stakeholders during the ODMP planning exercise, hence they were endorsed or specified more.
- The role of fire as a management tool versus the damage caused by uncontrolled **veld fires** was also a main area of concern. Specifically on the impact of high intensity **fires on the permanent swamp ecosystem** (impact on plant communities, birds, reptiles and mammals inhabiting the habitat) was identified by the ODMP consultants as a research gap. Hence research should not be focused on papyrus per se but on the habitat, and its role and function in the ecosystem in relation to the impact of veld fires as recommended in the Fire Management Strategy (Trollope, 2006).
- Damage to domestic stock caused by **predators** and management regulations related to compensation of losses and protection of predator populations are other problem topics where land managers are seeking guidance from non-biased investigations.
- The need for further investigations on the **African Skimmers**, an endangered bird species was questioned by BirdLife Maun. It was felt that enough information existed on the species itself. The conservation recommendation of previous research work should be put into practise first. Population trends and the impacts of the conservation efforts should be closely monitored.
- Research on **Pel's Fishing Owl** was not regarded as a high priority, as it is not one of the globally threatened bird species. It was suggested to give it a medium research priority considering that Pel's Fishing Owl is classified as a Birds of Concern in Botswana but not listed as a globally threatened species.
- Very little research has been carried out on the **Hippopotamus** even though it is seen as a keystone species. The DWNP pointed out that no reliable information on the population dynamics of this species is available. Baseline data depend on aerial counts which are not an ideal method for inventorying this aquatic species. Apart from more insight on the population and its dependence on the changing flood patterns, its function in the engineering of waterways and in the distribution of the aquatic weed salvinia molesta were seen as key research questions.

In addition to these comments and changes, the following suggestions were made for additional research that would need to be carried out:

- **The development of an ecological model linked to the hydrological model.** In order to get a clearer understanding of ecological response to changing hydrological conditions the hydrological model needs to be linked to an ecological model to enable land managers to understand the vegetation feedback to hydrological fluctuations.
- **Land use and land cover change in the ODRS and the entire Okavango Basin.** In relation to Limits of Acceptable Change the obligations for a Ramsar Site is to keep the ecological character unchanged or to improve it. Vegetation related research is clearly underrepresented in the priority research topics. To be able to monitor the impact of different types of land use on the ecosystem in the entire Okavango Basin land use and land cover changes need to be monitored and analysed.
- **Land use management and water pollution in peri-urban areas in the ODRS.** Maun is a fast growing semi-urban settlement with an increasing impact on the quality of open water

and groundwater sources in the village itself and in its immediate surroundings. To guide planning decisions and regulations it is important to understand the dimension of the impact.

- **Impact of nutrient load on the Delta and means to control it (connected to particular types of land use).** The population in the ODRS is increasing constantly. Land managers need to know to what extent the different types of land use related activities such as commercial and floodplain farming, the establishment of tourism camps and connected staff villages and settlement sprawl might contribute to the nitrification and eutrophication of the water sources in order to initiate the appropriate management interventions.
- **Impact of consumptive wildlife utilisation on key wildlife species.** Consumptive wildlife utilisation is an important income earner in the ODRS. To what extent this type of selected off-take is sustainable without changing the population structure of hunted wildlife species needs to be investigated to guide the quota setting decision.
- **Establish baseline information on indicator and keystone species.** The list of species to be researched has been revised. Apart from lions, more information on species dynamics and the human predator conflict is needed for other carnivores such as leopards, cheetah, wild dogs and hyena.
- **Population dynamics of all forms of wildlife and vegetation in relation to climate change, changes of flooding and changes of habitat.** To determine sustainable off-take rates the DWNP needs to have good baseline data on population trends of the different wildlife species. These dynamics need to be seen in the broader context of climatic change, its impact on the flood regime and the alterations in habitat types of the ODRS.
- **Resource exploitation**
  - The suggestions from the Research Strategy were broadened and specified. Research should not limit itself to the few species mentioned in the RS but focus on analysing the condition of the vegetation resources in general and their utilisation (quantities harvested, species composition, grazing pressure, carrying capacity) and determine the impacts on harvested areas and pasture condition.
  - An annual vegetation condition survey needs to be carried out to determine if the fuel load warrants the use of controlled burning measures.
  - The possibility of how best to involve and empower community based organisations in management of resource harvesting was seen as a key issue to be investigated.
  - The impact of invasive species in the ODRS needs to be investigated. Due to financial constraints this research has not been carried out as planned under the ODMP.



**Table 2: Priority topics for focused ecological research in the Okavango Delta**

Research Priorities from the Research Strategy (RS)		Additional or revised Research Topics or endorsement of RS
Priority Topic	Specific issues to be Investigated	Additional Specifications or Modifications
Detailed knowledge of elephant populations	<ul style="list-style-type: none"> <li>Numbers;</li> <li>Seasonal distribution of populations;</li> <li>Age structure of populations;</li> <li>Rate of annual increase;</li> <li>Impacts on vegetation (especially riparian woodland)</li> <li>Impacts on agricultural crops.</li> </ul>	<ul style="list-style-type: none"> <li>Endorsed unchanged as high priority topic</li> <li>Trans-boundary movements of the elephant population and impact on human-elephant conflict.</li> </ul>
Impacts of fire	<ul style="list-style-type: none"> <li>Impacts on vegetation, including riparian vegetation (Reformulated and specified)</li> </ul>	<ul style="list-style-type: none"> <li>Impact of fires on the permanent swamp habitat (papyrus).</li> <li>Impact of fires on vegetation already damaged by elephants</li> </ul>
Resource exploitation	<ul style="list-style-type: none"> <li>Measures of reed, palm, <i>mukwa</i>, bird plum and fish extraction (Reformulated and specified).</li> </ul>	<ul style="list-style-type: none"> <li>Condition of vegetation resources and their utilisation (quantities, species composition, and impacts on harvested areas, grazing pressure, carrying capacity, community based management, access to harvesting areas).</li> <li>Annual vegetation condition survey to determine if controlled burning measures should be carried out.</li> <li>Community involvement in the control of resource exploitation (harvested plant species).</li> </ul>
Impacts of poaching activities	<ul style="list-style-type: none"> <li>When?</li> <li>Where?</li> <li>What species?</li> <li>How much?</li> <li>By whom?</li> </ul>	<ul style="list-style-type: none"> <li>Endorsed unchanged as high priority topic.</li> </ul>
Aquatic invertebrates	<ul style="list-style-type: none"> <li>Selection of indicator species for water quality;</li> <li>Key species forming food base for fish populations.</li> </ul>	<ul style="list-style-type: none"> <li>Endorsed as high priority topic</li> </ul>
Important vertebrate species	<ul style="list-style-type: none"> <li>Lion;</li> <li>Wild dog;</li> <li>Hippo;</li> </ul>	<ul style="list-style-type: none"> <li>Research on (numbers; seasonal distribution; age structure of populations; rate of annual increase; population dynamics; human predator conflict) of large predator species such as lions, wild dogs, leopards, cheetah and hyena is a high priority.</li> </ul>

Research Priorities from the Research Strategy (RS)		Additional or revised Research Topics or endorsement of RS
Priority Topic	Specific issues to be Investigated	Additional Specifications or Modifications
	<ul style="list-style-type: none"> <li>• Nile crocodile;</li> <li>• Five key bird species (Wattled crane, Slaty egret, African skimmer, Pel's fishing owl, White pelican);</li> <li>• Sharptooth catfish;</li> <li>• Cichlid species (bream).</li> <li>• (Population and ecological information).</li> </ul>	<ul style="list-style-type: none"> <li>• Research on globally threatened bird species (Slaty egret, Wattled crane) should receive high research priority.</li> <li>• Population trends and the impacts of the conservation efforts for the African skimmer.</li> <li>• Birds of Concern in Botswana (Pel's Fishing Owl, Ground Hornbill and White Pelican) should be given medium priority.</li> <li>• Investigate the option of zoning of fishing grounds to solve fisheries conflict.</li> <li>• Fish stock population dynamics and ecological information on utilised fish species (mainly bream, catfish and tiger fish).</li> <li>• The Nile Crocodile has been thoroughly investigated by Stellenbosch University, hence it should be rated as medium priority research topic</li> </ul>
In-stream Flow Requirements (IFRs)	<ul style="list-style-type: none"> <li>• Specific water and sediment flows required at key points within the Panhandle and the Okavango Delta;</li> <li>• Seasonal patterns of aquatic habitat availability</li> <li>• Distribution and abundance of key species of aquatic invertebrates and vertebrates at key sites.</li> </ul>	<ul style="list-style-type: none"> <li>• Endorsed unchanged as high priority topic.</li> <li>• Productivity of habitats in relation to flooding.</li> </ul>
Biodiversity indicators	<ul style="list-style-type: none"> <li>• Identify potential indicator species (e.g. Papyrus), endemic species and threatened species;</li> <li>• Monitor trophy species;</li> <li>• Study poorly-known groups, especially rodents, frogs, termites, ants and algae.</li> </ul>	<ul style="list-style-type: none"> <li>• Endorsed as high priority topic and complemented</li> <li>• Assess possibility to involve communities in monitoring and analysing simple biodiversity indicators (fish species).</li> <li>• Assess possibility to involve tour operators in macro invertebrate monitoring.</li> </ul>
Implications of loss of riparian trees for salt accumulation in Okavango Delta islands		<ul style="list-style-type: none"> <li>• Implications of loss of riparian woodlands for salt accumulation in Okavango Delta islands.</li> </ul>

Research Priorities from the Research Strategy (RS)		Additional or revised Research Topics or endorsement of RS
Priority Topic	Specific issues to be Investigated	Additional Specifications or Modifications
Influence of increased nutrient loads on aquatic ecosystem functioning		<ul style="list-style-type: none"> <li>• Endorsed as high priority topic and complemented.</li> <li>• Investigate possibility of setting standards for services and facilities (waste management, roads, oil spillage) of tourism facilities.</li> </ul>
Influence of flooding on grazing availability and resource utilisation patterns		<ul style="list-style-type: none"> <li>• Endorsed as high priority topic.</li> </ul>

## **Socio-economic Research**

In the Research Strategy the socio-economic area was formulated in very broad terms which need to be defined more precisely in order to provide the resource users, managers and planners with answers to their key management questions. The Research Strategy pointed out that the socio-economic concerns and issues in various land use sectors need to be investigated in order to address them adequately in the ODMP planning process.

Together with the stakeholders the Research and Monitoring Action Plan identified the particular research needs in the four research framework areas (livelihood, governance, economy and special organisation) and the research questions in the specific land use sectors (tourism, livestock sector, wild plant collection, crop production and human health).

Even though, the **human-elephant conflict** is the key land use problem most frequently mentioned by communities during the ODMP consultation process, not much research work has been carried out to investigate the causes and effects and possible mitigation measures in detail (see Table 4 and Figure 2). Stakeholders stressed that the human-elephant conflict remains a priority research area despite the fact that one of the ODMP components focuses solemnly on this topic. It should be noted that a project has recently been started on this issue by the Imperial College in collaboration with HOORC).

## **Non-use value of the ODRS**

For a Ramsar area such as the Okavango Delta the calculation of values of the area is to be based upon multi-criteria analysis, which allows evaluation of all social, cultural and ecological values of the wetland as well as its economic use and non-use value. Specifically the latter has not been covered adequately in the ODMP economic evaluation of the ODRS and needs to be investigated in greater detail.

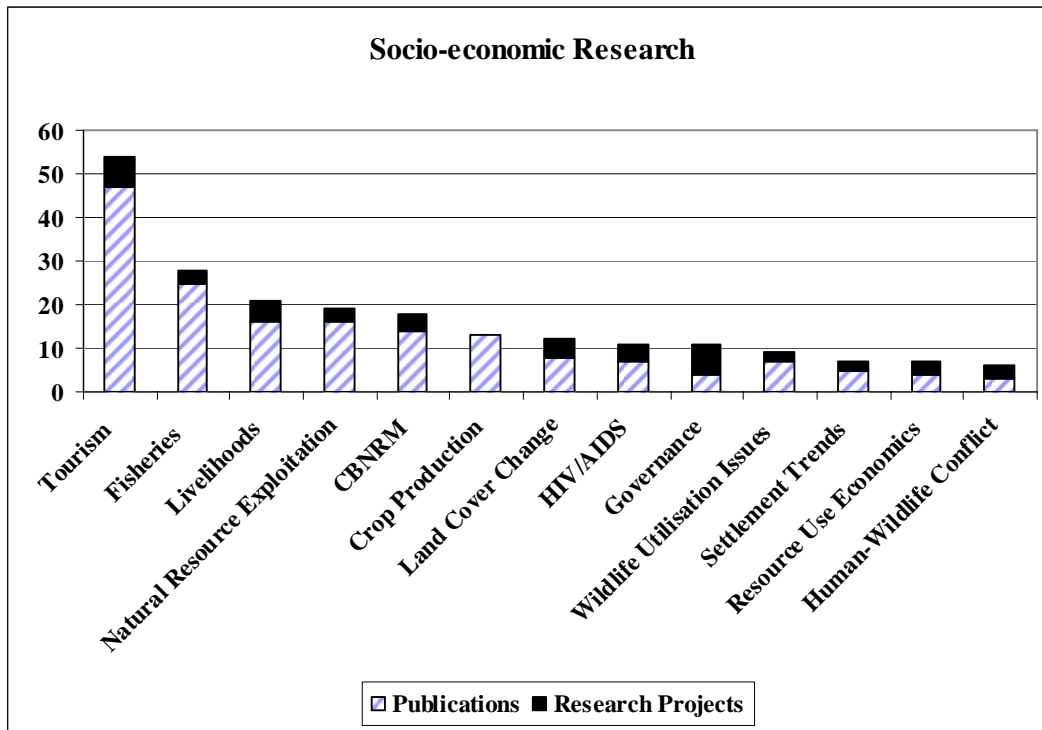
## **Tourism and CBNRM**

Table 4 and Figure 2 indicate that in the recent past the tourism sector has received a lot of research attention. Out of the 47 research publication 45 were produced after 2000. Despite of the wealth of publications now available, tourism has still been defined as a priority research area with several new topics suggested for investigation. The reason for the prioritisation is the fact that the sector is growing very fast, and plays a key role in the economy of the ODRS. However, if not properly managed it might have some adverse effects on the ecology of the Ramsar site. With support from the French embassy the University of Botswana is intending to establish a tourism research centre with four main research areas related to tourism as a socio-cultural encounter, as a shared income earner, to the governance of tourism and to tourism and sustainable resource use. The additional research topics, which have been identified by stakeholders, have been sorted into these four research areas (see Table 3).

**Table 3: Priority topics for focused socio-economic research in the Okavango Delta**

Research Priorities from the Research Strategy	Specified Research Topics of the RMAP
Livelihood framework	<ul style="list-style-type: none"> <li>• Impacts of changing <b>flooding patterns</b> on rural <b>livelihoods</b> in the ODRS.</li> </ul>
	<ul style="list-style-type: none"> <li>• Strategies of land users to cope with climate induced changes.</li> </ul>
	<ul style="list-style-type: none"> <li>• The role of <b>local knowledge</b> in resource management.</li> </ul>
	<ul style="list-style-type: none"> <li>• Social, economic and ecologic impact of commercial <b>veld product marketing</b>.</li> </ul>
Governance framework	<ul style="list-style-type: none"> <li>• Analyse <b>policies and planning</b> methods for their capacity to <b>accommodate change</b>.</li> </ul>
	<ul style="list-style-type: none"> <li>• Analysis of the impacts of <b>new policies</b> and regulations on the livelihood options of local communities in the ODRS (Fisheries Act).</li> </ul>
	<ul style="list-style-type: none"> <li>• Analysis of community governance issues in natural resource management.</li> </ul>
	<ul style="list-style-type: none"> <li>• Impact of <b>management interventions</b> to mitigate land use conflicts.</li> </ul>
	<ul style="list-style-type: none"> <li>• Effectiveness of <b>communication</b> channels between researchers, land users, resource management and legislative institutions.</li> </ul>
Economic framework	<ul style="list-style-type: none"> <li>• Economic valuation of the <b>non-use value</b> of the <b>ecosystem services</b> in the ODRS.</li> </ul>
	<ul style="list-style-type: none"> <li>• <b>Money flow</b> in the tourism industry in the ODRS.</li> </ul>
	<ul style="list-style-type: none"> <li>• Relation between ownership structure in the tourism sector and national and local <b>income generation</b> possibilities and benefits.</li> </ul>
	<ul style="list-style-type: none"> <li>• Distribution of benefits from wetland resources (national, district and household level).</li> </ul>
Special organisation framework	<ul style="list-style-type: none"> <li>• <b>Demographic dynamics</b> of Maun and its implications on livelihood options.</li> </ul>
	<ul style="list-style-type: none"> <li>• The impact of the district <b>settlement strategy</b> on rural <b>livelihood</b> and poverty reduction.</li> </ul>
Tourism as a socio-cultural encounter	<ul style="list-style-type: none"> <li>• Cultural tourism as means of <b>tourism product diversification</b> in the ODRS.</li> </ul>
Tourism as a shared income earner	<ul style="list-style-type: none"> <li>• An assessment of the ecological and socio-economic impacts of government's high cost low volume tourism policy.</li> </ul>
Tourism as a governance of tourism	<ul style="list-style-type: none"> <li>• The <b>quality of the tourism product</b> in the ODRS and improvement possibilities to sustain the tourism sector.</li> </ul>
Tourism as a tourism and sustainable resource use	<ul style="list-style-type: none"> <li>• Assess the environmental outcome of <b>CBNRM</b> in the ODRS.</li> <li>• A comparative study on the effectiveness of different <b>waste management systems</b> in tourist camps.</li> </ul>
Livestock sector	<ul style="list-style-type: none"> <li>• Effects of the <b>veterinary fences</b> on wildlife and livestock development.</li> </ul>
Human health issues	<ul style="list-style-type: none"> <li>• Impact of <b>HIV/AIDS</b> on the development of the tourism industry.</li> </ul>
	<ul style="list-style-type: none"> <li>• HIV/AIDS and livelihood strategies to cope with stress and shocks.</li> </ul>

**Figure 2: Research Outputs related to ODMP Priority Areas in Socio-economic Research**



**Table 4: Research Outputs related to ODMP Priority Areas in Socio-economic Research**

Socio-economic Research Area				
Research Topic	Total no. of Publications	Total no. of Research Projects	DWNP Research Projects	HOORC Research Projects
Tourism	47	7	5	2
Fisheries	25	3	0	3
Livelihoods	16	5	3	2
Natural Resource Exploitation	16	3	2	1
CBNRM	14	4	2	2
Crop Production	13	0	0	0
Land Cover Change	8	4	0	4
HIV/AIDS	7	4	1	3
Governance	4	7	3	4
Wildlife Utilisation Issues	7	2	2	0
Settlement Trends	5	2	0	2
Resource Use Economics	4	3	1	2
Human-Wildlife Conflict	3	3	3	0

### ***Physical and chemical processes and features (mainly hydrology)***

The Research Strategy is very explicit in research related to physical and chemical processes. For each of the research topics research activities of high, medium and low priority were listed (see Tables 5-7). Hence the Research and Monitoring Action Plan concentrated its efforts in the research area 'physical and chemical processes' on getting the individual topics endorsed, re-ranked or modified by the stakeholders. Stakeholders felt that the research topics listed in the Research Strategy do not address any of the acute land use problems of key interest to the institutions in charge of managing the resources. Several of the new priority areas of investigation suggested in the action plan are focused on analysing these water related land use conflicts.

Almost all the research topics in the Research Strategy are focused on hydrology with the aim to provide more information to complete, fine-tune and adapt the hydrological model (MIKE SHE) developed under the ODMP.

Researchers and ODMP stakeholders felt that the validity of the different existing hydrological models for the Delta (MIKE SHE-ODMP; Pieter Bauer's Model; HOORC's Model) should be further investigated and that research needs to remain open also for new hydrological models that might be better suited to the conditions of the ODRS.

The additional priorities in the hydrological area mainly include **interdisciplinary research questions** that **address hydrological issues** in the ODRS, but are not directly linked to the hydrological model. Some of these **cross-cutting research topics** (e.g. "vegetation feedback to hydrological fluctuations") have been grouped under ecological research priorities (see Table 2). Different water off-take scenarios in the ODRS and in the Okavango Basin were seen as additional research need.

Another group of new research proposals aim at improving the general understanding of the functioning and interdependencies of the wetland ecosystem as a whole. Some of the findings might be suited to calibrate the hydrological model.

An analysis of the research outputs and ongoing research indicates that especially the areas of sediment transport and salinisation have been given very little attention in the past (see Table 8 and Figure 3). Hence they remain priority research topics that need to be addressed.

The impact of different types of land use on water quality is seen as a key issue by communities and resource management institutions. Many of the ongoing research projects are focusing on this aspect (see Table 8).

**Table 5: High priority topics for research on physical and chemical processes and features (mainly hydrology) in the ODRS**

High priority areas from the Research Strategy (RS)			Additional or revised Research Topics or endorsement of RS
Topic	Delta-wide activities	Local-scale activities	
Sediment transport	<ul style="list-style-type: none"> <li>Finalize sediment transport module in the ODMP hydrological model</li> </ul>	<ol style="list-style-type: none"> <li>Sediment transport processes and rates</li> <li>Sediment accumulation and effect on channel blocking               <ul style="list-style-type: none"> <li>Morphological studies</li> </ul> </li> </ol>	<ul style="list-style-type: none"> <li>Endorsed as high priority topic</li> </ul>
Water quality	<ul style="list-style-type: none"> <li>Include water quality module in the ODMP hydrological model to simulate:               <ul style="list-style-type: none"> <li>Turbidity</li> <li>Nutrients</li> <li>Selected pollution compounds</li> </ul> </li> </ul>	<ol style="list-style-type: none"> <li>Studies of transport and turnover of selected compounds (topic altered, see next column)</li> <li>Effect of land use:               <ol style="list-style-type: none"> <li>Irrigation</li> <li>Settlements</li> <li>Fire</li> <li>Lodges</li> </ol> </li> <li>Interaction with vegetation, especially channel blocking</li> <li>Interaction with animals</li> </ol>	<ul style="list-style-type: none"> <li>Instead of studying 'compounds', 'nutrients' and 'toxic substances' in the water should be investigated.</li> </ul>



High priority areas from the Research Strategy (RS)			Additional or revised Research Topics or endorsement of RS
Topic	Delta-wide activities	Local-scale activities	
Factors affecting flood distribution and frequency	<ol style="list-style-type: none"> <li>1. Development of improved mapping techniques for flooding based on remote sensing</li> <li>2. Mapping of floods. This should explicitly address derivation of factors such as long-term data on flood duration and flooding frequency at detailed spatial scales;</li> <li>3. Analyze sensitivity of hydrological model to topography, morphology, vegetation.</li> </ol>	<ol style="list-style-type: none"> <li>1. Ground truth mapping of flooding</li> <li>2. In-stream Flow Requirements (IFRs) at key sites that reflect ecological water and sediment needs for maintenance of habitats.</li> </ol>	<ul style="list-style-type: none"> <li>• Projection of flooding trends (climate change, shifting flood patterns, seismic activity) in the future as a basis for land use planning and adaptive management.</li> <li>• The role of hippos in the hydrological process.</li> <li>• Need of a LIDAR survey for micro-topographic profiling</li> </ul>
In-stream Flow Requirements (IFRs)			<ul style="list-style-type: none"> <li>• In-stream Flow Requirements (IFRs) at selected points.</li> </ul>
Flooding patterns and flooding trends			<ul style="list-style-type: none"> <li>• Implications of fire for flooding patterns and water quality</li> <li>• Analysis long term flooding trends.</li> <li>• Desiccation dynamics related to changes in flood pattern and its impact on vegetation and land use</li> </ul>
Channel blockages			<ul style="list-style-type: none"> <li>• Implications of channel blockages for the management of the Okavango Delta.</li> </ul>
Hydrological Model			<ul style="list-style-type: none"> <li>• Establish validity of the existing hydrological models (MIKE SHE (ODMP); Pieter Bauer's Model; HOORC Model) - Remain open to other models. Need for a deeper understanding of the control zone flow (geomorphologic controls).</li> </ul>
Nutrient distribution in the air			<ul style="list-style-type: none"> <li>• The role of aeolian transport in nutrient distribution</li> <li>• Ozone distribution over the Okavango Delta and its impact on plant growth and human health.</li> </ul>

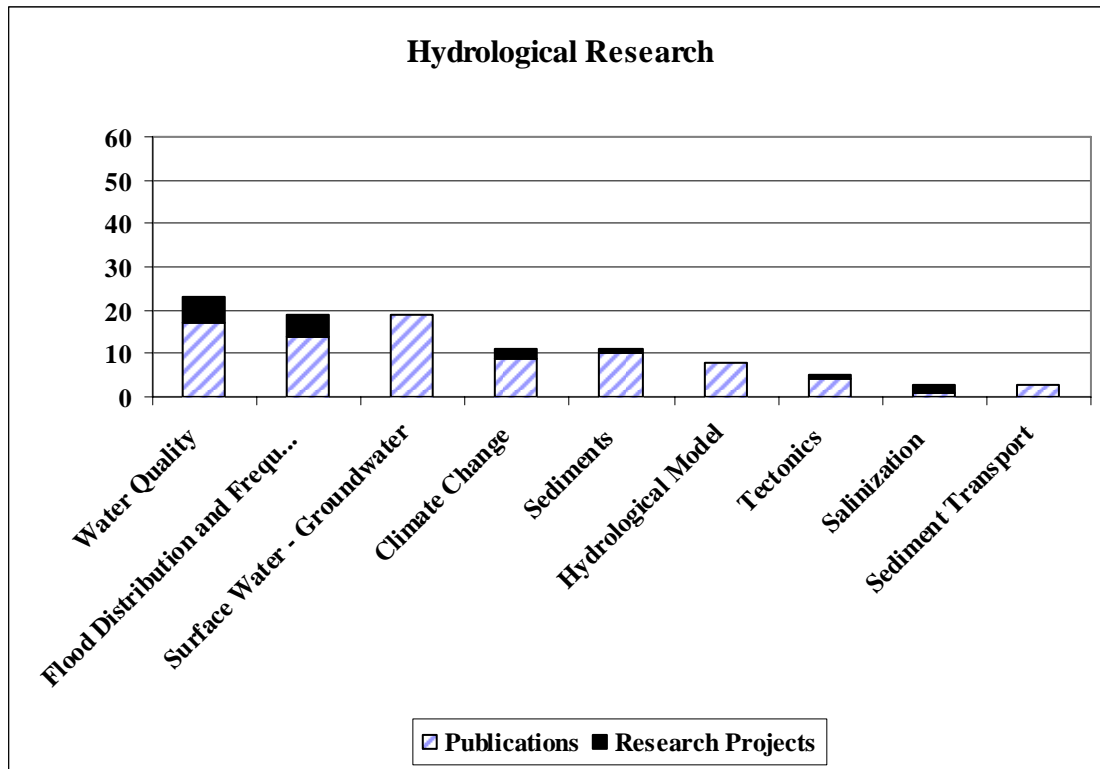
**Table 6: Medium priority topics for research on physical and chemical processes and features (mainly hydrology) in the ODRS**

Hydrological research topics of medium priority from the Research Strategy (RS)			Additional or revised Research Topics or endorsement of RS
Topic	Delta-wide activities	Local-scale activities	
Assimilation of remote sensing data in the ODMP Hydrological model	<ol style="list-style-type: none"> <li>Improvement of spatial coverage of rainfall estimates</li> <li>Improvement of estimates of Evapo-transpiration</li> </ol>	<ol style="list-style-type: none"> <li>Ground truth mapping</li> </ol>	<ul style="list-style-type: none"> <li>Endorsed as high priority topic.</li> <li>Sep flow studies.</li> </ul>
Tectonic activity	<ol style="list-style-type: none"> <li>Analysis of effect of tectonic activity on flow and flooding patterns in the ODMP model</li> </ol>		<ul style="list-style-type: none"> <li>More detailed climatic data (synotic studies).</li> <li>More seismic stations and related analysis of results.</li> </ul>
Impact of climate change	<ol style="list-style-type: none"> <li>Analysis of effect of climate change on flooding conditions in Delta using climate change scenarios in the ODMP model</li> </ol>		<ul style="list-style-type: none"> <li>Projection of flooding trends (climate change, shifting flood patterns, seismic activity) in the future as a basis for land use planning and adaptive management.</li> <li>Impact of the wetland on the microclimate.</li> </ul>
Surface water – groundwater interaction		<ol style="list-style-type: none"> <li>Process studies of linkages between surface water and groundwater in flood plains.</li> <li>Effect of groundwater depth on evapo-transpiration</li> <li>Effects of groundwater abstraction for water supply (complemented by suggestion 3, column 4)</li> </ol>	<ul style="list-style-type: none"> <li>Improve understanding of the formation and flow of saline groundwater.</li> <li>Determine the potential ecological and socio-economic impacts of water off-take (high, low and no change scenarios).</li> <li>Effects of groundwater on evapotranspiration in relation to alkalinity and salinity.</li> </ul>
Salinisation		<ol style="list-style-type: none"> <li>Relationships between fresh water and saline water.</li> <li>Effect of groundwater mining on salinization.</li> <li>Impact of groundwater salinity on root uptake.</li> </ol>	<ul style="list-style-type: none"> <li>Endorsed as high priority topic.</li> </ul>

**Table 7: Low priority topics for research on physical and chemical processes and features (mainly hydrology) in the ODRS**

Hydrological research topics of lower priority from the Research Strategy (RS)			Additional or revised Research Topics or endorsement of RS
Topic	Delta-wide activities	Local-scale activities	
Airborne measurements	<ol style="list-style-type: none"> <li>Airborne geophysics for measurements of aquifer characteristics: <ul style="list-style-type: none"> <li>Geological structure, stratification and composition.</li> <li>Saline areas and interface fresh water / saline water.</li> <li>Depth to groundwater table.</li> </ul> </li> </ol>	<ol style="list-style-type: none"> <li>More detailed investigations and ground truthing.</li> </ol>	
Groundwater boundaries and dynamics	<ol style="list-style-type: none"> <li>Analysis of boundaries of regional aquifer and impact on overall water balance</li> <li>Analysis of flow exchanges between aquifer units.</li> </ol>	<ol style="list-style-type: none"> <li>Borehole logging</li> <li>Surface seismic and electrical resistivity profiling.</li> <li>Analysis of groundwater dynamics and exchange between aquifer units.</li> </ol>	<ul style="list-style-type: none"> <li>Endorsed as high priority topic.</li> </ul>
Hydraulic study of river inflows at Mohembo that focuses on:	<ul style="list-style-type: none"> <li>Establishing correction factors for overflows;</li> <li>Reviewing and correcting historical time series as needed; and</li> <li>Designing, improving and maintaining the control section at the flow gauge.</li> </ul>		<ul style="list-style-type: none"> <li>Establish inflow water quality and changes throughout the system.</li> </ul>

**Figure 3: Research Outputs related to ODMP Priority Areas in Hydrological Research**



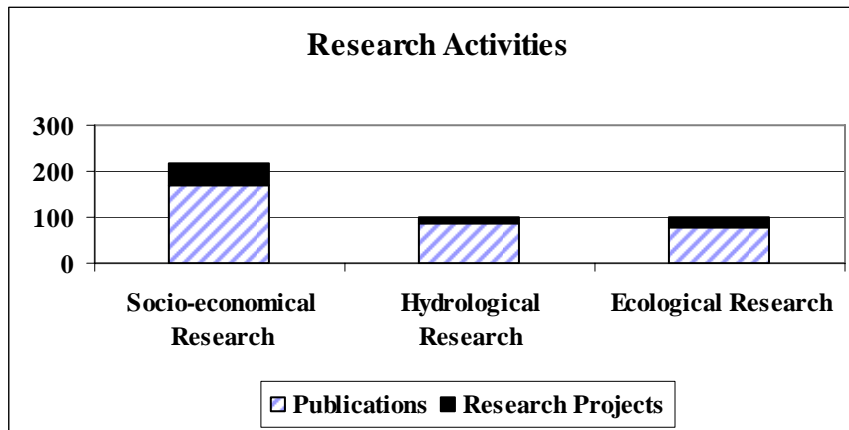
**Table 8: Research Outputs related to ODMP Priority Areas in Hydrological Research**

Hydrological Research Area				
Research Topic	Total no. of Publications	Total No. of Research Projects	DWNP Research Projects	HOORC Research Projects
Water Quality	17	6	0	6
Flood Distribution and Frequency	14	5	0	5
Surface Water - Groundwater	19	0	0	0
Climate Change	9	2	0	2
Sediments	10	1	0	1
Hydrological Model	8	0	0	0
Tectonics	4	1	0	1
Salinisation	1	2	0	2
Desiccation	3	2	0	2
Sediment Transport	3	0	0	0

## Way Forward: Maintaining an Adequate Balance in Research

The table and figure below provide an overview up until now of the *quantity* of publications that have been published and research projects that have been done or are still ongoing in the three research categories. They show that in the recent past the socio-economic research area has received more than twice as much attention compared to ecology or hydrology. Most research topics in this sector are related to land and resource use issues and fall under the category of applied research that has been prioritised by resource managers.

**Figure 4: Research Outputs and Activities in the different priority research areas**



**Table 9: Research Outputs and Activities in the different priority research areas**

Research Activities		
Research Area	Publications	Research Projects
Socio-economical Research	169	47
Hydrological Research	85	17
Ecological Research	80	21

This is a significant recent development of research in the ODRS. In 2002, an evaluation of HOORC’s function versus its mandate (EDDI report) suggested that the social aspects of resource management were not adequately addressed by HOORC research projects. As a result of this study HOORC was restructured with more emphasis on the staffing in the socio-economic research units. Specifically in the tourism sector many new research findings were published in the last five years. As can be seen, the restructuring has been a success.

The most important conclusion to draw from this is that a right balance must be found in addressing *all* relevant factors affecting the ODRS, and that achieving this balance is feasible. The Ramsar Convention – to which Botswana is expected to adhere – provides a comprehensive list of factors with implications for the ecological character of wetlands. These categories should serve as a guideline for finding such a balance within research and have it contribute effectively to management and long term planning encompassing all dimensions of the ODRS:

**Internal natural factors** – include natural succession in vegetation and variations in water level caused by precipitation.

**Internal human-induced factors** – include spread of invasive alien species, onsite pollution, and inappropriate, or unsustainable, agricultural practices.

**External natural factors** – include factors arising outside the wetland, such as positive or negative impacts of climate change and variations in currents or sea level.

**External human-induced factors** – include diversion of water supply, changing natural pattern and variability of water flows, effective water allocation regimes, increased or decreased sedimentation caused by upstream engineering works, and pollution.

**Factors arising from legislation, tradition** – include legal and traditional rights and obligations placed on the managers of the site. Legal obligations can arise from national or local legislation or international commitments, with national and local laws likely to be more important factor. Traditional and culture issues may include grazing, fishing, and logging rights and / or religious aspects.

**Conflicts /communality of interest** – includes the likely opposition or support of different stakeholders, depending on whether they see the management plan as contributing to maintain their benefits or not, or providing an opportunity to develop their interests.

**Physical considerations and constraints** – include physical factors, such as inaccessibility, which may affect the achievement of management objectives.

**Institutional factors** – includes any limitations to the capacity and authority of organisations responsible for plan implementation, and inter-relationship between the organisations or agencies responsible for wetland conservation and wise use and those responsible for other sectors directly or indirectly affecting the wetland, at local, regional and national scales.

While the research priorities described and specified in this chapter give a kind of ‘wish list’ of what should be researched in order to get a comprehensive overview of the ODRS, financial and institutional limitations will require certain choices and further prioritisations. In these, care should be given to avoid earlier biases and cover as comprehensively as possible the categories mentioned above.

## Chapter 2 - Monitoring the ODRS

Implementing the ODMP requires an effective monitoring system in order to provide both research and management with up-to-date information, increase the knowledge of the status of the Delta and help in making informed decisions. In addition, the ODMP's adaptive management approach implies a system that is comprehensive in its coverage of the ODRS, efficient in its delivery of information to those who need it and flexible enough to quickly adapt to changing circumstances and needs.

Such a monitoring system cannot be the work and responsibility of one institution alone. Within the ODRS there are already several governmental departments which have monitoring tasks as part of their mandate. Similarly, specific NGOs, communities and private organisations gather data as part of their work or their legal obligations. Last but not least, HOORC as a research institution has recently begun setting up an Environmental Monitoring Unit with the aim of co-ordinating monitoring within the institution.

While much data is thus gathered and used for specific management decisions, the results are not used outside of the particular institution, if they are used at all. So far there is no coherent attempt to use monitoring results for integrated planning. Much more can therefore be done to use current monitoring within the ODRS for integrated planning, implementation and overall adaptive management.

This potential for monitoring to contribute to ODMP implementation might be limited by some of the problems that current monitoring efforts are faced with. Most predominant among them is lack of funding or resources (staff, means of transport), which at times and within some institutions may lead to patchy data gathering. While such issues might be relatively difficult to solve within the frame of the ODMP, others could be addressed and solved. These include for instance standardisation of wildlife data collection methods and storage among tour operators, as well as ensuring compatibility of data collection with ODIS. In addition, simply knowing about each others' monitoring activities might provide room for mutual learning, exchange and improvement of practices.

It is with such an idea of 'harmonising' efforts that the monitoring-part of the RMAP was drafted and developed. This involved the compilation of all monitoring activities taking place within the ODRS and summarising them in a table, (see Annex 2). In a second step, monitoring gaps were identified and added to the table. Finally, where possible mechanisms were discussed through which monitoring efforts can be streamlined and co-ordinated.

This work is far from complete, and should rather be seen as a further step in the process of integrating research and monitoring efforts within the ODRS. The table itself should be updated regularly, and thus become a working tool for keeping an overview of the status of ODMP-related monitoring. And whenever possible, new means could and should be found to further systematise and harmonise monitoring efforts between stakeholders.

The monitoring activities have been subdivided into the three thematic areas identified by the Research Strategy, i.e. Ecology, Physical Processes (mainly Hydrology) and Socio-economy. Below a short overview is given of the main elements of each area, meant mainly as an introduction and guideline to the table in Annex 2. The chapter closes with a brief 'glance forward' on how the information about ongoing monitoring activities within the ODRS should be maintained.

### **Ecology**

The main responsibility for monitoring **wildlife** lies with the DWNP, in some cases in collaboration with NGOs or projects. Large mammals and predators are surveyed by the DWNP on an annual (every second year bi-annual) basis through aerial surveys in combination with spoor counts. Especially the aerial surveys however had to be discontinued several times in the past due to lack of funding.

In addition to DWNP, some tour operators are also involved in the monitoring of mammals. The main shortcoming of these efforts is however their lack of standardisation and computerisation, with the result that data thus collected is not yet used for management purposes.

Finally, an important shortcoming of ODRS wildlife monitoring is the lack of information on the population dynamics of hippos, certainly considering their influence on the shaping of waterways in the Delta.

The main ODMP partner involved in monitoring **terrestrial vegetation** is the DFRR. Its activities include the monitoring of fire scars and progress of fires, forest resources (albeit not yet representative enough for an accurate assessment of sustainable use) and the conditions of rangelands. In addition, this year a system for fuel load surveys for assessing fire risks and controlled burning is planned to be introduced, but might not take place due to lack of funding and staff. An additional gap in the current information available on the Delta includes a comprehensive mapping of invasive species. Besides terrestrial vegetation, DWA is involved in monitoring of **aquatic weeds** in collaboration with specific communities. However, difficulties in accessing the monitoring areas make it problematic to perform these efforts systematically.

Concerning **birds**, a great advantage for the ODRS is the presence of BirdLife Botswana in the area. Their monitoring efforts provide a relatively complete overview of a range of bird varieties, including population trends and keeping track of Important Birding Areas (IBAs). However, all their work, funding and transport means are based on voluntary contributions. This means that the continuity of their efforts is always in a relatively vulnerable position. Part of their work is done in collaboration with DWNP, but with the Department having only one ornithologist their contribution to birdlife monitoring is only limited.

The monitoring of **fish stocks** is the main area of responsibility of DWNP's Fisheries Division. Its monitoring system involves receiving records from commercial fishermen on their daily catches, as well as experimental catches by the Division itself. In addition, the Division performs monthly creel surveys as well as fish frame surveys every fifth year. Analysis of the data is performed by HOORC.

### ***Physical Processes and Hydrology***

Most of the **water monitoring** performed within the ODRS is currently the responsibility of the DWA. It monitors water flow both on the inflow at Mohebo, on the outflow in Maun and in various places within the Delta. This system however still has some flaws, including the inability to make accurate measurements during high floods. **Water levels** are checked through water level loggers, but sampling has not always been equally regular. An improved system with surface level sensors will therefore be introduced this year. For various reasons including software incompatibility and the lack of a data sharing agreement, much of the data thus gathered has not yet been integrated within ODIS, thus limiting its accessibility for analysis management purposes.

**Water quality** has up until recently mainly been checked both by DWA and EHD for its suitability for (human) consumption, thus being limited to bacteriological analysis. Since December 2006 it is also now being monitored regularly for modelling purposes, albeit only at three sites within the Panhandle and still only bacteriologically. HOORC is complementing this information by a study of N and P in the Nxaraga Valley. However, DWA's water quality data has not yet been integrated into ODIS, meaning that its potential for informing management decisions is not yet fully being exploited.

Additional areas of monitoring include **channel blockages** by the DWA, in order to manage their removal where required (even though the effect of such clearing has not been studied yet). Similarly, **precipitation** within the ODRS is expected to be monitored **for modelling purposes** by MEWT's meteorological services starting this year, while DWA's Division for Meteorological Services has been monitoring the **climate** on an ongoing basis.

### ***Socio-economy***

One of the main sources of data on people's **agricultural activities** is the Ministry of Agriculture's annual agricultural census, which includes land, land use, yields, number and type of livestock etc. The information on **livestock** can be complemented by the DAHP's cattle censuses during vaccination campaigns, as well as their and the DHT's records on cattle diseases. Livestock data are however not yet fully integrated into ODIS.



Data on **fishing** and estimates of the fishing stocks are gathered and maintained by the DWNP's Fisheries Division. Their compilation includes records of daily fish catches by commercial fishermen (probably not always accurate) and monthly experimental catches by the Division itself.

The availability, harvesting and illegal collection of **veld products** is the responsibility of the DFRR. Details on the method and frequency were not available at the time of writing, but according to their indications it involves the participation of at least one community.

Interactions between **people and wildlife** are monitored by the DWNP. It works in collaboration with the BDF with recording of any poaching that is reported. In addition, it tracks all incidents of human-wildlife conflicts for compensation purposes. In the latter the collaboration covers the Department of Agriculture for damage assessments, and HOORC for making a compilation of conflict 'hot spots'.

The monitoring of **tourism activities** is still very limited. It includes keeping track of the number and type of camps both by the TLB and the DoT for the allocation and management of concessions and controlling purposes. Concession holders do submit monitoring reports, but these are hardly used nor made available.

**Waste management** is monitored by the EHD, taking the Waste Management Strategy as its starting point. Based on this strategy it keeps track of available collection, storage and disposal facilities within communities. This does however not include waste management in the non-gazetted communities, nor does it keep track of waste that is burned by people themselves. In addition, in collaboration with the DoT it monitors the waste management practices of safari camps.

### ***Steps to Take***

While the overview table in Annex 2 probably outlines most of the currently ongoing monitoring activities, it is likely that it is neither fully accurate nor that it will remain up-to-date for long. It should therefore mainly be seen as a working document that is always 'under construction' and requires regular updating. At this stage, the responsibility for keeping the document updated falls under DEA. At a later stage however the hope is that such an overview – either with this table or in any other format – will (also) be maintained by any other institution or group with a more direct need for such information, e.g. HOORC's ODIS staff (e.g. by including it as document attached to each new version of ODIS being distributed to the partners) or its Environmental Monitoring Unit.

Whatever the institutional structure that is chosen and developed, the 'essence' to be retained is that any ODMP partner should be able to quickly and easily get an overview of where to find relevant information to inform its research and/or management decisions.

## Chapter 3 - Institutional Structures (working title)

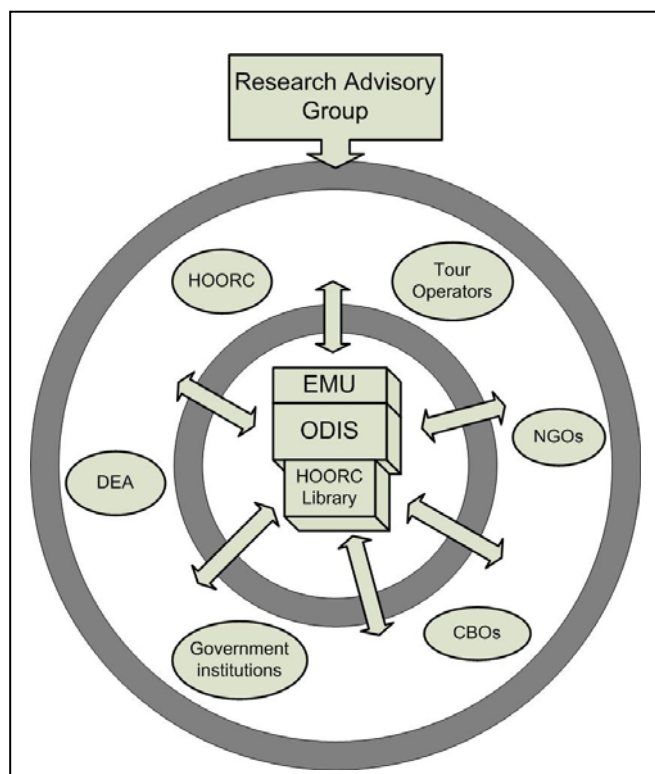
The Research and Monitoring efforts within the ODMP involve a whole range of institutions, organisations and individuals. As was already highlighted in the ODMP Communication Strategy, effective communication, dialogue and information exchange is needed in order to provide everyone with the necessary information to make well-informed management decisions and avoid duplication of efforts. This chapter describes ways through which information this can be achieved. It is based on recommendations of the Research Strategy and outcomes from the workshop held as part of the drafting of this plan.

### Overall Structure

The organisation structure suggested in this RMAP can roughly be subdivided into three 'levels' (Figure 5).

**Figure 5: Institutional Structures**

The first level, at the 'centre' of the system represents the 'central point' at which all information about the ODRS is gathered, systematised and made available for further consultation. It is a direct translation of the Communication Strategy's objective to enhance the state of knowledge in the Delta by improving access to information about it: it consists of the combination of ODIS and the HOORC Research Library, meaning in practice both a physical point where all knowledge and information about the ODRS is gathered, structured, organised and made available, and a 'digitised' information system - ODIS - that can easily be distributed to all stakeholders that require it. In addition, HOORC's Environmental Monitoring Unit is likely to play a crucial role in the near future in coordinating the central gathering of ODRS information and data. This level has been placed in the centre to highlight its crucial position within the ODMP, being the easiest and most effective way to make information accessible to all ODMP partners.



The second level is 'all around' this first one, consisting of all the stakeholders involved in and/or affected by research and monitoring within the ODMP, and their ongoing communication and interaction (or the lack of it). These include government institutions, research institutions (especially HOORC), NGOs, tour operators, community based organisations etc. The Communication Strategy's objectives include improving information flow and shared learning between stakeholders, as well as achieving an increased appreciation of each others' interests and viewpoints. Ideally this should translate into an ongoing exchange of information and access of data between and among them, as well as close collaboration where possible and required.

This level is very much a matter of creating a certain 'sharing mentality' or 'culture' among ODMP stakeholders. They should increasingly realise the need and become willing to share information between each other. This can take the form of a whole range of sharing and collaboration mechanisms. Some of them already exist, and as part of the drafting of this plan some additional ones were decided upon. As the ODMP implementation gains momentum however additional ones might emerge, old ones be discarded or existing ones improved.

Finally, the third level is composed of the overall co-ordination and guidance provided by the Research Advisory Group (RAG), as recommended by the Research Strategy. This group consists of

representatives of the main ODMP stakeholder institutions, as well as representatives from other organisations acting as ex officio members. It will have as function to check the status of the ongoing R&M efforts within the ODMP, provide guidance to the process and establish linkages to national research. The importance of this group lies in the fact that it has the potential to provide continuity and coherence to the communication and R&M efforts within the ODMP, offer strategic guidance as well as identify links to national and international networks and initiatives.

### ***Gathering and Systematising Information***

The idea behind the establishment of HOORC was to create a centre for collecting data and improving the knowledge about the Okavango Delta in order to provide answers to issues as they arise. In this sense, the ODMP's appointment of HOORC as gathering point for all information relevant to the implementation of the plan is a further refinement of this idea. In this specific case, this is expected to take place through two 'mechanisms': ODIS and the HOORC library. While both mechanisms are already in place, some steps still need to be undertaken in order to exploit them to their fullest potential.

As far as the library is concerned, it should become the physical place where all research reports on the ODRS are gathered. It is therefore crucial that all ODMP partners commit to providing both hard and digital copies of any relevant reports to it, especially the reports of independent researchers affiliated to them.

Concerning ODIS, the software is already available, has been distributed, and there is an ongoing annual training programme to train in its use, as well as an annual update provided to partners. The main weakness of the system as it is now is that much of its information is not yet up to date, and that there are no reliable mechanisms in place for providing it with the 'freshest' data. The latest ODIS Status Report identifies a series of information gaps that would need to be filled. During the workshop held as part of the drafting of this plan, some of these issues were discussed, and ways to address them decided upon. These include amongst others DEA approaching relevant ODMP partners to discuss data sharing agreements, including copyright clauses within ODIS wherever required, HOORC contacting others to check inclusion of data and/or compatibility issues etc. Please refer to Annex 3 for further details.

### ***Information Sharing and Exchange between Stakeholders***

Being a management plan, the ODMP is very much a matter of effectively co-ordinating the activities of a range of stakeholders. This involves making sure that all have a similar picture of the problems at hand and of the best ways to address them, and identifying ways to combine their efforts for maximum impact. During the stakeholder workshop several 'communication mechanisms' were identified to achieve this, of which the main ones are outlined below (see Annex 3 for full details). These mechanisms should be seen as one of the main elements of the Research and Monitoring Action Plan, being an attempt to take some first steps beyond 'business as usual' and promote more pro-active forms of information sharing.

### **Capacity Building of Relevant Staff**

The development of the ODMP has been a 4-year process involving a large number of individuals, many of which are not any more working in Ngamiland. Especially the high turnover among government staff means that the implementation of the ODMP will include dealing with an ongoing stream of new staff who need to be 'brought into the picture', acquiring a complete understanding of the ODMP and what it means for their work and responsibilities. If not addressed properly, this issue might become a weak link of lack of awareness and commitment of new staff members that might prevent ODMP in general and R&M specifically to work effectively.

During the workshop a suggestion was made for HOORC and the DEA to organise every year a three-day training course, during which new government staff are introduced to the Okavango Delta and the implementation processes of the ODMP. This would be a crucial event to generate common understanding, knowledge and most of all commitment to the ODMP process. In addition, the Wetland Management Committee should have the function to brief partners – including new staff – on the progress of all ODMP institutions.

Getting a common understanding of the ODMP and the ODRS is a first step. In a second step, new staff needs to be provided with the skills with which to access the information that is required for effective management. Most notably this involves learning the use of ODIS and the library. It will likewise be crucial for HOORC to provide an annual training in these areas to relevant (government) staff. Last but not least, users need to be kept informed on the status and information contained within ODIS through the ODIS annual status report, and user support should be provided whenever it is needed.

Finally, one has to consider that in the flow of daily work and staff changes regular reminders are needed on the possibilities of the information systems provided through the ODMP. At this stage the suggestion has been made to have a short 'publicity campaign' among stakeholders (probably via e-mail) informing them on the possibilities offered by ODIS, the HOORC Library and the library's web-based information newsletter 'WebFlow'. At a later stage, similar 'reminders' could be sent out to keep even new people and staff getting involved in the ODMP about the available information resources.

### Outreach and Information Exchange

All stakeholders directly involved in the ODMP need to acquire the habit of accessing and exchanging information relevant to the management plan. They should not only stick to the confines of their own sector or institution, but whenever needed should actively seek new or updated information 'outside' that might assist them in the performance of their tasks and enable them to analyse their data within the 'bigger picture' of the ODRS. Three processes have been identified during the workshop to address such issues:

First comes the plan for the RAG to hold a one-day 'mini-congress' or workshop at least once per year, addressing a specific thematic area within the ODRS (e.g. wildlife, tourism, local communities...). This meeting would involve presentation of research findings, discussions, debates, presentation of each others' activities or of current issues of relevance or even concern. It would help in creating and/or strengthening networks and personal contacts, thus making stakeholders aware about each others' activities, views and interests, and providing a forum for shared learning and collaboration.

The second process is already taking place, but needs to be improved. HOORC is – at least twice per month – organising research seminars in which interested stakeholders are invited to take part of the latest research findings in specific areas. The attendance has so far been relatively low, probably implying that the information on these seminars should be spread more widely. In addition, the relevance of the seminars could be enhanced for many if – whenever possible – the seminars do not only cover the research findings as such, but also include their application in current management issues.

A third process relates to the spreading of research findings to wider audiences. For these findings to be used, other channels than the seminars should be identified, and – most importantly – the findings should be 'translated' into an easy-to-understand and quick-to-read format. Initial attempts were made to produce fact-sheets by HOORC and publish findings in the Ngamiland Times by the ODMP Secretariat. These initiatives should be further strengthened, for it to become a regular feature of information exchange.

### **Overall Co-ordination through the Research Advisory Group**

The Research Strategy recommended that a Research Advisory Group (RAG) should be set up to guide research and monitoring (R&M) and provide a clear link between R&M activities and the management of the ODMP. Following discussions with the DEA and endorsement by stakeholders during the Research and Monitoring Action Plan Workshop, it was decided that the RAG would consist of representatives of the following institutions:

- Harry Oppenheimer Okavango Research Centre (HOORC)
- Department for Environmental Affairs (DEA)
- Department for Water Affairs (DWA)
- Department for Wildlife and National Parks (DWNP)
- Department for Forestry and Range Resources (DFRR)
- Department of Tourism (DoT)

- Hotel and Tourism Association of Botswana (HATAB) (who will be asked to select a suitable representative who is actively involved in monitoring and research activities)
- BirdLife Botswana

Membership of the Department of Agricultural Research will also be investigated by HOORC and DEA.

HOORC will be responsible for the chairmanship of the meetings, whereas the DEA will provide secretarial services (arrange meetings, record and distribute minutes).

In addition to the secretarial services for the RAG, DEA will also have the responsibility to update an overview of the ongoing monitoring activities. At this stage this overview consists of the table found in Annex 2. However, the actual format might have to be adapted as needs evolve.

Besides these permanent members, the RAG will also include a series of **Ex Officio Members**, who will be invited to attend the meetings whenever needed. These include:

- Nhabe-Museum
- One NGO representative based on the following criteria: having a close linkage to communities and a thorough understanding of indigenous knowledge, being involved in community outreach activities and able to channel new research questions from the communities to the RAG
- North West District Council (NWDC)
- District Health Team (DHT)
- NWDC's Social and Community Development Office (SCD)

The overall role of the RAG will be to coordinate and monitor implementation of recommendations from the Research Strategy and Research and Monitoring Action Plan and update them as new management challenges arise. It is essential that the RAG could guide the research inputs in such a way that they inform the ODMP planning process.

Adequate resources are needed for RAG to fulfil its specific roles.

Specifically, this translates into the following tasks:

- Find out about the current status of the procedures for issuing Research Permits, and establish the extent at which the RAG can provide an advisory and/or guiding role for all permits related to the ODRS.
- Ensure that all research reports and monitoring data on the ODRS are deposited in ODIS and the HOORC library.
- Introduce the production of fact-sheets (i.e. simplified, 1-2 page summaries of the findings) as an additional condition for the issuing of research permits.
- Facilitate communication between research institutions (HOORC), resource managers (government departments) and other stakeholders.
- Initiate outreach-seminars on research outputs/results for all relevant ODMP stakeholders. Wherever appropriate, these seminars will also include the presentation of current monitoring results by those institutions responsible for them.
- Identify gaps in understanding the processes that contribute to the functioning of the ODRS and new challenges and management issues, and define new priorities for R&M accordingly. These priorities should be used to guide the decisions of funding agencies (e.g. Ministry of Science and Technology; Office of Research and Development).
- Find out whether a linkage can be established between the RAG and the Research Division at the Ministry of Science and Technology, in order to provide an input for the setting of research and funding priorities.
- Regularly review and adapt the tasks of the RAG.

## Chapter 4 - Funding

Successful implementation of any programme or project depends on the availability of human and financial resources. Therefore, it is important to evaluate the existing and possible future funding mechanisms that will be used to carry out the tasks identified in this action plan. There are already existing funding institutional structures nationally and internationally, which have been used to source funds for programmes and projects in the country. However, it is not obvious that the same structures will be applicable when it comes to sourcing of funds to carry out the tasks for this action plan. This section discusses the envisaged funding mechanisms.

The research funding landscape has significantly changed during the past years. Since Botswana got classified as middle income country, the international donor community has moved out. Some of the main donors so far – **Sida, NORAD, USAID, Danida, GTZ and the VW Foundation** – are still in the country, but most are phasing out their support. Nevertheless, some might still provide funding and might be worth investigating into.

Notwithstanding these developments, the **EU** still remains a very important source for research funding, with a range of bilateral agreements that might be of interest. The EU has recently published the Framework Package 7, in which it is calling for proposals. However, to be eligible for funding institutions in Botswana will have to partner up with universities in Europe and other African countries. Information on this package can be downloaded from the Internet, including a list of potential partner institutions.

The **UNDP** and its Global Environmental Facility are also available, with an emphasis on applied research that has a developmental effect. They have an office in Gaborone that can be approached for further information.

The South African **National Foundation for Science** does also fund research in Botswana, provided the research is done in collaboration with a partner in South Africa. To be able to pursue an ODMP relevant research agenda it would be advisable to come up with research proposals, and search for South African partners. This will provide more leverage in negotiations and a better possibility for directing research to the needs of the ODMP.

Within **national funding**, the following options are available:

The Ministry of Science and Technology has recently produced the **Botswana National Research, Science and Technology Plan (BNRSTP)**, in which priority research areas were identified for funding by the government. Currently a **White Paper** is being developed, through which the government will make funds centrally available, for which researchers can compete. Most likely this paper will have applied research as the main focus, even though some 'curiosity-driven', basic research with no direct application might also be considered for funding.

The BNRSTP also includes **line ministry funding**, through which ministries themselves can identify and carry out research (mostly MEWT and MoA as far as the ODRS is concerned). Several ODMP research priority topics are of interest to these ministries, hence limited funding possibilities might be available. **However the Ministries** have their own research departments that could carry out some of the research work, or try to engage private researchers in taking up some of the research questions.

To solve some of the immediate information and research needs the different line ministries often engage short term consultants.

The Office of Research and Development (ORD) of the University of Botswana accepts proposals every February and August. Funding of research proposals (up to P100 000) is granted in February. Funding for smaller research projects (P30 000-P80 000 P) is considered in August. Only UB staff can apply for these funds. No priorities have been identified for these yet. A UB Research Strategy has been drafted, and should soon go through the approval process. For all matters relating to these funds, contact the Assistant



## ODMP Research and Monitoring Action Plan

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Director for Funding at UB. In addition, the ORD has very recently launched a website on which it publishes funding opportunities for researchers.

It is important to identify interests of a particular funding organisation, and see how they can match the priorities identified in the plan. Whenever negotiating for funding, the intentions and plans have to be very clear (i.e. ODMP), so that partners know exactly what they are expected to contribute.

## Annex 1: Research Outputs and Ongoing Research Projects in Research Areas Prioritised in the ODMP Research Strategy

### Table of Contents

<b>1</b>	<b>Priority research related to ecological processes linking habitats to populations of species .....</b>	<b>35</b>
1.1	Fire .....	35
1.1.1	Research Publications Related to Fire.....	35
1.1.2	DWNP Research Projects Related to Fire.....	36
1.1.3	HOORC Research Projects Related to Fire.....	36
1.2	Poaching .....	36
1.2.1	Research Publications Related to Poaching .....	36
1.3	Aquatic Invertebrates .....	37
1.3.1	Research Publications Related to Aquatic Invertebrates.....	37
1.3.2	DWNP Research Projects Related to Aquatic Invertebrates.....	37
1.3.3	HOORC Research Projects Related to Aquatic Invertebrates .....	37
1.4	Vertebrates .....	37
1.4.1	Elephants .....	37
1.4.2	Research Publications Related to Elephants .....	37
1.4.2.1	DWNP Research Projects Related to Elephants .....	38
1.4.3	Lions.....	39
1.4.3.1	Research Publications Related to Lions .....	39
1.4.3.2	DWNP Research Projects Related to Lions .....	39
1.4.4	Wild Dogs .....	39
1.4.4.1	Research Publications Related to Wild Dogs.....	39
1.4.4.2	DWNP Research Projects Related to Wild Dogs.....	39
1.4.5	Hippos .....	40
1.4.5.1	Research Publications Related to Hippos.....	40
1.4.6	Crocodiles.....	40
1.4.6.1	Research Publications Related to Crocodiles.....	40
1.4.6.2	DWNP Research Projects Related to Crocodiles.....	40
1.4.7	Fish .....	41
1.4.7.1	Research Publications Related to Fish .....	41
1.4.7.2	DWNP Research Projects Related to Fish .....	44
1.4.7.3	HOORC Research Projects Related to Fish.....	44
1.4.8	Cichlid.....	44
1.4.8.1	Research Publications Related to Cichlid .....	44
1.4.9	African Skimmer .....	44
1.4.9.1	Research Publications Related to African Skimmer .....	44
1.4.10	Perl’s Fishing Owl.....	45
1.4.10.1	Research Publications Related to Pel’s Fishing Owl .....	45
1.4.11	Slaty Egret.....	45
1.4.11.1	Research Publications Related to Slaty Egret .....	45



1.4.12	Wattled Crane.....	45
1.4.12.1	Research Publications Related to Wattled Crane.....	45
1.4.12.2	DWNP Research Projects Related to Wattled Crane.....	45
1.5	Biodiversity Indicators .....	45
1.5.1	Rodents.....	45
1.5.1.1	Research Publications Related to Rodents.....	45
1.5.1.2	DWNP Research Projects Related to Rodents.....	46
1.5.2	Termites.....	46
1.5.2.1	Research Publications Related to Termites.....	46
1.5.3	Papyrus.....	46
1.5.3.1	Research Publications Related to Papyrus.....	46
<b>2</b>	<b>Physical and chemical processes and features.....</b>	<b>47</b>
2.1	Sediment Transport .....	47
2.1.1	Research Publications Related to Sediment Transport .....	47
2.2	Sediments .....	47
2.2.1	Research Publications Related to Sediments .....	47
2.2.2	HOORC Research Projects Related to Sediments .....	48
2.3	Water Quality .....	48
2.3.1	Research Publications Related to Water Quality .....	48
2.3.2	DWNP Research Projects Related to Water Quality .....	49
2.3.3	HOORC Research Projects Related to Water Quality .....	50
2.4	Flood Distribution and Frequency.....	50
2.4.1	Research Publications Related to Flood Distribution and Frequency.....	50
2.4.2	HOORC Research Projects Related to Flood Distribution and Frequency...	51
2.5	Hydrological Model .....	52
2.5.1	Research Publications Related to Hydrological Model.....	52
2.6	Tectonics .....	52
2.6.1	Research Publications Related to Tectonics.....	52
2.6.2	HOORC Research Projects Related to Tectonics .....	53
2.7	Climate Change .....	54
2.7.1	Research Publications Related to Climate Change .....	54
2.7.2	HOORC Research Projects Related to Climate Change .....	54
2.8	Surface Water - Groundwater .....	55
2.8.1	Research Publications Related to Surface Water – Groundwater.....	55
2.9	Salinisation.....	56
2.9.1	Research Publications Related to Salinisation .....	56
2.9.2	HOORC Research Projects Related to Salinisation .....	56
<b>3</b>	<b>Social and economic processes that exploit or derive benefits from the ecosystem..</b>	<b>57</b>
3.1	Livelihood .....	57
3.1.1	Research Publications Related to Livelihood.....	57
3.1.2	DWNP Research Projects Related to Livelihood.....	58
3.1.3	HOORC Research Projects Related to Livelihood .....	58

3.2	Resource Use Economics .....	58
3.2.1	Research Publications Related to Resource Use Economics .....	58
3.2.2	DWNP Research Projects Related to Resource Use Economics .....	59
3.2.3	HOORC Research Projects Related to Resource Use Economics .....	59
3.3	Governance.....	59
3.3.1	Research Publications Related to Governance.....	59
3.3.2	DWNP Research Projects Related to Governance.....	60
3.3.3	HOORC Research Projects Related to Governance.....	60
3.4	Settlement Trends and Pattern.....	60
3.4.1	Research Publications Related to Settlement Trends and Settlement Pattern.....	60
3.4.2	HOORC Research Projects Related to Settlement Trends and Settlement Pattern.....	60
3.5	Land Cover Change.....	61
3.5.1	Research Publications Related to Land Cover Change.....	61
3.5.2	HOORC Research Projects Related to Land Cover Change.....	61
3.6	Fisheries .....	62
3.6.1	Research Publications Related to Fisheries.....	62
3.6.2	HOORC Research Projects Related to Fisheries.....	63
3.7	Crop Production .....	64
3.7.1	Research Publications Related to Crop Production.....	64
3.8	Exploitation of Natural Resources .....	65
3.8.1	Research Publications Related to Exploitation of Natural Resources.....	65
3.8.2	DWNP Research Projects Related to Exploitation of Natural Resources.....	66
3.8.3	HOORC Research Projects Related to Exploitation of Natural Resources ..	67
3.9	Wildlife Utilisation Issues.....	67
3.9.1	Research Publications Related to Wildlife Utilisation Issues .....	67
3.9.2	DWNP Research Projects Related to Wildlife Utilisation Issues .....	67
3.10	Tourism .....	68
3.10.1	Research Publications Related to Tourism.....	68
3.10.2	DWNP Research Projects Related to Tourism.....	71
3.10.3	HOORC Research Projects Related to Tourism .....	72
3.11	CBNRM .....	72
3.11.1	Research Publications Related to CBNRM.....	72
3.11.2	DWNP Research Projects Related to CBNRM.....	73
3.11.3	HOORC Research Projects Related to CBNRM.....	73
3.12	HIV/AIDS .....	73
3.12.1	Research Publications Related to HIV/AIDS.....	73
3.12.2	DWNP Research Projects Related to HIV/AIDS.....	74
3.12.3	HOORC Research Projects Related to HIV/AIDS .....	74
3.13	Human-Wildlife Conflict .....	74
3.13.1	Research Publications Related to Human-Wildlife Conflict.....	74
3.13.2	DWNP Research Projects Related to Human-Wildlife Conflict.....	75

# 1 Priority research related to ecological processes linking habitats to populations of species

## 1.1 Fire

### 1.1.1 Research Publications Related to Fire

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Tacheba, B., & Harry Oppenheimer Okavango Research Centre. (2002). *Fire occurrence distribution in the floodplains of the Okavango wetlands (2000-2001 burning season) / Budzanani Tacheba*. Maun: Harry Oppenheimer Okavango Research Centre.

Tacheba, B., & Harry Oppenheimer Okavango Research Centre. (2002). *Fire occurrence distribution in the floodplains of the Okavango wetlands (2000-2001 burning season) / Budzanani Tacheba*. Maun: Harry Oppenheimer Okavango Research Centre.

Tacheba, B., & University College London. (2003). *Burned area mapping in the Lower Okavango wetlands, Botswana using Landsat Enhanced Thematic Mapper imagery submitted as part of MSc Remote Sensing, University College London, September 2003*. London: University College London.

Trollope, W. S. W., Okavango Delta Management Plan Project Secretariat., & EnviroNet Solutions Pty Ltd. (2006). *A fire management plan for the Okavango Delta Ramsar site in Botswana : final report*. Maun.: ODMP.

### 1.1.2 DWNP Research Projects Related to Fire

Dr Martin Wooster	Mapping Burnt Area and Fire Intensity from Low Resolution Satellite Imagery for Improved Nitrogen Flux, Botswana	2001-2003
Dr Cornelius Vanderpost	The Effects of Fire Regime on Vegetation and Small Mammals in the Okavango Delta, Botswana	2005-2006

### 1.1.3 HOORC Research Projects Related to Fire

Dr C. Vanderpost	Fire and vegetation in Okavango ecosystems.
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## 1.2 Poaching

### 1.2.1 Research Publications Related to Poaching

Benn, J. (1983). *Poaching in Botswana*. Kalahari Conservation Society.

Milliken, T. (1997). *The status of Ivory stocks in Africa 1990 - 1996*.

Mokalane, B. T., & Botswana. Dept. of Wildlife and National Parks. *Anti-poaching unit SLR instructors manual*.

Parker, I. S. C., & Amin, M. (1983). *Ivory crisis*. London: Chatto & Windus.

Walker, O., & Dunn, D. (1967). *The hippo poacher*. London: Cassell.

## 1.3 Aquatic Invertebrates

### 1.3.1 Research Publications Related to Aquatic Invertebrates

Curtis, B., Curtis Consulting., & Permanent Okavango River Basin Commission. (1998). *Aquatic invertebrates (Namibian Sector) and water-borne diseases of the Okavango River Basin*. Windhoek: OKACOM.

Palmer, C. G., Davies-Coleman, H. D., & Institute for Water Research. *Recovery monitoring of aquatic invertebrates*.

### 1.3.2 DWNP Research Projects Related to Aquatic Invertebrates

Lefatshe Innocent Magole	Okavango Aquarap 2000, Botswana	2000-2003
Belda Q. Mosepele	Aquatic Biodiversity and Water Quality of the Okavango Delta(Botswana)	2005-2006

### 1.3.3 HOORC Research Projects Related to Aquatic Invertebrates

Dr M. Moleele	BIOKAVANGO
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## 1.4 Vertebrates

### 1.4.1 Elephants

#### 1.4.2 Research Publications Related to Elephants

Barnes, M. E., & University of Nevada Reno. (1999). *Acacia woodland ecology and elephants in northern Botswana : a thesis submitted in partial fulfilment of the requirements for the degree of Doctor of Philosophy in Ecology, Evolution and Conservation Biology*. Unpublished Thesis (Ph.D.), University of Nevada, Reno, 1999.

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Botswana. Ministry of Commerce and Industry. (1980). *A review of elephants management in Botswana*. Gaborone Botswana.

Burnham, S. (1996). *The identification, distribution and foraging habits of the African elephant along the Boro River of the Okavango Delta*.

Coequyt, A., & College Semester Abroad Botswana. (1995). *Soil and vegetation interaction and elephant utilization on Chief's Island*.

Conservation International Botswana. *Ecology, metapopulation structure and movements of African elephant (Loxodonta Africana) populations in northern Botswana : a research proposal*. Maun: Conservation International Botswana.

Envik, K. L. *Living with elephants : a non-government organization (NGO) based strategy for Botswana*. University of Calgary (Canada), 2000.

Hamel, S. K. *A participatory approach to community-based curriculum development for the living with elephants outreach program in Botswana*. Lakehead University, Canada, 2004.

Kalahari Conservation Society and the Department of Wildlife and National Parks., & Hancock, P. (1990). *The future of Botswana's elephants : proceedings of a workshop organised by the Kalahari Conservation Society in conjunction with the Department of Wildlife and National Parks 10 Nov. 1990, Gaborone*. Gaborone, BW: Kalahari Conservation Society and the Department of Wildlife and National Parks.

Kurusu, M., & College Semester Abroad Botswana. (1995). *Tourist participation in the Okavango Elephant Research Project an information board*.

Milliken, T. (1997). *The status of Ivory stocks in Africa 1990 - 1996*.

Natural Resources and People (Pty) Ltd., Botswana Dept. of Wildlife and Natural Parks., & Okavango Delta Management Plan Project Secretariat. (2006). *Final report December 2006 (Draft) Okavango Delta Management Plan : component 5 : wildlife management - human elephant conflict*. Maun: ODMP.

Parker, I. S. C., & Amin, M. (1983). *Ivory crisis*. London: Chatto & Windus.

Schlotterbeck, E. (1995). *Foraging habits of elephant in the Okavango Delta*.

Thomas, E., & School for International Training. (2006). *International willingness to pay for relocation as a method of elephant population management*. Maun: SIT Botswana.

### 1.4.2.1 DWNP Research Projects Related to Elephants

Mr Michael Chase	Population status, Ecology and Trans-boundary Movements of elephants in the Okavango River Basin	2001-2006
Ms Kate Evans	The Behaviour and Movements of Adolescent Male African Elephant of the Okavango Delta	2001-2005
Prof. R.J. van Aarde	The Population Demography of Elephants in the Northern Botswana	2005-2008

## 1.4.3 Lions

### 1.4.3.1 Research Publications Related to Lions

Adams, E. (1997). *A behavioural study of the lions of the Xudum pride in NG29*. School of International Training.

Evans, K. E., & University of Wales School of Biological Sciences. (2003). *Relating faecal endoparasite counts to the ecology of a pride of lion (Panthera leo) in north-eastern Botswana : a thesis*. Swansea: University of Swansea.

Kat, P., & Kat, P. (2000). *Prides : the lions of Moremi* (Johannesburg : ed.).

Setlhabi, P. K., & University of Botswana Harry Oppenheimer Okavango Research Centre. (2006). *Tourists' willingness to pay to conserve lions in Moremi Game Reserve: A contingent valuation study: Project Proposal*. Maun: HOORC.

### 1.4.3.2 DWNP Research Projects Related to Lions

Dr. Pieter Kat	Ecology Dynamics and interactions of lions and leopards population in Northern Botswana	1996-2005
Stephen J. O'Brien	FIV Infected lions: Clinical Assessment and Patterns of Replication and adaptive Evolution in Infected Tissue Compartments	2002-2006
Dr Mike Briggs	Multi Disciplinary Carnivore Conservation Research	2004-2007

## 1.4.4 Wild Dogs

### 1.4.4.1 Research Publications Related to Wild Dogs

Bulger, B. *Population status of the african wild dog (Lycaon pictus) in northern Botswana: distubution, abundance and conflicts*.

Creel, S., & Creel, N. M. (2002). *The African wild dog : behaviour, ecology, and conservation*. Princeton, N.J.: Princeton University Press.

McNutt, J. *Running wild: dispelling the myths of the African wild dog*.

### 1.4.4.2 DWNP Research Projects Related to Wild Dogs

Dr Mike Briggs	Multi Disciplinary Carnivore Conservation Research	2004-2007
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**1.4.5 Hippos**

**1.4.5.1 Research Publications Related to Hippos**

Badrinath, V. K., & College Semester Abroad Botswana. (1995). *Hippopotamus habitat relationships in the Okavango Delta*.

Martin, C. S. (1997). *Hippopotamus counts and identifications along six sites of the Okavango details Boro region*. School for International Training.

McCarthy, T. S., Ellery, W. N., & Bloem, A. *Some observations on the geomorphological impact of hippopotamus (Hippopotamus amphibius L.) in the Okavango Delta, Botswana*.

Robinson, M. (1996). *The importance of hippos in the nutrient transfer of the Okavango Delta*.

Walker, O., & Dunn, D. (1967). *The hippo poacher*. London: Cassell.

**1.4.6 Crocodiles**

**1.4.6.1 Research Publications Related to Crocodiles**

Blomberg, G. E. D. Population dynamics and management of the Okavango river crocodiles.[microform].

Blomberg, G. E. D., & Michigan State University. (1990). *Population dynamics and management of the Okavango river crocodiles in Botswana*. Unpublished Thesis (PH.D.), MICHIGAN STATE UNIVERSITY, 1990.

Graham, A., Patterson, L., Graham, J., & United Nations Development Programme. (1976). *Aerial photographic techniques for monitoring crocodile populations*. Gaborone, BW: Food and Agriculture Organization of the United.

Graham, A., & United Nations Development Programme. (1976). *Crocodile management plan for the Okavango river*. Gaborone, BW: Food and Agriculture Organization of the United.

Leslie, A. J., & University of Stellenbosch Dept. of Conservation Ecology. *Crocodiles of the Okavango : expedition briefing*. [s.l.]: University of Stellenbosch.

Smith, G. A., & University of Pretoria Dept. of Animal Science. (1991). *Report on Okavango Swamp crocodile farm : Managing Director, John J. Seaman*. Pretoria: University of Pretoria.

**1.4.6.2 DWNP Research Projects Related to Crocodiles**

Dr Alison Jane Leslie	The Ecology and Physiology of the Nile Crocodile in the Okavango Delta	2001-2005
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## 1.4.7 Fish

### 1.4.7.1 Research Publications Related to Fish

*Preliminary study on the distribution of the fish species on the headwaters and the upstream waters of the Thamalakane River.*) [s.l.].

*A preliminary study on the spawning grounds of some fish species on the Okavango.*) [s.l.].

As, J. G. v., Basson, L., & As, L. L. V. (2004). *Fish parasites of the Okavango river and delta, Botswana : Report on the fish parasite project.*

Basimane, O., & University of Botswana Harry Oppenheimer Okavango Research Centre. (2005). *Preliminary assessment of 'unit stock' in the Okavango Delta fishery, Botswana: Project Proposal.* Maun: HOORC.

Bernard, T., & Moetapele, N. (2005). Desiccation of the Gomoti River : Biophysical process and indigenous resource management in Northern Botswana. *Journal of Arid Environments*, 63, 256-283.

Bills, R. (1996). *Investigational report no. 56: fish stock assessment of the Okavango River : a contract for the Kalahari Conservation Society.* Grahamstown, SA: J L B Smith Institute of Ichthyology.

Bills, R., Skelton, P. H., & JLB Smith Institute of Ichthyology. (1985). *A fish identification course with emphasis on the fishes of the Okavango, Botswana (held at Shakawe May 23rd - June 3rd, 1998).* Grahamstown: JLB Smith Institute of Ichthyology.

Botswana. Dept. of Water Affairs., Brian, M., & Snowy Mountains Engineering Corporation. (1987). *Aquatic ecology - fisheries: Annexes E.* Gaborone: Ministry of Mineral Resources and water affairs.

Conservation International. (2003). *A rapid biological assessment of the aquatic ecosystems of the Okavango Delta, Botswana : high water survey.* Washington, DC:: Conservation International.

Fox, R. J., & Mathiessen, P. (1982). *Acute toxicity to fish of low-dose aerosol applications of endosulfan to control tsetse fly in Okavango Delta, Botswana.*

Hoberg, P., Ramberg, L., Hessen, D. O., & University of Botswana Harry Oppenheimer Okavango Research Centre. (2002). Aquatic food web dynamics on a floodplain in the Okavango Delta, Botswana. *Hydrobiologia*, 470(1-3), 23-30.

Inman, C. (1997). *Biodiversity of fish species in a receding flood plain habitat in sector NG32 of the Okavango Delta.* School for International TrainingãbCSA Botswana.

Joel, K. *Fish ecology within shallow water in the Boro River.* [s.l.].

Johnson, V., & School for International Training. (2006). *Spatial and temporal variations in the feeding ecology of the silver catfish (Schilbe intermedius) in the lower Okavango Delta,*

Botswana. Maun: SIT Botswana.

Johnston, B. R., & School for International Training. (2006). *Migratory behavior of the silver catfish (Schilbe intermedius) in the lower Okavango Delta*. Maun: SIT Botswana.

Keenleyside, M. H. A. (1991). *Cichlid fishes : behaviour, ecology and evolution*. London: Chapman & Hall.

Liversedge, T. N., & Southern African Ornithological Society. (1980). *A study of Pel's Fishing Owl Scotopelia peli Bonaparte 1850 in the 'Pan Handle' region of the Okavango Delta*. s.l.: Southern African Ornithological Society.

Mantuane, D. (1997). *Fish ecology within shallow water habitats in the lower Okavango Delta*.

Mazebedi, R., & University of Botswana Harry Oppenheimer Okavango Research Centre. (2005). *Fish migrations and habitat partitioning in a recently inundated floodplain of the Okavango : final project*. Maun: Harry Oppenheimer Okavango Research Centre.

Merron, G. S. *The ecology and management of the fishes of the Okavango Delta, Botswana with particular reference to the role of the seasonal floods*. Unpublished Thesis (Ph.D) - Rhodes University, 1991.

Merron, G. S. (1985). *Predator-prey interactions in the Okavango Delta : the annual catfish run, October-December, 1986*. Grahamstown: JLB Smith Institute of Ichthyology.

Merron, G. S. (1992). *Tsetse fly control and the environmental implications for fish in the Okavango Delta, Botswana*. Gaborone: The Botswana Society.

Merron, G. S. (1995). *The ecology and utilisation of the fishes of the wetlands of Northern Botswana with particular reference to the Okavango Delta*. Gaborone: Wetlands Coordinating Committee.

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Merron, G. S., & Bruton, M. N. *Community ecology and the conservation of the fishes of the Okavango Delta, Botswana*.

Merron, G. S., & Bruton, M. N. (1985). *Report on the October-November 1983 expedition to the Okavango Delta, Botswana*. Grahamstown: JLB Smith Institute of Ichthyology.

Merron, G. S., Bruton, M. N., & Skelton, P. H. (1985). *Progress report for the Okavango Fisheries Research Program for 1985*. Grahamstown: JLB Smith Institute of Ichthyology.

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Mosepele, K., & Conservation International. (2003). *AquaRAP II : rapid assessment of the aquatic ecosystems of the Okavango Delta, Botswana : preliminary report*. s.l.:: Conservation International.

Mosepele, K., Mosepele, B., Onalethata, B., Thethela, B., & University of Botswana Harry Oppenheimer Okavango Research Centre. (2005). Using population parameters to separate fish stocks in the Okavango Delta fishery : a preliminary assessment. *Botswana notes and records special edition on human interactions and natural resource dynamics in the Okavango Delta and Ngamiland*, 37, 292-305.

Mosepele, K., Mosepele, B., Williams, L., & University of Botswana Harry Oppenheimer Okavango Research Centre. (2005). Preliminary assessment of the feeding ecology of the silver catfish (*Schilbe intermedius*, Ruppel, 1832) in a seasonal floodplain of the Okavango Delta. *Botswana notes and records special edition on human interactions and natural resource dynamics in the Okavango Delta and Ngamiland*, 37, 208-217.

Mosepele, K. , 2000 , Preliminary length-based stock assessment of the main exploited stocks of the Okavango Delta Fishery (Edition statement. ed.). Bergen: Department of Fisheries and Marine Biology University of Bergen.

Naesje, T. F., & Sandlund, O. T. (1993). *Feasibility study of fish stock assessment programme in Okavango*. Trondheim, NO: Norwegian Institute for Nature Research.

Reed, C. *Fish myxosporeans from the Okavango delta, Botswana and the South coast of South Africa*. Butterworths, 2003.

Scudder, T., Manley, R. E., Coley, R. W., Davis, R. K., & Howard, G. W. (1992). *The IUCN review of the Southern Okavango Integrated Water Development Project: final report*. IUCN.

Shelmerdine, R., & University of, A. (1998). *A comparison of two flood plains in the Okavango Delta*. Aberdeen: University of Aberdeen.

Skelton, P. H., Merron, G. S., Bruton, M. N., Van der Waal, B. C. W., & JLB Smith Institute of Ichthyology. (1985). *The fishes of the Okavango drainage system in Angola, South West Africa and Botswana : taxonomy and distribution*. Grahamstown: JLB Smith Institute of Ichthyology.

Smit, N. J., Van As, J. G., & Davies, A. J. *Fish trypanosomes from the Okavango Delta, Botswana*.

Swedeplan Gaborone. (1989). *Programme for the planning of resource utilisation in the Okavango Delta region: natural resource and utilization inventory: volume 1 - Natural resource and utilisation inventory*.

Williams, L. M., & University of Botswana Harry Oppenheimer Okavango Research Centre. (2005). *Preliminary assessment of the feeding ecology of the Silver Catfish (Schilbe Intermedius) in the Okavango Delta, Botswana: Final Report*. Maun: HOORC.

#### 1.4.7.2 DWNP Research Projects Related to Fish

Lefatshe Innocent Magole	Okavango Aquarap 2000, Botswana	2000-2003
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#### 1.4.7.3 HOORC Research Projects Related to Fish

K. Mosepele	Floodplain fish ecology
K. Mosepele	The future of fishing in the Okavango River
Dr M. Moleele	BIOKAVANGO
K. Mosepele	Fish stock assessment

### 1.4.8 Cichlid

#### 1.4.8.1 Research Publications Related to Cichlid

Keenleyside, M. H. A. (1991). *Cichlid fishes: behaviour, ecology and evolution*. London: Chapman & Hall.

### 1.4.9 African Skimmer

#### 1.4.9.1 Research Publications Related to African Skimmer

Gall, B. (1995). *The influence and effects of disturbance on the population size and distribution of the African skimmer in the panhandle of the Okavango Delta: an update*.

#### 1.4.10 Pel’s Fishing Owl

##### 1.4.10.1 Research Publications Related to Pel’s Fishing Owl

Liversedge, T. N., & Southern African Ornithological Society. (1980). *A study of Pel's Fishing Owl Scotopelia peli Bonaparte 1850 in the 'Pan Handle' region of the Okavango Delta*. s.l.: Southern African Ornithological Society.

#### 1.4.11 Slaty Egret

##### 1.4.11.1 Research Publications Related to Slaty Egret

Birdlife Botswana. (2006). *Report on Slaty Egret breeding in Moremi Game Reserve, April 2006*. Maun: Birdlife Botswana.

Hancock, P., Mpofu, Z., Tyler, S. J., Meyer, T., & Okavango Delta Management Plan Project. (2006). *A baseline survey of the Slaty Egret in the Okavango Delta Ramsar site, Botswana : final report*. Maun: ODMP.

Okavango Delta Management Plan Project. (2005). *A baseline survey of the Slaty Egret in the Okavango Delta Ramsar site, Botswana : progress report 1*. Maun: ODMP.

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#### 1.4.12 Wattled Crane

##### 1.4.12.1 Research Publications Related to Wattled Crane

Hancock, P., Z. Mpofu, et al. (2006). *A baseline survey of the Slaty Egret in the Okavango Delta Ramsar site, Botswana: final report*. Maun, ODMP. (HOORC-L)

Scott, H. (1998). *Wattled crane behaviour and ecology*.

##### 1.4.12.2 DWNP Research Projects Related to Wattled Crane

P. Hancock	Ecology and Population Dynamics of the Endangered Wattled Crane <i>Bugeranus carunculatus</i> -Botswana	2002-2006
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### 1.5 Biodiversity Indicators

#### 1.5.1 Rodents

##### 1.5.1.1 Research Publications Related to Rodents

Plavsic, M., & Hamman, D. *Footprints in the ashes: fire and mice in the Okavango Delta*.

## 1.5.1.2 DWNP Research Projects Related to Rodents

Dr Cornelius Vanderpost	The Effects of Fire Regime on Vegetation and Small Mammals in the Okavango Delta, Botswana	2005-2006
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## 1.5.2 Termites

### 1.5.2.1 Research Publications Related to Termites

Dangerfield, J. M., & Schuurman, G. W. (2000). *Foraging by fungus - growing termites (Isoptera : termitidae, macrotermitidae) in the Okavango, Botswana*. Washington: Cambridge University Press.

Schuurman, G. W. *Foraging and distribution patterns in a termite assemblage dominated by fungus-growing species in semi-arid northern Botswana*.

Schuurman, G. W. *Termite diets in dry habitats of the Okavango Delta region of northern Botswana : a stable carbon isotope analysis*.

Settle, H., & Holtzer, C. (1997). *Termite distribution and foraging patterns in the Okavango*. School of International TrainingãbCSA Botswana.

## 1.5.3 Papyrus

### 1.5.3.1 Research Publications Related to Papyrus

Ellery, W. N., Ellery, K., Rogers, K. H., & McCarthy, T. S. (1995). *The role of Cyperus papyrusL. in channel blockage and abandonment in the Northwestern Okavango Delta, Botswana*.

Ellery, W. N., & University of the Witswatersrand Faculty of Science. (1988). *Channel blockage and abandonment in the north-eastern Okavango Delta : the role of cyperus papyrus : a dissertation submitted to the Faculty of Science, University of the Witswatersrand, Johannesburg, for the degree of Master of Science*. Johannesburg: University of the Witswatersrand.

## 2 Physical and chemical processes and features

### 2.1 Sediment Transport

#### 2.1.1 Research Publications Related to Sediment Transport

Cairncross, B., & Cairncross, B. (1988). *Palaeochannels (stone-rolls) in coal seams : Modern analogues from fluvial deposits of the Okavango Delta, Botswana, Southern Africa.*

Gumbrecht, T. M. T. S., & Merry, C. L. *The topography of the Okavango Delta, Botswana, and its tectonic and sedimentological implications.*

Shaw, P. (1988). *After the flood: the fluvio-lacustrine landforms of northern Botswana.* Amsterdam: Elsevier Science Publishers.

### 2.2 Sediments

#### 2.2.1 Research Publications Related to Sediments

Daka, P. S. (2003). *A study of Deltamethrin in sediment from the Okavango Delta Botswana.* Unpublished Thesis - (Msc)Analytical chemistry, University of Botswana, Faculty of Science, Department of Chemistry, Gaborone, 2003.

Daka, P. S., Huntsman-Mapila, P., Obuseng, V. C., & Torto, N. (2006). Deltamethrin in sediment samples of the Okavango Delta, Botswana. *Water SA*, 32(4), 6 p.

Gumbrecht, T. M. T. S., & Merry, C. L. *The topography of the Okavango Delta, Botswana, and its tectonic and sedimentological implications.*

Huntsman-Mapila, P., Mapila, T., Letshwenyo, M., Wolski, P., Hemond, C., & Harry Oppenheimer Okavango Research Centre. (2006). Characterization of arsenic occurrence in the water and sediments of the Okavango Delta, NW Botswana. *Applied Geochemistry*, 21(2), 1376 - 1391.

Huntsman-Mapila, P., Ringrose, S., & Vanderpost, C., 2006 , Use of the geochemical and biological sedimentary record in establishing palaeo-environments and climate change in the Lake Ngami basin, NW Botswana. *Quaternary international*, 148(1), 51-64.

Huntsman-Mapila, P., Kampunzu, A. B., Vink, B., & Ringrose, S., 2005 , Cryptic indicators of provenance from the geochemistry of the Okavango Delta sediments, Botswana. *Sedimentary geology*, 174(1-2), 123-148.

Laletsang, K., & Memorial University of Newfoundland. (1995). *Groundwater investigations using geophysical techniques at Marophe, the Okavango Delta, Botswana.* Unpublished Masters Thesis (M.SC.), MEMORIAL UNIVERSITY OF NEWFOUNDLAND (CANADA), 1995.

Nash, D. J., Gulliver, V. L., & Meadows, M. E. *Holocene environmental change in the*

*Okavango Panhandle, northwest Botswana.*

Ringrose, S., Huntsman-Mapila, P., Kampunzu, A. B., Downey, W., Coetzee, S., Vink, B., et al. (2005). Sedimentological and geochemical evidence for palaeo-environmental change in the Makgadikgadi subbasin, in relation to the MOZ rift depression, Botswana. *Palaeography, Palaeocology*, 217(3-4), p.265-287.

Swedeplan Gaborone Bw. (1989). *Topography and geomorphology*.

## 2.2.2 HOORC Research Projects Related to Sediments

Dr P. Huntsman-Mapila	Rift basins, climate change and tectonics
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## 2.3 Water Quality

### 2.3.1 Research Publications Related to Water Quality

Anderson, T. A., & University of Botswana Harry Oppenheimer Okavango Research Centre. (2004). *Willingness to pay for improved water quality and reliability of supply in Maun : final report*. Maun: HOORC.

Andersson, J. (2006). *Land cover change in the okavango river basin: Historical changes during the angolan civil war contributing causes and effects on water quality*. Gaborone: SIDA.

Andersson, J., & Linkoping University. (2006). *Land cover change in the Okavango River Basin : historical changes during the Angolan Civil War : contributing causes and effects on water quality : Masters thesis in Water Resources and Livelihood Security, Linkoping University*. Linkoping: Linkoping University.

Bruch, C. (2005). *Public participation in the governance of international freshwater resources*. Tokyo ; New York: United Nations University Press.

Fernkvist, P., & Liden, A. (2003). *Inorganic ions and nutrients in ground water of Okavango Delta Islands, Botswana*. Sweden

Huntsman-Mapila, P., University of Botswana Harry Oppenheimer Okavango Research Centre., & Conservation International. (2005). *Surface water quality of the Okavango Delta, Botswana : AquaRAP II, low water survey*. Maun: HOORC.

Huntsman-Mapila, P., Mapila, T., Letshwenyo, M., Wolski, P., Hemond, C., & Harry Oppenheimer Okavango Research Centre. , 2006 , Characterization of arsenic occurrence in the water and sediments of the Okavango Delta, NW Botswana. *Applied Geochemistry*, 21(2), 1376 - 1391.

Inman, C. (1997). *Biodiversity of fish species in a receding flood plain habitat in sector NG32 of the Okavango Delta*. School for International TrainingãbCSA Botswana.



Kiptoo, J. K., Ngila, J. C., Masamba, W. R. L., Sawula, G. M., & Harry Oppenheimer Okavango Research Centre. (2005). Comparative studies of the speciation patterns of nickel and chromium in surface-, ground- and wastewater systems in Botswana/ Kiptoo, Jackson K. et al. *South African Journal of Chemistry*, 58(1), 120-126p.

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Masamba, W. R. L., Muzila, A., & University of Botswana Harry Oppenheimer Okavango Research Centre. (2005). Spatial and seasonal variation of major cation and selected trace metal ion concentrations in the Okavango-Maunachira-Khwai channels of the Okavango Delta. *Botswana notes and records special edition on human interactions and natural resource dynamics in the Okavango Delta and Ngamiland*, 37, 218-227.

Masamba, W. R. L., Sajidu, S. M., Thole, B., Mwatseteza, J. F., & Harry Oppenheimer Okavango Research Centre. *Water defluoridation using Malawi's locally sourced gypsum/ Masamba, W.R.L., S.M. Sajidu, B. Thole, and J.F. Mwatseteza.*

Reavell, P. E., Lee, R. E., White, R. E., & University of Witswatersrand Dept. of Botany. (1974). *Okavango hydrobiological project : first yearly report, 1972 - 1973*. Johannesburg: University of Witswatersrand.

Sechele, B., & University of Botswana Harry Oppenheimer Okavango Research Centre. (2005). *Impact of tourist's camps on the water quality of the Okavango Delta :, final report l*. Maun: HOORC.

Shelmerdine, R., & University of, A. (1998). *A comparison of two flood plains in the Okavango Delta*. Aberdeen: University of Aberdeen.

Swedeplan Gaborone BW. (1989). *Hydrology*.

### 2.3.2 DWNP Research Projects Related to Water Quality

Dr Phillimon T. Odirile	Influent Copnstituent Characteristics of the Modern Waste Streams from Single Sources
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### 2.3.3 HOORC Research Projects Related to Water Quality

Dr W. Masamba	Assessing groundwater quality in Okavango islands
Dr W. Masamba	Monitoring water quality in the Okavango Delta
Dr P. Huntsman-Mapila	Pesticides in the Okavango Delta
Dr W. Masamba	Persistent Organic Polutants
Dr W. Masamba	Methane flux: Okavango Delta
Dr P. Huntsman-Mapila	Arsenic in groundwater in the MOZ basin

## 2.4 Flood Distribution and Frequency

### 2.4.1 Research Publications Related to Flood Distribution and Frequency

Bartsch, A., Wolski, P., Wagner, W., Scipal, K., Pathe, C., & Sabe, D. (2006). ENVISAT ASAR global mode capabilities for global monitoring of wetlands. In *Proceedings of GlobWetland : Looking at Wetlands from Space (SP-634, November 2006)* (pp. 6 p.). Noordwijk, The Netherlands: European Space Agency.

Gumbrecht, T., Wolski, P., Frost, P., & McCarthy, T. S. (2004). Forecasting the spatial extent of the annual flood in the Okavango Delta, Botswana. *Journal of hydrology* 290, 178-191.

Mladenov, N., & University of Colorado Dept. of Civil Environmental and Architectural Engineering. (2004). *Evaluating the effects of hydrologic change in the Okavango Delta of Botswana : analysis of aquatic organic matter transport and ecosystem economics*. Boulder: University of Colorado at Boulder.

Murray-Hudson, M., Wolski, P., & Ringrose, S. (2006). Scenarios of the impact of local and upstream changes in climate and water use on hydro-ecology in the Okavango Delta, Botswana. *Journal of hydrology*, 331, 73-84.

Ramberg, L., Wolski, P., & Krah, M. (2006). Water balance and infiltration in a seasonal floodplain in the Okavango Delta, Botswana. *Wetlands*, 26(3), 677-690.

Scudder, T., Manley, R. E., Coley, R. W., Davis, R. K., & Howard, G. W. (1992). *The IUCN review of the Southern Okavango Intergrated Water Development Project: final report*. Iucn.

Timmermans, W. J., Parodi, G. N., Arneth, A., Wolski, P., Kustas, W. P., & Gieske, A. S. (2004, February 2004). *Determination of water and heat fluxes with MODIS imagery - Maun, Botswana*. Paper presented at the Proceedings of SPIE : Remote Sensing for Agriculture, Ecosystems, and Hydrology V, Enschede, Netherlands International Institute for Geo-information Science and Earth Observation.

Wolski, P., Gumbrecht, T., & McCarthy, T. S. (2003). Assessing future change in the Okavango Delta : the use of a regression model of the maximum annual flood in a Monte Carlo simulation. In T. Bernard, K. Mosepele & L. Ramberg (Eds.), *Environmental Monitoring of Tropical and Subtropical Wetlands : proceedings of a conference in Maun, Botswana, December 4-8, 2002* (pp. 113-131). Maun: University of Botswana Harry Oppenheimer Okavango Research Centre.

Wolski, P., Masaka, T., Raditsebe, L., Murray-Hudson, M., & Centre, U. o. B. H. O. O. R. (2005). Aspects of seasonal dynamics of flooding in the Okavango Delta. In *Botswana notes and records special edition on human interactions and natural resource dynamics in the Okavango Delta and Ngamiland* (Vol. 37, pp. 179-195). Gaborone: Botswana Society.

Wolski, P., & Murray-Hudson, M. (2006). Flooding dynamics in a large low-gradient alluvial fan, the Okavango Delta, Botswana, from analysis and interpretation of a 30-year hydrometric record. *Hydrology and earth system sciences*, 10, 127-137.

Wolski, P., & Murray-Hudson, M. (2006). Recent changes in flooding in the Xudum distributary of the Okavango Delta and Lake Ngami, Botswana. *South African journal of science*, 102, 173-176.

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Wolski, P., & Savenije, H. H. G. (2006). Dynamics of floodplain-island groundwater flow in the Okavango Delta, Botswana. *Journal of hydrology*, 320(3-4), 283-301.

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## 2.4.2 HOORC Research Projects Related to Flood Distribution and Frequency

Dr P. Wolski	Flooding dynamics in Santantadibe and Gomoti
Dr D. Mazvimavi	Long-term variations of rivers flows
Dr P. Wolski	Monitoring Seasonal Floodplain Hydrology
Dr P. Wolski	Monitoring African Wetlands Using Radar Images
Dr P. Wolski	Darwin Biodiversity

## 2.5 Hydrological Model

### 2.5.1 Research Publications Related to Hydrological Model

Andersson, L. (2006). Impact of climate change and development scenarios on flow patterns in the Okavango River. *Journal of hydrology*, 331, 43-57.

Hughes, D. A., Savenije, H. H. G., Andersson, L., & Wilk, J. *Regional calibration of the Pitman model for the Okavango River*.

Murray-Hudson, M., Wolski, P., & Ringrose, S. (2006). Scenarios of the impact of local and upstream changes in climate and water use on hydro-ecology in the Okavango Delta, Botswana. *Journal of hydrology*, 331, 73-84.

Timmermans, W. J., Parodi, G. N., Arneth, A., Wolski, P., Kustas, W. P., & Gieske, A. S. (2004, February 2004). *Determination of water and heat fluxes with MODIS imagery - Maun, Botswana*. Paper presented at the Proceedings of SPIE : Remote Sensing for Agriculture, Ecosystems, and Hydrology V, Enschede, Netherlands International Institute for Geo-information Science and Earth Observation.

Wilk, J., Hughes, D. A., Andersson, L., Layberry, R., Todd, M. C., Ringrose, S., et al. (2006). Estimating rainfall and water balance over the Okavango River Basin for hydrological applications. *Journal of hydrology*, 331, 12 p.

Wolski, P. (2003). *Update of conceptual hydrological model of the Delta: Water and Ecosystem resources for regional development*. Maun: Okavango Research Centre.

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## 2.6 Tectonics

### 2.6.1 Research Publications Related to Tectonics

Gumbricht, T. M. T. S., & Merry, C. L. *The topography of the Okavango Delta, Botswana, and its tectonic and sedimentological implications*.

Scholtz, C. H., United Nations Development Programme., Food and Agriculture Organization of the United Nations., Botswana. Geological Survey Dept., & Columbia University Lamont-Doherty Geological Observatory. (1975). *Seismicity, tectonics and seismic hazard of the Okavango Delta*. Food and Agriculture Organization of the United Nations with the Government of Botswana.

Huntsman-Mapila, P., Ringrose, S., & Vanderpost, C. , 2006 , Use of the geochemical and biological sedimentary record in establishing palaeo-environments and climate change in the Lake Ngami basin, NW Botswana. *Quaternary international*, 148(1), 51-64.

Huntsman-Mapila, P., Kampunzu, A. B., Vink, B., & Ringrose, S. , 2005 , Cryptic indicators of provenance from the geochemistry of the Okavango Delta sediments, Botswana. *Sedimentary geology*, 174(1-2), 123-148.

## 2.6.2 HOORC Research Projects Related to Tectonics

Dr P. Huntsman-Mapila	Rift basins, climate change and tectonics
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## 2.7 Climate Change

### 2.7.1 Research Publications Related to Climate Change

Andersson, L. (2006). Impact of climate change and development scenarios on flow patterns in the Okavango River. *Journal of hydrology*, 331, 43-57.

Huntsman-Mapila, P., Kampunzu, A. B., Vink, B., & Ringrose, S. , 2005 , Cryptic indicators of provenance from the geochemistry of the Okavango Delta sediments, Botswana. *Sedimentary geology*, 174(1-2), 123-148.

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### 2.7.2 HOORC Research Projects Related to Climate Change

Dr P. Huntsman-Mapila	Rift basins, climate change and tectonics
Prof. S. Ringrose	Drying gradients (HELOD)

## 2.8 Surface Water - Groundwater

### 2.8.1 Research Publications Related to Surface Water – Groundwater

Andersson, L., Gumbrecht, T., Hughes, D., Kniveton, D., Savenije, H., Todd, M., et al. (2003). Water flow dynamics in the Okavango River Basin and Delta a prerequisite for the ecosystems of the Delta. *Physics and chemistry of the earth*, 28, 1165-1172.

Botswana. Dept. of Water Affairs., & Water Resources Consultants (pty) Ltd. (2004). *Maun groundwater development project Phase 2 : Resource assessment and wellfield development. Final Report, volume 6 - Hydrogeological report (Part 2 : Upper Thamalakane Exploration Area. ed.)*. Gaborone, BW: Dept. of Water Affairs.

Fernkvist, P., & Liden, A. (2003). *Inorganic ions and nutrients in ground water of Okavango Delta Islands, Botswana*. Sweden

Heusser, D., Langer, T., & Swiss Federal Institute of Technology Dept. of Environmental Sciences. (2004). *Geochemical groundwater evolution and age estimations for islands in the Okavango Delta : diploma thesis in the Department of Environmental Sciences, Swiss Federal Institute of Technology, Zurich*. Zurich: Swiss Federal Institute of Technology.

Hughes, D. A., Savenije, H. H. G., Andersson, L., & Wilk, J. *Regional calibration of the Pitman model for the Okavango River*.

Laletsang, K., & Memorial University of Newfoundland. (1995). *Groundwater investigations using geophysical techniques at Marophe, the Okavango Delta, Botswana*. Unpublished Masters Thesis (M.SC.), MEMORIAL UNIVERSITY OF NEWFOUNDLAND (CANADA), 1995.

Leenaers, H. (1986). *Groundwater flow and soil water availability: the hydrology of an arable area along the Thaoge River, Okavango Delta, Botswana*. Utrecht: State University of Utrecht.

McCarthy, T. S. *Groundwater in the wetlands of the Okavango Delta, Botswana, and its contribution to the structure and function of the ecosystem*.

McCarthy, T. S., & Ellery, W. N. *The effect of vegetation on soil and ground water chemistry and hydrology of islands in the seasonal swamps of the Okavango Fan, Botswana*.

Murray-Hudson, M., Wolski, P., & Ringrose, S. (2006). Scenarios of the impact of local and upstream changes in climate and water use on hydro-ecology in the Okavango Delta, Botswana. *Journal of hydrology*, 331, 73-84.

Ramberg, L., Wolski, P., & Krahl, M. (2006). Water balance and infiltration in a seasonal floodplain in the Okavango Delta, Botswana. *Wetlands*, 26(3), 677-690.

Ringrose, S., Huntsman-Mapila, P., Kampunzu, A. B., Downey, W., Coetzee, S., Vink, B., et al. (2005). Sedimentological and geochemical evidence for palaeo-environmental change in the Makgadikgadi subbasin, in relation to the MOZ rift depression, Botswana. *Palaeography, Palaeocology*, 217(3-4), p.265-287.

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Sefe, F. T. K. (1996). *Maun groundwater development project: phase I: exploration and resource management: draft final report*. Gaborone: Department of Water Affairs, Ministry of Mineral Resources and Water Affairs.

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Wolski, P. (2003). *Surface water-groundwater interactions in the Okavango Delta*. Maun: Harry Oppenheimer Okavango Research Centre.

Wolski, P. (2003). *Update of conceptual hydrological model of the Delta: Water and Ecosystem resources for regional development*. Maun: Okavango Research Centre.

Wolski, P., & Savenije, H. H. G. (2006). Dynamics of floodplain-island groundwater flow in the Okavango Delta, Botswana. *Journal of hydrology*, 320(3-4), 283-301.

Wolski, P., Savenije, H. H. G., Murray-Hudson, M., & Gumbricht, T. (2006). Modelling of the flooding in the Okavango Delta, Botswana, using a hybrid reservoir-GIS model. *Journal of hydrology*, 331, 58-72.

## 2.9 Salinisation

### 2.9.1 Research Publications Related to Salinisation

Ringrose, S., Vanderpost, C., Mathson, W., Wolski, P., Huntsman-Mapila, P., Murray-Hudson, M., et al. (2007). Indicators of desiccation-driven change in the distal Okavango Delta, Botswana. *Journal of arid environments*, 68(1), 88-112.

### 2.9.2 HOORC Research Projects Related to Salinisation

Dr W. Masamba	Assessing groundwater quality in Okavango islands
Dr W. Masamba	Monitoring water quality in the Okavango Delta



### 3 Social and economic processes that exploit or derive benefits from the ecosystem

#### 3.1 Livelihood

##### 3.1.1 Research Publications Related to Livelihood

Bendsen, H., Meyer, T., & University of Botswana Harry Oppenheimer Okavango Research Centre. (2002). *The dynamics of the land use systems in Ngamiland, Botswana : changing livelihood options and strategies.*

Cassidy, L., & University of Florida. (2003). *Anthropogenic burning in the Okavango panhandle of Botswana : livelihoods and spatial dimensions : a thesis presented to the Graduate School of the University of Florida in partial fulfilment of the requirements for the degree of Master of Science.* Gainesville: University of Florida.

Kgathi, D. L., Mbaiwa, J., N., N. B., J., W., & Sweden, L. U. L. (2004). *Rural livelihoods, indigenous knowledge systems, and political economy of access to natural resources in the Okavango Delta, Botswana.* Maun, BW: Harry Oppenheimer Okavango Research Centre, University of Botswana.

Kgathi, D. L., Ringrose, S., Kniveton, D., Turton, A. R., Ringrose, S., Kniveton, D. R., et al. *The Okavango : a river supporting its people, environment and economic development.*

Kgomotso, P. K., & Swatuk, L. A. *Access to water and related resources in Ngamiland, Botswana : toward a more critical perspective and sustainable approach.*

Magole, L., Ngwenya, B. N., & University of Botswana Harry Oppenheimer Okavango Research Centre. (2005). The impact of extreme flooding of the Okavango River on the livelihood of the molapo farming community of Tubu village, Ngamiland sub-district. *Botswana notes and records special edition on human interactions and natural resource dynamics in the Okavango Delta and Ngamiland*, 37, 125-137.

Mangadi, K. (2004). *The economic contribution of safari hunting to rural livelihoods in the Okavango, Botswana : the case of Sankuyo Village, final report, Applied Research Methods Course.* Maun, BW: Harry Oppenheimer Okavango Research Centre.

Mbaiwa, J. E. *Prospects of basket production in promoting sustainable rural livelihoods in the Okavango Delta, Botswana.*

Mbaiwa, J. E. (2004). Prospects of basket production in promoting sustainable rural livelihoods in the Okavango Delta, Botswana. *International Journal of Tourism Research*, 6(4), 14 p., Map, tables.

Moepeng, S., & University of Botswana Harry Oppenheimer Okavango Research Centre. (2006). *Evaluating basket making as a livelihood strategy and its role on poverty alleviation: the case of Etsha 6 basket weavers: Final report.* Maun: Hoorc.

Mosepele, K., & Ngwenya, B. N. , 2006 , Artisanal fishing and food security in the Okavango Delta, Botswana. In A. Ahmed (Ed.), World sustainable development outlook 2006 (pp. 159-168). Geneva: Inderscience Enterprises.

Motlamme, T., & University of Botswana Harry Oppenheimer Okavango Research Centre. (2006). *The evolution of land use and livelihoods in the Lake Ngami area: final report*. Maun: HOORC.

Petraglia, J., & School for International Training. (2002). *Traditional BaYei livelihood strategies: an ethnographic study of human-ecological niches in Sankoyo*. [Maun]: School for International Training.

Sorensen, F. L., & University of Copenhagen Dept. of Geography. (2003). *Community based tourism and prospects for sustainable livelihoods : the case of the Okavango Polers Trust in Botswana : Master of Science thesis, Dept. of Geography, University of Copenhagen*. Copenhagen: University of Copenhagen.

Thakadu, O. T., Mangadi, K. T., Bernard, F. E., Mbaiwa, J. E., & University of Botswana Harry Oppenheimer Okavango Research Centre. *The economic contribution of safari hunting to rural livelihoods in the Okavango : the case of Sankoyo Village*.

Tshologelo, M., & University of Botswana Harry Oppenheimer Okavango Research Centre. (2005). *The contribution of the Boteti river to the livelihoods of the Chanoga community: final report*. Maun: HOORC.

### 3.1.2 DWNP Research Projects Related to Livelihood

Jeffrey Burm	Analysis of the Impact of Veterinary Fences on the Ability of remote Communities to Sustain Traditional Lifestyles	1999-2000
Delpnine Glain-Dubray	The Impact of Tourism on the Moremi Game Reserve and Surrounding Villages	2000-2001
Mr Lefatshe Innocent Magole	Ecotourism and Socio-Economic Development of Basarwa: the case of Gudigwa Village	2004-2005

### 3.1.3 HOORC Research Projects Related to Livelihood

Prof. D.L Kgathi	HELOD
Dr B. Ngwenya	Socio-economic survey of fisheries

## 3.2 Resource Use Economics

### 3.2.1 Research Publications Related to Resource Use Economics

Mbaiwa, J. E. (2005). Wildlife resource utilisation at Moremi Game Reserve and Khwai community area in the Okavango Delta, Botswana. *Journal of Environmental Management*, 77(2), 144-156.

Mmopelwa, G. (2006). Economic and financial analysis of harvesting and utilisation of river reed in the Okavango Delta. *Journal of environmental management*, 79(4), 329-335.

Mangadi, K. (2004). *The economic contribution of safari hunting to rural livelihoods in the Okavango, Botswana : the case of Sankuyo Village, final report, Applied Research Methods Course*. Maun, BW: Harry Oppenheimer Okavango Research Centre.

Moepeng, S., & University of Botswana Harry Oppenheimer Okavango Research Centre. (2006). *Evaluating basket making as a livelihood strategy and its role on poverty alleviation: the case of Etsha 6 basket weavers: Final report*. Maun: Hoorc.

### 3.2.2 DWNP Research Projects Related to Resource Use Economics

Mr Lefatshe Innocent Magole	Ecotourism and Socio-Economic Development of Basarwa: the case of Gudigwa Village	2004-2005
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### 3.2.3 HOORC Research Projects Related to Resource Use Economics

Dr G. Mmopelwa	Livestock grazing value
Dr G. Mmopelwa	water and vegetation values

## 3.3 Governance

### 3.3.1 Research Publications Related to Governance

Bruch, C. (2005). *Public participation in the governance of international freshwater resources*. Tokyo ; New York: United Nations University Press.

Kgomotso, P. K., & Swatuk, L. A. *Access to water and related resources in Ngamiland, Botswana : toward a more critical perspective and sustainable approach*.

Swatuk, L. A. *Whose values matter most? : Water and resource governance in the Okavango River Basin*.

Swatuk, L. A., & Harry Oppenheimer Okavango Research Centre University of Botswana. (2005). From "Project" to "Context": Community Based Natural Resource Management in Botswana/ Larry A. Swatuk. *Global Environmental Politics*, 5(3), 29 p.

### 3.3.2 DWNP Research Projects Related to Governance

E. Soderstrom	International river basin management :lessons learned applied to Okavango River Basin	
M. Schroeder	Participatory approach to wildlife management	1999-2000
Lapologang Magole	Problem of Plan Implementation: The Case of Okavango River Panhandle Management Plan	2004-2006

### 3.3.3 HOORC Research Projects Related to Governance

Prof L. Swatuk	Competing Claims
Prof L. Swatuk	CROSCOG
Dr D. Mazvimavi	Ephemeral river basins in SADC
Prof L. Swatuk	Toward Best Practice

## 3.4 Settlement Trends and Pattern

### 3.4.1 Research Publications Related to Settlement Trends and Settlement Pattern

Cook, E. J. (1991). *Environmental Conservation: the road to survival*.

Larson, T. J. (1990). *Settlement patterns and domiciles of the Hambukushu of Ngamiland*.

Mazvimavi, D., & Mmopelwa, G. , 2006 , Access to water in gazetted and ungazetted rural settlements in Ngamiland, Botswana. *Physics and Chemistry of the Earth*, 31, 713-722.

Vanderpost, C. (2004). Human sprawl and the African wilderness of the Okavango. *South African geographical journal*, 86, 122-130.

Vanderpost, C. , 2006 , Pathways of human sprawl in wilderness buffer zones. *Population and environment*, 27, 285-306.

### 3.4.2 HOORC Research Projects Related to Settlement Trends and Settlement Pattern

Dr C. Vanderpost	Human Footprint Ngamiland
Dr D. Mazvimavi	Water use along Thamalakane-Boteti River.

### 3.5 Land Cover Change

#### 3.5.1 Research Publications Related to Land Cover Change

Anderson, J., & Linkoping University. (2006). *Land cover change in the Okavango River Basin : historical changes during the Angolan Civil War : contributing causes and effects on water quality : Masters thesis in Water Resources and Livelihood Security, Linkoping University*. Linkoping: Linkoping University.

Bendsen, H., Meyer, T., & University of Botswana Harry Oppenheimer Okavango Research Centre. (2002). *The dynamics of the land use systems in Ngamiland, Botswana : changing livelihood options and strategies*.

Cassidy, L., & University of Florida. (2003). *Anthropogenic burning in the Okavango panhandle of Botswana : livelihoods and spatial dimensions : a thesis presented to the Graduate School of the University of Florida in partial fulfilment of the requirements for the degree of Master of Science*. Gainesville: University of Florida.

Ringrose, S., Vanderpost, C., Matheson, W., & University of Botswana Harry Oppenheimer Okavango Research Centre. , 1997 , Use of image processing and GIS techniques to determine the extent and possible causes of land management/fenceline induced degradation problems in the Okavango area, northern Botswana.

Ringrose, S., Sefe, F. T. K., & Ekosse, G. , 1995 , Progress towards the evaluation of desertification in Botswana.

Ringrose, S., Jellema, A., Huntsman-Mapila, P., Baker, L., & Brubaker, K. , 2005 , Use of remotely sensed data in the analysis of soil-vegetation changes along a drying gradient peripheral to the Okavango Delta, Botswana/ Susan Ringrose, Andre Jellema, Philippa Huntsman-Mapila, Lauren Baker, and Kristin Brubaker. *International Journal of Remote Sensing*, 26(19), p4293-4319.

Ringrose, S., Vanderpost, C., Mathson, W., Wolski, P., Huntsman-Mapila, P., Murray-Hudson, M., Jellema, A., & Harry Oppenheimer Okavango Research Centre. , 2007 , Indicators of desiccation-driven change in the distal Okavango Delta, Botswana. *Journal of arid environments*, 68(1), 88-112.

Sefe, F. T. K., Ringrose, S., & Matheson, W. , 1996 , Desertification in North-Central Botswana: causes, processes and impacts

#### 3.5.2 HOORC Research Projects Related to Land Cover Change

Dr C. Vanderpost	Sharing Water
Dr C. Vanderpost	Range degradation
Prof. S. Ringrose	Angola-Okacom training
Prof. S. Ringrose	SADC Headstreams Soil-Water Management

## 3.6 Fisheries

### 3.6.1 Research Publications Related to Fisheries

Fisheries Division Department of Wildlife and National Parks. *Performance audit report management of fisheries* (2005.). Gaborone.

Botswana. Dept. of Water Affairs., Brian, M., & Snowy Mountains Engineering Corporation. (1987). *Aquatic ecology - fisheries: Annexes E*. Gaborone: Ministry of Mineral Resources and water affairs.

Bruch, C. (2005). *Public participation in the governance of international freshwater resources*. Tokyo ; New York: United Nations University Press.

Kgathi, D. L., Mmopelwa, G., & Mosepele, K. (2005). Natural resources assessment in the Okavango Delta, Botswana : case studies of some key resources. *Natural Resources Forum*, 29(1), 70-81.

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Dr M. Moleele	BIOKAVANGO
K. Mosepele	Fish stock assessment
Dr B. Ngwenya	Socio-economic survey of fisheries

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Prof M.B.K. Darkol & J.E. Mbaiwa	Natural Resource Utilisation and Land Use Conflicts in the Okavango Delta, Botswana	2004-2005

**3.8.3 HOORC Research Projects Related to Exploitation of Natural Resources**

Dr W. Masamba	Utilisation of tswii
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Delpnine Glain-Dubray	The Impact of Tourism on the Moremi Game Reserve and Surrounding Villages	2000-2001
Prof F.E. Bernard	Limits of Acceptable Change in Tourism in the Okavango Delta-Botswana	2003-2004
Wanjiku Kiambo	Regional Tourism in South Africa as a source of, and Destination of Regional Tourists	2004
Lefatshe Innocent Magole	Ecotourism and Socio-Economic Development of Basarwa: the case of Gudigwa Village	2004-2005
Hanne Bruvik	Tourism as a development strategy in Botswana	2005
Lefatshe Innocent Magole	The Case of Moremi Game Reserve	2005-2006

### 3.10.3 HOORC Research Projects Related to Tourism

Dr M. Moleele	BIOKAVANGO
Dr S. Keitumetse	Cultural Heritage Conservation & Tourism

## 3.11 CBNRM

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### 3.11.2 DWNP Research Projects Related to CBNRM

Mr Saul Cohen	"Competitive Natures? The Impact of local and scientific knowledge upon Botswana's community Based Natural resources Management program"	2003-2004
Ms Elizabeth Frances Pienaar	Improving the Performance of Integrated Conservation and Development Projects; Evidence from the Implementation of Community Based Natural Resource Management (CBNRM) Programs in Botswana	2005

### 3.11.3 HOORC Research Projects Related to CBNRM

Dr B. Ngwenya	HIV/AIDS and CBNRM
Dr S. Keitumetse	BiOcultural resources Mgt & Community Tourism -MCT

## 3.12 HIV/AIDS

### 3.12.1 Research Publications Related to HIV/AIDS

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Watanabe, S., & University of Northern British Columbia. (2005). *HIV/AIDS in rural Botswana: poverty, gender inequality, marginalization and stigma : project submitted in partial fulfillment of the requirements for the degree of Master of Arts in International Studies, the University of Northern British Columbia*. Prince George, B.C.: University of Northern British Columbia.

### **3.12.2 DWNP Research Projects Related to HIV/AIDS**

Anna Birgit Sundby	An investigation of the impacts of HIV/AIDS on Community-based Natural Resources Management(CBNRM) in the Okavango Delta, Botswana	2005
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### **3.12.3 HOORC Research Projects Related to HIV/AIDS**

Dr B. Ngwenya	HIV/AIDS and CBNRM
Dr B. Ngwenya	HIV/AIDS Coping Strategies
Dr B. Ngwenya	Orphan Care Study

## **3.13 Human-Wildlife Conflict**

### **3.13.1 Research Publications Related to Human-Wildlife Conflict**

Bendsen, H., (2005), Observations, suggestions and concerns from communities regarding ODMP activities grouped according to components. Maun: HOORC.

Centre for Conservation of African Resources: Animals Communities and Land Use (CARACAL), & Okavango Delta Management Plan Project. (2006). *ODMP wildlife management component: leopard and cheetah baseline inventory in the Okavango Delta particularly in relation to areas of human wildlife conflict: [draft] final report*. Kasane: CARACAL.

Natural Resources and People (Pty) Ltd., Botswana Dept. of Wildlife and Natural Parks., & Okavango Delta Management Plan Project Secretariat. (2006). *Final report December 2006 (Draft) Okavango Delta Management Plan: component 5: wildlife management - human elephant conflict*. Maun: ODMP.

### 3.13.2 DWNP Research Projects Related to Human-Wildlife Conflict

Julien Marchais	Human-Elephant Conflict Mitigation Project-Evaluation Phase, Okavango Kopano Mokoro Community Trust, CBNRM Area	2004-2007
Rebecca Klein	A Survey of the Status and Distribution of Cheetah in Botswana, with a Focus on their Role in Predator Livestock Conflict	2003-2005
Prof M.B.K. Darkol & J.E. Mbaiwa	Natural Resource Utilisation and Land Use Conflicts in the Okavango Delta, Botswana	2004-2005

## Annex 2: Monitoring Overview

### Ecology

	Area/Topic	Institution	Collaboration partner(s)	Monitoring means	Time/frequency	Use of data	Storage of data	Problems	Notes
Wildlife	Baseline of leopard and cheetah populations	Caracal	DWNP	Spoor count indices	Once in 2006 under ODMP funding	Baseline for monitoring population trends	Data with consultant Report with DWNP and HOORC	Result inconclusive, poor quality; Raw data not submitted by CARACAL	Includes OWS concessions Data not available at DWNP, nor included in ODIS
	Large predator (leopard, cheetah, lion, wild dog, hyena) population monitoring and population structure estimates	DWNP	BPCP (Botswana Predator Conservation Project)	Spoor count indices, aerial surveys	Permanent	Data compiled and analysed to guide management decisions (quota setting and amendment of regulations)	DWNP and BPCP spread sheets and annual report		Data not included in ODIS
	Human Wildlife Conflict (HWC)	DWNP	BPCP, farmers	PAC reports, ground assessments of damage	Ongoing, on request	Hot spots assessment, guidance to management; design of mitigation measures			Data from last PAC not digitised by DWNP, and not included in ODIS
	Human Elephant Conflict (HEC)	DWNP	DCP, farmers	Crop damage reports, ground assessments of damage	Ongoing, on request	Determination of Hot spots; guidance to management; assessment of effectiveness of mitigation measures	Report and data with DWNP		Data not included in ODIS
	Population trends large mammals (elephant, buffalo, giraffe, hippo, wildebeest, reedbuck, waterbuck, lechwe, setatunga, tsessebe, zebra, impala, duiker, steenbok)	DWNP		Aerial survey and Buffalo survey under ODMP	Annually in the dry season; every second year in the rainy season	Assess population trends; guide quota setting	DWNP HQ, ODIS	Occasionally discontinued due to lack of funds, Not all survey data available in ODIS	Last survey included in ODIS 2004; 2005-6 missing
	Rhino species dynamics and results of rhino reintroduction	DWNP	Botswana Rhino Management Committee (DWNP, KCS, OWS)	Radio trekking (transmitters) and ground observations	Permanent, long-term	Monitor success of reintroduction of species, guide management decisions,	Database and at DWNP and OWS (confidential)	Observation data from early years of species reintroduction not computerized	Data not included in ODIS (confidential); could be included with restricted access
	Trophy quality survey	Mochaba Developments	One DWNP staff involved in data analysis	Random selection of trophies of all the key species that are hunted	Annually	Long-term data base could help decision makers in monitoring the state of environment and could influence the quota setting discussion.	Mochaba data bank, research results will be published.		Mochaba Developments is working with the private data bank specialist and HOORC on setting up a GIS based environmental monitoring project for concession areas. Data not included in ODIS – research still ongoing

	Area/Topic	Institution	Collaboration partner(s)	Monitoring means	Time/frequency	Use of data	Storage of data	Problems	Notes
	<ul style="list-style-type: none"> <li>• Big predators and rare wildlife species (number of animals, date, time, condition of the animal, sex, age, activity and type of kill per camp).</li> <li>• Presence and absence of all wildlife species.</li> <li>• Presence and absence of all bird species</li> <li>• Rhino sightings</li> </ul> Sightings of 13 rare and endangered bird species	Environmental Managers and Conservation Officers of Tour Operators	DWNP, BirdLife Maun	(ID)Observation sheets filled per grid unit (with a specific name) by guides. Ornithological data share with BirdLife Maun.	Daily	Obligated to monitor the environmental condition in the concession areas.	Data at DWNP	Data not computerized.	It is planned that assisted by camp managers guides should computerize daily observations. To be able to draw conclusions on the state of environment of the ODRS, it would be essential to standardize all the monitoring activities of private operators. Data not included in ODIS
Wildlife - proposals	Hippopotamus baseline survey and monitoring	DWNP or HOORC or private researcher				Keystone species, impact on shaping of delta waterways and salvinia distribution			
	Sable and Roan antelope (rare)	DWNP or HOORC or private researchers,							
Environmental monitoring	State of environment in CBNRM CHAs	CBNRM Communities	Assisted by the DWNP Community Extension and Outreach Division (CED)	Management Oriented Monitoring System (MOMS) Capturing vegetation conditions repeatedly in form of photos (OCT)	More frequent observations during hunting season by community escort guides	To monitor state of environment	Data kept at CHA Trust	Moms not carried out regularly	Communities know the state of environment (ITK) and do not see the need for a formal monitoring system
	Environmental monitoring CHAs	Concessionaires,	HOORC, Sheller data base consultant, Mochaba Developments	Field observation records (per grid unit). GIS database for monitoring of flora, fauna fire events)	Daily records compiled on monthly basis.	Monitoring report conditional for renewal of lease agreement with TLB	OWS and other concessionaires' data sheets or data bank.		Need to standardise monitoring to make it compatible with ODIS.
Tourism	Monitoring of impact of tourism on the environment.	HOORC BIOCAVANG project	DoT, DWNP Fisheries division			Include information on biodiversity into planning and decision making processes. Empower communities to monitor environmental impact.		Projects started in May 2006 – Dec. 2010)	Data only from 2004 inspections included in ODIS

	Area/Topic	Institution	Collaboration partner(s)	Monitoring means	Time/frequency	Use of data	Storage of data	Problems	Notes
Birds	Various types of "trigger" bird species. Birds of Concern in Botswana (Hooded Vulture, Bateleur, Southern Ground Hornbill, Martial Eagle, Pel's Fishing-Owl, Kori Bustard) and 28 bird species that are data deficient.	BirdLife Botswana	DWNP	Surveys by a network of BirdLife members and partners (on a voluntary basis).		For inclusion in revised version of Botswana bird atlas.  Basis for species action plans.	BirdLife Botswana database, Bird atlas and reports at DWNP and HOORC	Based exclusively on voluntary work	Site support groups (CBOs) will be established and trained for data collection. DWNP is understaffed with only one ornithologist. Data from BirdLife included in ODIS
	Status of globally threatened bird species (Wattled Crane, Slaty Egret, Lappet-Faced and Cape Vulture, Lesser Kestrel), eight near threatened species (Lesser Flamingo, African Skimmer, Black-winged Pratincole, Black-tailed Godwit, Pallid Harrier, Melodious Lark, Denham's Bustard, Corn Crane) and four species under consideration for up-listing as threatened (White-backed Vulture, Egyptian Vulture, White-headed Vulture, Chestnut-banded Plover).	BirdLife Botswana		African Water Bird Census by a network of BirdLife members and partners (on a voluntary basis).  African Skimmer nest and breeding success survey	AWBC = 2 x year.  Annual African Skimmer survey in October.	Basis for species action plans.	BirdLife data bank and monitoring protocols, HOORC ODIS	Lack of funds. Shortage of trained personnel. Limited GIS equipment and skills. Accessibility of the Okavango Delta as one of the Important Birding Sites. Lack of transport facilities (4x4 vehicle, boat, aircraft). All monitoring is based on private transport availed by members and friends of BirdLife on a voluntary basis. Monitoring activities depend largely on a network of volunteers.	Some of the data included in ODIS
	Important birding areas (IBA) in the ODRS (the Okavango Delta, Lake Ngami and the Linyanti/Chobe area).	BirdLife Botswana, Avian Demography Unit of the University of Cape Town		African Water Bird Census, twice a year by Surveys by a network of BirdLife members and partners (on a voluntary basis). Annual bird ringing activity at Lake Ngami.	AWBC = 2 x year.  Ringing Lake Ngami = 1x year	IBA monitoring as planning input.  Waterbirds monitoring throughout Africa.	BirdLife data bank	BL depends largely on the inputs from volunteers and availability of funds.	Data available in ODIS

	Area/Topic	Institution	Collaboration partner(s)	Monitoring means	Time/frequency	Use of data	Storage of data	Problems	Notes
	Slaty egret distribution and breeding sites.	BirdLife Maun	DWNP	Baseline survey (ODMP). Observation of historical breeding sites. Bi-annual water bird counts. Fixed transects (monthly). Pilot aerial counts. Breeding site survey (Sept.) Reports from safari operators.	Base line (2003-2004) and breeding site survey 2005		BirdLife data bank		Data available in ODIS
	Wattled crane population trends	BirdLife Maun crane working group		Baseline aerial survey (2001,2002,2003) Annual juvenile-adult ration survey during breeding season (sample counts).	Baseline 2001-03 Sample counts since 2004	Population trends for crane action plan	BirdLife data bank	BL depends largely on voluntary work and availability of funds.	Data available in ODIS
Insects	Dragon Fly baseline survey and monitoring (indicator species)	Anhalt University	HOORC	Field survey in selected aquatic habitat types		Health of environment monitoring. Indicator species for condition of wetland.	Report at HOORC, data in ODIS		Survey needs to be repeated every five years. No data with geographical references available for ODIS
	Presence of tsetse fly	DAHP		Surveillance by fly-traps, concentrated along river in BT, NM, AG			Reports for 2001 and 2002 EI studies at HOORC		2006 environmental monitoring still ongoing Results of surveillance negative, hence not deposited in ODIS
Vegetation	Baseline on distribution of rare and endangered plant species	DFRR (under ODMP)	Kew Gardens UK, Safari operators	ODMP funded baseline survey	1x dry and 1x rainy season observations 2006		Report at HOORC Library	Data not available in ODIS	
	Distribution of aquatic weeds (salvinia molesta and water hyacinth) and response to control measures in OD and Kwando/Linyanti system (ecology)	DWA	Safari operators and fishermen report outbreaks; communities involved in manual control activities (Gomoti)	Regular field surveys: follow up of reports from private sector and communities	Monthly	Production of aquatic weed distribution maps to determine control activities.	DWA/Aquatic Weed control Division and HOORC-ODIS	Lack of transport.	No systematic way of involving other stakeholders. Planned to involve safari operators actively in the biological control program.

	Area/Topic	Institution	Collaboration partner(s)	Monitoring means	Time/frequency	Use of data	Storage of data	Problems	Notes
	Fire scars and progressing fires	DFRR	Technical assistance from Senior Veldt Fire Specialist, headquarters Gaborone; Reports from environmental manager of OWS	Remote sensing	On a regular basis.	To coordinate and rationalise fire fighting activities. To inform planning of fire break locations.	Long-term data stored at HQ ODIS		Staff are generalists no specific GIS and statistics skills. Data needs continuous updating
	Condition of rangeland in the entire district. Range conditions in selected locations (commercial ranches in the Hainaveld, Quarantine camp, AI cam,	DFRR		BRIMP project baseline national survey. Limited monitoring in the AI and the quarantine camps by the range management officer Priority surveys sites outside ODRS.	Monthly, quarterly and annually	Decision-making tool to assess whether district is declared a drought area	BRIMP data stored at MoA/HQ and HOORC	Specific survey areas not representative for all vegetation units in the Ramsar site. All survey sites outside the ODRS. Data not included in ODIS	Lack of systematic surveys on the changing rangelands carrying capacity and their status in the entire district.
	Forest resources in the Tsodilo/Tamacha Area	DFRR		65 research plots with a 30m diameter	Supposed to be repeated every 5 years			Limited staff resources Data not included in ODIS	In northern Ngamiland high demand to use some of the hardwood resources. A district forestry inventory would be required to determine sustainable off-take rates.
	Quantification of utilisation of the vegetation resources harvested as veldt products	DFRR (with ODMP funding)	HOORC (might be able to assist in statistical analysis)	Resource user questionnaires all major villages in the ODRS.	Baseline survey under ODMP	Trends in use of vegetation resources for comparing off-take with regeneration rate.	DFRR databank	No capacity to analyse data statistically. Data not included in ODIS	
	Riparian woodland and water quality monitoring of biological indicators in pilot sites	HOORC Environmental Monitoring Unit, BIOCAVANG O project	Tour operators, University of Virginia	Monitoring plots set up and monitored by tour operators		Determining of ecosystem health, Can be used by DEA for state of environment report, Fulfil obligations under Convention on Biodiversity	HOORC ODIS		
Vegetation - proposals	Fuel load survey	DFRR		Field surveys to determine fire danger index (use of Disc pasture meter)	Planned annually to start in 2007	Assess fuel load, and determine areas that warrant controlled burning	Report at HOORC	Not clear whether possible, due to lack of funding and staff limitations Field survey data not available in ODIS	
	Baseline of distribution of alien and invasive plant species	DFRR						Planned under ODMP, not carried out due to financial constraints.	



	Area/Topic	Institution	Collaboration partner(s)	Monitoring means	Time/frequency	Use of data	Storage of data	Problems	Notes
Fish and aquatic invertebrates	Fish stock monitoring	DWNP-Fisheries Division	HOORC assistance in data analysis	Experimental fishing in different habitat types	Monthly	To inform management decisions.	DWNP Quarterly reports,	Lack of equipment Data not included in ODIS	
	Catch and effort survey	Fishermen DWNP-Fisheries Division	HOORC assistance in data analysis	Gill net fishermen fill monthly record sheets, fishery extension staff hand in sheets for compilation at district FD office,	Daily, compiled monthly at district level DWNP-FD	To inform management decisions.	DWNP and HOORC fishery research data bank	Some fishermen falsify records Data not included in ODIS	
	Fish frame survey	DWNP-Fisheries Division	HOORC assistance in data analysis	Questionnaires to fishermen	Every five years	To inform management decisions.	DWNP and HOORC fishery research data bank	Data not included in ODIS	
	Creel survey	DWNP-Fisheries Division	HOORC assistance in data analysis	Questionnaires to fishermen	monthly	To inform management decisions.	DWNP and HOORC fishery research data bank	Lack of motivation of DF staff Data not included in ODIS	
	Floodplain fish ecology survey	HOORC		Experimental fishing in different habitat types	Monthly in different habitat types	Contribution to state of environment report. Fulfil obligations under Convention on Biodiversity	HOORC fishery research data bank, reports to DWNP-DF	Occasionally discontinued due to lack of funding Data not included in ODIS	
	Aquatic biodiversity inventory (RA)	CI	HOORC	Various experimental catch and collection methods in different habitat types	2000, 2003	Contribution to state of environment report. Fulfil obligations under Convention on Biodiversity	HOORC fishery research data bank, CI in Washington DC ODIS	Funding discontinues	
	Socio-economic surveys of fishery sector	DF (1987) HOORC (2005)		Questionnaires	1987 and 2005	To inform management decisions.	HOORC data bank	Funding discontinues Data not included in ODIS	
	Detailed bio assessment (plankton, fish and aquatic invertebrates)	HOORC	CI	Various experimental catch and collection methods in different habitat types	2005-2006	Contribution to state of environment report. Fulfil obligations under Convention on Biodiversity	HOORC fishery research data bank,	Funding discontinues Data not included in ODIS	

## Physical processes and hydrology

	Area/Topic	Institution	Collaboration partner(s)	Monitoring means	Time/frequency	Use of data	Storage of data	Problems	Notes
Water monitoring	Effluent water quality	Maun Council (EHD)	Needs to collaborate with DWA; would like to use HOORC labs for analysis	Surface water; ground water; mainly bacteriological	Irregular	Rarely used; sometimes by MoH	Hard copy files in EHD	Capacity constraints	Needed: regular monitoring
	Drinking water quality	EHD; DWA	HOORC	Mainly bacteriological	Upon request of communities	Feedback to communities and sometimes to MoH	Hard copy files in EHD	Capacity constraints	Needed: regular monitoring
	Water quality	DWA	Would like to collaborate with HOORC for use of labs	Three points in the panhandle (Mohembo, Fishing camp, Sepopa)	Monthly since December 2006	Incorporation hydrological model	DWA – software also to ODIS (soon)	Data sharing agreement missing	Pesticides missing Intercalibration missing Some data in ODIS
	Water levels	DWA		20 water level data loggers on 20 sites; 2 staff in Maun and 2 in Gumare trained	Sampling started 70s-80s; monthly	Flooding analysis; community service; modelling?	DWA – software also to ODIS (soon)	Programme/data Incompatibility with ODIS Irregular sampling	Some data in ODIS
	Water levels	DWA		27 surface water level sensors	To be implemented in 2007	Flooding analysis; community service; modelling?	DWA – software also to ODIS (soon)	Lack of analytical capacity in the DWA	Some data in ODIS
	Water flow	DWA		Inflow at Mohembo and outflow at Maun, as well as flow in all permanent and seasonal lakes and rivers	Daily in Mohembo; 10 days/month outflow Maun; monthly in Delta	Flooding analysis; community service; modelling	DWA – software also to ODIS (soon)	High flows difficult to monitor in Mohembo	Some data in ODIS
Modelling	Hydrological modelling	DWA	HOORC	MIKE SHE		Input to management	DWA – software also to ODIS (soon)	4 staff trained in model use, 3 left and 1 still in training Limited predictability of model	Comparison needed between models
Channels	Channel blockages and impact of channel clearing	DWA		Inventory of blockages	Continuously	Removal of blockages	DWA Maun	Effects of clearing not studied	
Climate	Precipitation	MEWT, Meteorological Services Department	DWA	Rain gauges	To be implemented in 2007	Modelling	MEWT; DWA	Data not being transferred to ODIS	Launch expansion of system under way by DWA
	Climate	DWA (DMS)			Continually updated				

## Socio-economy

	Area/Topic	Institution	Collaboration partner(s)	Monitoring means	Time/frequency	Use of data	Storage of data	Problems	Notes
Livestock	Livestock off-take to the BMC	DAHP							
	Domestic stock diseases	DAHP	DWNP (FMD) NWDC						
	Notifiable diseases among domestic stock	DHT	BDF, DAHP, private individuals	Informed by partners on disease occurrences	Whenever notified	Sent to Ministry of Health	At DHT offices		
	Livestock numbers	DAHP	DFRR DEA	During FMD vaccination campaigns	Twice a year,	Determination of carrying capacity RR (DFRR) EIA for ranch inception (DEA) MoA (meat exports)	MoA Research Unit (incl. statistics); ODIS	Data missing in ODIS for 2000, 2003 onwards	
Fishing	Daily fishing-catches	Fisheries Division (DWNP)	Commercial fishermen	Records by commercial fishermen	Daily	Fish stock assessments	DWNP Research Unit ODIS	Some fishermen are illiterate, hence poor quality of data	Association of commercial fishermen was defunct, but is currently being re-established. Part of its new activities will be monitoring. The association includes commercial fishermen, recreational fishing operators and subsistence fishermen
	Fish stocks	Fisheries Division (DWNP)	HOORC, commercial fishermen	Experimental fishing on selected ODRS sites	Monthly	Fish stock assessments	DWNP Research Unit ODIS		
Wildlife	Poaching activities	DWNP in collaboration with BDF	CBNRM Communities (MOMS) Tour operators	Patrols	Whenever observed	Control and legal action	DWNP Research Unit	Not in ODIS	
	Human wildlife conflict	DWNP (HOORC compilation into hot spots)	DAHP (Fences) Department of Agriculture (assessment of damage)	Conflict incidence reports from farmers (PAC and HEC reports)	As it occurs	Compensation payments	DWNP Research Unit		
	State of veterinary/wildlife fences	DAHP	DWNP	Regular surveillance (camps along the fences)		Control of diseases			

	Area/Topic	Institution	Collaboration partner(s)	Monitoring means	Time/frequency	Use of data	Storage of data	Problems	Notes
Waste management	Storage, collection, treatment and disposal facilities of solid and fluid waste	NWDC/EHD	DWNP Tour operators	Baseline: Waste Management Strategy report	Weekly	Planning purposes of future facilities	Hard copies at EHD office	Information not representative of community	Information not available from all communities; only from waste stored in containers
	Waste management practices of safari operators	EHD	DoT	Irregular annual inspections			At EHD office	Accessibility and transport Very incomplete picture of waste generation in the Delta; no systematic way of collecting data	
Veld products	Condition of vegetation resources and their utilisation	DFRR							
	Natural resource harvesting	Local authority in Tubu		Community monitoring					
	Illegal use of natural resources (e.g. harvesting of live trees)	DFRR		Ad hoc Reports from community members					
Tourism	Number of tourism camps and mobile operators	DoT	TLB (allocate concessions) DWNP (in protected areas)	Through licensing system and inspections	Each camp at least once per year	Regulating standards	DoT	Not enough capacity; difficult access to camps	Some data in ODIS, but outdated
	Number of tourism camps and mobile operators in each CHA	TLB		Through lease systems					
Tourism - proposals	Environmental impact of tourism outside of camp areas (tracks, airfields, movement of boats)								
	Social impact of tourism activities on local communities (e.g. on traditions and lifestyle)								
	Economic impact of tourism on the ODRS (communities, private sector, government...)								
	Expectations of tourists on visits to the ODRS								

	Area/Topic	Institution	Collaboration partner(s)	Monitoring means	Time/frequency	Use of data	Storage of data	Problems	Notes
Agriculture	Agricultural land use in the Ngamiland District (area cultivated per crop, yields, livestock and small-stock numbers, socio-economic characteristics of farming households)	MoA		Annual agricultural statistics					
Population	Population census and socio-economic characteristics of population	Central Statistics Office (CSO)		Every 10 years (last 2001)			CSO ODIS		
Land	Cadastral records of land allocations (customary law and common law) and monitoring compliance with lease agreements	TLB						Allocation records not geo-referenced and stored systematically	A land database management system is set up and populated with allocation records (ongoing)

- No economic impact monitoring of tourism
- Waste: the biggest problem is the access to the Delta and the monitoring of waste handling
- The Delta is not gazetted; EHD can only provide waste disposal services to gazetted areas
- Tourism expectations

## Annex 3: Communication Processes Overview

Partner(s) involved	Topic/Content	Activity	Purpose	Format	Time/frequency	Steps to take	Notes
<b>General</b>							
Relevant departments; HOORC	Independent research reports	Provision of one hard-copy and one digital copy to HOORC library Link digital copy to ODIS		Hard copy Computer File Outreach through WebFlow	Whenever appropriate	Relevant department to link researcher to HOORC library RAG to ensure that research permit conditions include report and raw data deposit to HOORC	Some reports not submitted All reports related to the ODRS should be stored at HOORC Time-lag possible in provision of raw data due to publication needs
HOORC	Information about possibilities for WebFlow	Promotion activity informing ODMP stakeholders	Increase use of WebFlow as information sharing tool	Short presentation at HOORC	Every second year	HOORC Library to organise event by end of June	
DEA; HOORC; relevant departments and institutions	Raising interest of non-ODMP departments and institutions to be linked to ODIS	DEA communication to relevant institutions and departments	Widen the range of data providers and users of ODIS	Letter	Once	DEA to write letter to relevant departments and institutions – done early April	
RAG; relevant stakeholders; HOORC	Topic-specific information exchange on research and monitoring	'Mini-congress/workshop' of all stakeholders involved in specific research/monitoring area	Promote networking between ODMP stakeholders	One-day event	Annually	RAG to decide during first meeting on thematic area/format	Funding might be an issue; should be covered through DEA budget
Government departments involved in the ODMP	Information about the Delta and the ODMP	Short course	Bring new stakeholder staff 'up to speed' on Delta/ODMP	Three day event	Annually	HOORC/DEA organise first training by end of 2007	Has to go through departmental training budget
HOORC; relevant stakeholders	HOORC Research results	Short seminars at HOORC	Inform about research results	One-day seminar	Twice/month	HOORC to ensure that invitations reach several people within the institutions HOORC to improve advertising of events Depending on topic -HOORC to stress implication for ODMP management	HOORC open for inclusion of outside researchers in the seminar programme
ODMP Communication team; relevant researchers	Research findings	Synthesise research findings	Widen 'public' of research findings	1-2 page fact-sheet with easy to understand summary of findings	Whenever applicable (aim for 1 fact-sheet per month)	ODMP CT to identify 2-3 'hot topics', contact relevant researchers for information, create fact-sheet(s) – 3 fact-sheets produced and disseminated by end of June 2007	Consider also publication/distribution within the Ngami Times
<b>ODIS In</b>							
DWA, HOORC	Water levels; water discharges; water quality data	Export data to Excel spreadsheet	Update ODIS	Excel spreadsheet	Monthly	DEA to examine donor agreements concerning availability of data Include copyright clause within use of ODIS data DEA to approach DWA in order to identify ways to provide information to ODIS	DWA has policy for cost-recovery
DWNP, HOORC	Large mammals	Provision of aerial survey results	Update ODIS	Excel spreadsheet	Annually	ongoing	Annually for dry season; every second year for wet season Data provided for free (with acknowledgement)
DWNP; HOORC	Human-wildlife conflict data	Provision of data	Update ODIS	Excel spreadsheet	Annually	ongoing	
BirdLife Botswana; HOORC	Wattled crane distribution	Provision of survey results	Update ODIS	Excel spreadsheet	Annually	ongoing	Free of charge; nesting site info restricted
BirdLife Botswana; HOORC	Waterbird populations	Provision of waterbird-count data	Update ODIS	Excel spreadsheet	Bi-annually	ongoing	Free of charge
BirdLife Botswana; HOORC	Slaty egret distribution	Provision of survey data	Update ODIS	Excel spreadsheet	One-off	-	
BirdLife Botswana;	Slaty egret distribution	Provision of survey data	Update ODIS	Excel spreadsheet	Annually	BirdLife to provide first dataset to HOORC by	Free of charge

Partner(s) involved	Topic/Content	Activity	Purpose	Format	Time/frequency	Steps to take	Notes
HOORC		(transects)				end of 2007	
BirdLife Botswana; HOORC	Heroneries	Provision of geographical data	Update ODIS	Excel spreadsheet	One-off	-	Free of charge
DAHP; HOORC	Livestock population	Provision of data from cattle crushes	Update ODIS	Excel spreadsheet (with co-ordinates)	Bi-annually	HOORC to contact DAHP in Gaborone with support letter DEA in April	Currently out-dated within ODIS
DoT; HOORC	Visitor statistics to the Delta	Provision of data	Update ODIS	Excel spreadsheet		DoT to investigate possibility to provide district-specific data to ODIS (starts in April)	Data collected nation-wide
DWNP; DoT; HOORC	Visitor statistics for National Parks	Provision of data	Update ODIS	Excel spreadsheet		To be included into ODIS	
CSO; HOORC	Human population distribution within the ODRS	Provision of data	Update ODIS	Download from CSO website		HOORC to investigate possibility for use within ODIS (broken up in settlements) – (done in April)	
DoT; DCA; HOORC	Distribution of camps, airstrips and lodges in Delta	Provision of data	Update ODIS	Excel spreadsheet; ArcGIS maps	Update whenever required	HOORC GIS technician to visit DoT to co-ordinate and get data	
<b>ODIS Out</b>							
HOORC; relevant stakeholders (new staff)	Use of ODIS	Training of new staff in the use of ODIS	Ensure familiarity in use of ODIS	Three-day training course	Annually	HOORC to provide next training by tomorrow Next course: HOORC to co-ordinate timing of training with relevant departments	Include WebFlow and use of Library Shortcoming: availability of funds
HOORC; all ODIS users	'User support'	Provide support in ODIS installation and use	Ensure functioning of ODIS	Co-ordinated visits; telephone and e-mail support	Whenever needed	ongoing	
HOORC	ODIS data, meta-data and gaps	Update annual report	Raise awareness for ODIS data and gaps	ODIS Annual Report (+- 20p)	Annually	Next report to be published by HOORC by December 2007	Include also information on availability of remote-sensing data at HOORC

**Annex 4: Timetable for Main Communication Processes**

Activity	Responsible	April	May	June	Jul-Sep	Oct-Dec	2008	2009	2010	2011	2012
Provide research reports	All relevant stakeholders	■ ■ ■ ■	■ ■ ■ ■	■ ■ ■ ■	■ ■ ■ ■	■ ■ ■ ■	■ ■ ■ ■	■ ■ ■ ■	■ ■ ■ ■	■ ■ ■ ■	■ ■ ■ ■
Communication about ODIS to relevant partners	DEA	■ ■ ■ ■									
R&M workshop/mini-congress on specific topic	RAG	■ ■ ■ ■	■ ■ ■ ■	■ ■ ■ ■	■ ■ ■ ■	■ ■ ■ ■	■ ■ ■ ■	■ ■ ■ ■	■ ■ ■ ■	■ ■ ■ ■	■ ■ ■ ■
Training course on ODMP/ODRS	ODMP Govt. departments						■ ■ ■ ■	■ ■ ■ ■	■ ■ ■ ■	■ ■ ■ ■	■ ■ ■ ■
Research seminars	HOORC	● ● ● ●	● ● ● ●	● ● ● ●	● ● ● ●	● ● ● ●	● ● ● ●	● ● ● ●	● ● ● ●	● ● ● ●	● ● ● ●
Outreach research findings (fact-sheets)	DEA	■ ■ ■ ■	■ ■ ■ ■	■ ■ ■ ■	● ● ● ●	● ● ● ●	● ● ● ●	● ● ● ●	● ● ● ●	● ● ● ●	● ● ● ●
Provision of data to ODIS	All relevant stakeholders	● ● ● ●	● ● ● ●	● ● ● ●	● ● ● ●	● ● ● ●	● ● ● ●	● ● ● ●	● ● ● ●	● ● ● ●	● ● ● ●
ODIS training course	HOORC						■ ■ ■ ■	■ ■ ■ ■	■ ■ ■ ■	■ ■ ■ ■	■ ■ ■ ■
ODIS User support	HOORC	● ● ● ●	● ● ● ●	● ● ● ●	● ● ● ●	● ● ● ●	● ● ● ●	● ● ● ●	● ● ● ●	● ● ● ●	● ● ● ●
Annual ODIS Report	HOORC					■ ■ ■ ■	■ ■ ■ ■	■ ■ ■ ■	■ ■ ■ ■	■ ■ ■ ■	■ ■ ■ ■

**Legend:**

- Perform within this period, timing yet to be decided: ■ ■ ■ ■
- Perform within this period: ■ ■ ■ ■
- Ongoing activity: ● ● ● ●



**Annex 5: List of Participants RMAP Meeting with HOORC Staff (12.03.2007)**

<b>SURNAME</b>	<b>NAME</b>	<b>POSITION</b>	<b>E-MAIL</b>
Prof. Ramberg	Lars	HOORC Director	<a href="mailto:lramberg@orc.ub.bw">lramberg@orc.ub.bw</a>
Prof. Ringrose	Susan	Professor	<a href="mailto:sringrose@orc.ub.bw">sringrose@orc.ub.bw</a>
Prof. Swatuk	Larry	Associate Professor	<a href="mailto:lswatuk@orc.ub.bw">lswatuk@orc.ub.bw</a>
Prof. Kgathi	Don	Associate Professor	<a href="mailto:dlkgathi@orc.ub.bw">dlkgathi@orc.ub.bw</a>
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Dr. VanderPost	Cornelis	Senior Research Fellow	<a href="mailto:cvanderpost@orc.ub.bw">cvanderpost@orc.ub.bw</a>
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L. Sebele	Lesego	Research Fellow, Tourism Marketing	
D. Mazvimavi	Dominic	Senior Research Fellow	<a href="mailto:dmazvimavi@orc.ub.bw">dmazvimavi@orc.ub.bw</a>
M. Morrison	Monica	Senior Librarian	<a href="mailto:mmorrison@orc.ub.bw">mmorrison@orc.ub.bw</a>
Frederik	Oberthür	Consultant	<a href="mailto:frederik.oberthur@scanagri.se">frederik.oberthur@scanagri.se</a>
Bendsen	Hannelore	Research Fellow Participatory Planning	<a href="mailto:hbendsen@orc.ub.bw">hbendsen@orc.ub.bw</a>

## Annex 6: Individual Meetings with ODMF Partners on the RMAP

Date	Institution	Attendance
17.01.2007	Department of Wildlife and National Parks	Mr. Gaseitsiwe Masunga Mrs. Pearl Galebotswe Mrs. Eda Gaobinelwe Mrs. C. Mpofu Mr. T. T. Bokhutlo Mrs. Hannelore Bendsen, HOORC Dr. Kelebogile Mfundisi, HOORC
17.01.2007	Department of Forestry and Range Resources	Mr. Boikago Maswabi, District Coordinator Forestry and Range Resources Mr. K. Kemoreile, outgoing Regional Forestry Officer, now Head of Resource Inventory and Monitoring, Gaborone Mr. Mafoko, Scientific Officer Forestry and Range Resources Dr. Kelebogile Mfundisi, HOORC Mrs. Hannelore Bendsen, HOORC
22.01.2007	BirdLife Maun Branch	Mr. Pete Hancock, Birdlife Botswana, Maun Branch Dr. Kelebogile Mfundisi, HOORC Mrs. Hannelore Bendsen, HOORC
26.01.2007	NWDC, Department of Environmental Health	Mrs. B. Gandhi, Environmental Health Department, NWDC Mr. T. Balapi, Environmental Health Department, NWDC Mrs. Hannelore Bendsen, HOORC
02.02.2007	Okavango Wilderness Safaris (OWS)	Mr. Map Ives, Environmental Manager, OWS Mrs. Angela Morgan, outgoing Conservation Officer OWS Mrs. Hannelore Bendsen, HOORC
09.02.2007	Department of Environmental Affairs, Headquarters	Mrs. Dollina Malepa, Natural Resources Officer, DEA Mrs. Hannelore Bendsen, HOORC
19.02.2007	Mochaba Developments	Mrs. Debbie Peak, Mochaba Developments Mrs. Hannelore Bendsen, HOORC
26.02.2007	Department of Water Affairs, Maun	Dr. Naidu Kurugundla, Senior Botanist Aquatic Weed Control, DWA Mrs. Hannelore Bendsen, HOORC
07.03.2007	Department of Animal Health and Production	Mr. Bruce Mafonko, Veterinary Officer, Maun Mr. Paul Otokile, Assistant Scientific Officer, Maun Mrs. Hannelore Bendsen, HOORC
07.03.2007	Tsetse Control Division, Maun	Mr. Patrick Kgori Mrs. Hannelore Bendsen, HOORC
15.03.2007	DEA Maun	Mr. Sekgowa Motsumi, District Environment Coordinator Mokgadi Monamati, DEA Mr. Frederik Oberthür, Scanagri Consultant Mrs. Hannelore Bendsen, HOORC
06.03.2007	DEA-IUCN Maun	Mr. Mokobe Tigele, Communication Specialist Mr. Frederik Oberthür, Scanagri Consultant Mrs. Hannelore Bendsen, HOORC
27.02.2007	HOORC	Dr. Masamba, Senior Research Fellow, Hydro-Chemistry Dr. Kelebogile Mfundisi, HOORC
01.03.2007	HOORC	Mrs. Lesego Sebele, Dr. Susan Keitumetse Mrs. Hannelore Bendsen, HOORC

16.03.2007	Biokavango	Dr. Nkobi M. Moleele, National Project Coordinator Mrs. Belda Mosepele, Research Fellow, Aquatic Biology Mr. Frederik Oberthür, Scanagri Consultant Mrs. Hannelore Bendsen, HOORC
05.03.2007	HOORC	Dr. Cornelis Vanderpost, Senior Research Fellow Mr. Frederik Oberthür, Scanagri Consultant Mrs. Hannelore Bendsen, HOORC
05.03.2007	HOORC	Prof. Sue Ringrose, Mr. Frederik Oberthür, Scanagri Consultant Mrs. Hannelore Bendsen, HOORC

**Annex 7: RMAP Workshop Participants (19.03.2007)**

	SURNAME	NAME	POSITION	INSTITUTION	TEL.	FAX	E-MAIL	POSTAL ADDRESS
Working Group Socio-Economy	Rabolo	Felicity	Assistant Tourism Officer	Department of Tourism	6860492	6861676	<a href="mailto:frabolo@botmail.com">frabolo@botmail.com</a> <a href="mailto:felie78@yahoo.com">felie78@yahoo.com</a>	Box 439, Maun
	Mokobi	Tigele	Communication Specialist	ODMP/DEA	6801237	6862503	<a href="mailto:tigele.mokobi@iucn.org">tigele.mokobi@iucn.org</a>	Box 35, Maun
	Batlhoki	K.	Tourism Officer	NWDC	6860241	6861423	<a href="mailto:kbatlhoko@yahoo.co.uk">kbatlhoko@yahoo.co.uk</a>	P Bag 01 Maun
	Bokhutlo	T.		DWT, Fisheries Division	6860368			
	Gaborekwe	Ramogaupi	Rural Sociologist	ODMP/DEA	6801237	6862503	<a href="mailto:rgaborekwe@iucn.org">rgaborekwe@iucn.org</a>	Box 35, Maun
	Sebele	L. S.	Research Fellow Tourism	HOORC	6861833	6861835	-	
	Balapi	T.	Principal Technical Officer	NWDC, EHD, Waste Management Section	6860241 dir. 6860325		-	P/Bag 01 Maun
	Frederik	Oberthür	Consulatant	Niras/Scanagri	0046-854553314	0046-854553333	<a href="mailto:frederik.oberthur@scanagri.se">frederik.oberthur@scanagri.se</a>	
Working Group Ecology	Bendsen	Hannelore	Research Fellow Participatory Planning	HOORC	6861833	6861835	<a href="mailto:hbendsen@orc.ub.bw">hbendsen@orc.ub.bw</a>	P/Bag 285, Maun
	Monamati	Mokgadi		DEA/ODMP	6801237 6801126	6862503	<a href="mailto:mmonamati@gov.bw">mmonamati@gov.bw</a>	P.O.Box 35 Maun
	Mosepele	Kite	Research Fellow - Fisheries	HOORC	6861833	6861835	<a href="mailto:kmosepele@orc.ub.bw">kmosepele@orc.ub.bw</a>	P/Bag 285, Maun
	Gaobinelwe	Eda	Wildlife Biologist	DWNP	6860368	6860053	<a href="mailto:edgaobine@yahoo.com">edgaobine@yahoo.com</a>	Box 11, Maun
	Masunga	Gaseitsiwe	Researcher	DWNP	6860275		<a href="mailto:gaseitsiwe.masunga@umb.no">gaseitsiwe.masunga@umb.no</a>	Box 11, Maun
	Hancock	Pete	Conservation Officer	BirdLife Botswana Maun	6865618		<a href="mailto:birdlifemaun@ngami.co.za">birdlifemaun@ngami.co.za</a>	P.O.Box 1529
	Moleele	Nkobi	Bi-Okavango Project	HOORC	6861833	6861835	<a href="mailto:mmoleele@orc.ub.bw">mmoleele@orc.ub.bw</a>	P/Bag 285, Maun
	Motsumi	Sekgowa	District Environment Coordinator	DEA	6801237	6862503	<a href="mailto:semotsumi@gov.bw">semotsumi@gov.bw</a>	P.O.Box 35 Maun

	SURNAME	NAME	POSITION	INSTITUTION	TEL.	FAX	E-MAIL	POSTAL ADDRESS
Working Group Hydrology	Kurugundla	Naidu	Senior Botanist Aquatic Weed Control	DWA	6860452	6860372	<a href="mailto:nkurugudla@gov.bw">nkurugudla@gov.bw</a>	P/Bag 02 Maun
	Huntsman-Mapila	Philippa	Research Fellow - Environmental chemistry	HOORC	6861833	6861835	<a href="mailto:pmaplila@orc.ub.bw">pmaplila@orc.ub.bw</a>	P/Bag 285, Maun
	Ramberg	Lars	Director	HOORC	6861833	6861835	<a href="mailto:lramberg@orc.ub.bw">lramberg@orc.ub.bw</a>	P/Bag 285, Maun
	Masamba	Wellington	Senior Research Fellow - water chemistry	HOORC	6861833	6861835	<a href="mailto:wmasamba@orc.ub.bw">wmasamba@orc.ub.bw</a>	P/Bag 285, Maun
	Dhliwayo	Masego	GIS Technician	HOORC	6861833	6861835	<a href="mailto:mdhliwayo@orc.ub.bw">mdhliwayo@orc.ub.bw</a>	P/Bag 285, Maun

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## **Annex 9: Suggestion for topics to be covered during the first Research Advisory Group Meeting**

**Date:** *Latest end of June 2007*  
**Participants:** *See Research and Monitoring Action Plan, Chapter 3*  
**Time:** *Plan for a whole day*

### **Suggested Topics:**

#### **Terms of Reference (ToR) of the RAG**

- Go through the tasks of the RAG described in Chapter 3 of the RAG; agree upon their content and scope
- Appoint someone to draft ToR based on the previous discussion
- Decide on steps for further refinement and approval of ToR

#### **Research Permits**

- Get an overview of what we know about the current procedures for issuing research permits
- Discuss the possible role of the RAG within these procedures in order to guide research and monitoring in the ODRS
- Decide on steps to be taken to get a better overview of the current procedures, alt. on steps to be taken for the RAG to achieve this role (Be specific - who does what, when, how, reporting)

#### **Communication in Research and Monitoring**

- Go through the Communication Processes Overview (RMAP Annex 3) and check status of the current and planned activities. Pay special attention to:
  - Provision of information to ODIS – what is being done? How can the RAG help to facilitate the process?
  - Planning of the workshop for topic-specific exchange on research and monitoring outputs
  - Identify any other R&M bottlenecks, and decide on how they can be addressed and overcome; decide upon and add additional communication processes/activities if required