

APPENDIX C

Introduction

Okavango Delta

The Okavango River rises as the Cubango in south east Angola. Some 600km downstream, the river forms the boundary with north east Namibia for a distance of 400km, along which course it is joined by its largest tributary, the Cuito. After crossing the Caprivi Strip, the Okavango River enters north west Botswana, forming the terminal Delta in the Kalahari sands, with a maximum flood area around 15,000km². The total area of the basin in Southern Africa is around 400,000km². Neighbouring major river basins are to the east the Zambezi, to the north the Congo, and to the south west the Kunene.

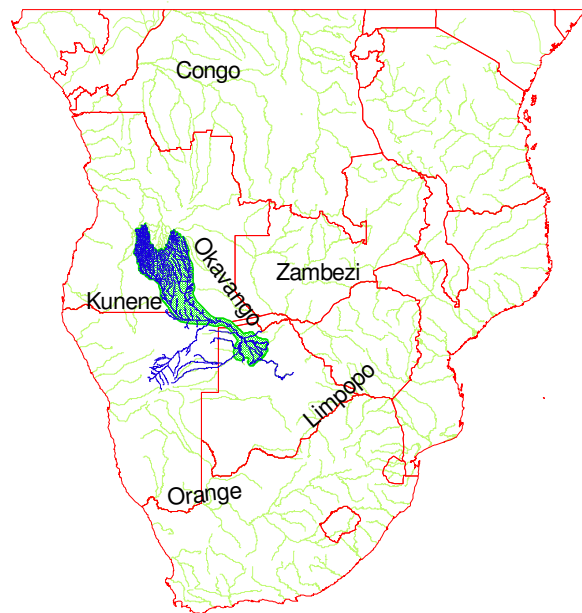


Figure 1.1: Location of Okavango River Basin

The importance of the land-water interface to the environment of the planet cannot be overstated. In the Okavango Delta, Botswana has the largest and probably most prestigious wetland in the world. The Okavango River and Delta comprise a phenomenon virtually unique in the world. The delta is in a state of dynamic equilibrium. The channels flow over an alluvial fan, spreading out and running up to a geological fault downstream. The travel time of the flood wave through the delta is from four to five months, with the upstream peak occurring around the end of March, and the peak downstream around mid August. Considerable variations in the flows and flooded areas have been recorded, since David Livingstone first saw Lake Ngami in 1849.

There is a high floral diversity in the delta including many aquatic and semi-aquatic species. The fauna are also numerous in respect of their variety and rarity. In an arid country water is precious and the delta and its abundant water, vegetation, and wildlife resources has always attracted people. Human habitation in the delta and its periphery dates back around 100,000 years. Natural factors such as climatic changes, changes in the flow pattern, outbreaks of epidemic diseases and the spreading of tsetse fly have affected settlement and land use. Many ethnic groups with different perceptions of land and natural resource utilisation are presently living mainly along the fringes of the delta. A large population depends directly on the utilisation of natural resources of the delta for subsistence.

While the impact of human activities on the delta to date has not been major, the increasing number of small scale abstractions from the IVL/DHI/SOTON/CONAMA/AIPET/CEH-W/RU



surface and ground water, and the strong likelihood of major schemes upstream pose a severe threat to the future of the delta environment.

Communication and Participation

Following Botswana's accession to the Ramsar Convention in 1997, twelve government departments are cooperating to prepare a management plan for the delta, with international assistance. Stakeholders associated with the planning process include local communities, district institutions, tourist operators, national government and international organisations. A critical issue is that international collaboration is assured, and the upstream countries in the basin share the philosophy behind the management plan, and respect its provisions.

Numerous constraints have been identified: lack of capacity to implement the strategy, lack of mutual understanding among stakeholders and unclear definition of the roles and functions of newly established institutions. Communities need to agree to invest in the long term stewardship of the delta. Unequal opportunities among stakeholders and communities result in political friction and lack of commitment to policies by those who do not directly benefit.

Communication implies the exchange of information leading to mutual enhanced understanding among the stakeholders. Through fully involving all stakeholders, their cooperation, assistance and participation can be assured. There will be significant investment of time and resources in the communication process, which should be seen as an essential part of the plan to achieve the environmental objectives.

The Ramsar guidelines give stakeholder involvement in the development and delivery of decision making as a fundamental principle. The stakeholders comprise organisations and communities with interests at the local, national and international level. The interests of the individual stakeholders are potentially conflicting, especially in regard to the upstream-downstream interaction in the basin.

In order to develop a mutual understanding, it is essential to develop and implement a communication and participation strategy encompassing the lateral intersectoral issues, and the vertical community-national-international issues. An important dialogue lies between the technical expertise (in hydrology, biology and sociology), and the indigenous expertise of the local people acquired over many lifetimes living in and interacting with the delta and its natural resources.

The Permanent Okavango River Basin Water Commission (OKACOM) was established in 1994 as a regional, high level committee to ensure the water resources of the Okavango River Basin are managed in appropriate and sustainable ways, and to foster cooperation and coordination among the three Basin states: Angola, Namibia, and Botswana. The OKACOM Project Management Unit is based in Luanda, Angola, while the executive secretariat will be based in Maun, Botswana.

Objectives

The objective of communication and participation is through sharing knowledge develop a mutual understanding of the issues affecting all stakeholders, leading to agreement on the conservation and wise use of the natural resources of the river basin and delta as expressed in an integrated management plan. To this end, the stakeholders must be fully involved in drafting, adopting and implementing the plan.

Among the communication and participation problems which can be foreseen at the outset are:

- Accurately targeting individual stakeholders and communities

- Ensuring the free flow of information among communities, government organisations, non-government organisations, and private organisations, and also among the three basin states
- Access by remote delta communities to communication media

Definitions

In discussing communication issues, the terms public and stakeholders are frequently employed. While the terms may be intentionally vague to allow flexibility in the approach for each river basin, and also as the participation process evolves, definitions are offered here.

The **public** refers to individuals with some limited interest in the river basin. Members of the public will include residents of the basin, citizens of the countries with a geographic part of the basin, and citizens of countries who tap the resources of the basin, eg by interbasin water or hydropower transfer.

Stakeholders refers to individuals and organisations with direct interests in the river basin. Stakeholders will include poor communities depending on the basin's natural resources for their livelihoods, farmers relying on surface and ground water for irrigation, municipal water suppliers (public and private), industries utilising the basin's natural resources, including hydropower, water and environmental organisations (government and non-government).

Anyone can include persons and organisations interested (as opposed to having a direct interest in) and willing to contribute to the management planning in the basin. Such may be persons and organisations who can contribute experience at all levels from other river basins, educational establishments wishing to draw on the knowledge and experience generated by the management planning process, research establishments wishing to conduct research which may contribute to the planning process, etc.

General Approach

Principles

A starting point to establish the principles for public participation is the lesson learnt from the past: the command and control of natural resources determined by technical experts with generic experience has in some cases led to adverse environmental consequences. It is essential to share the management planning process with the people who depend on these natural resources for their livelihood, and who have corresponding direct local knowledge and experience from the basin. The combination of expert and lay knowledge of the basin leads to a better understanding of the root causes and effects, and thereby a more appropriate management plan.

The purpose of public participation may be stated as improved decision making, based on shared knowledge, experience and scientific evidence among stakeholders, and influenced by the views and experience of those directly affected. This will lead to fewer misunderstandings, particularly between technical and lay persons, a plan that is broadly acceptable to the public and a smooth and effective implementation. The principle of subsidiarity should be adopted, ie the central authority should have a subsidiary function, performing only those tasks which cannot be performed at a more local level.

Participation in the planning process has commenced as it should at an early stage, with traditional council (kgotla) meetings held in 33 settlements in and around the delta (further particulars of these sessions are described in section 3, Outputs). This early face to face consultation between governmental officials and technical experts, and the local communities and their leaders is intended to engender a spirit of transparency and trust, which should run through the entire participation process.

As identified in the ODMP project document, not all stakeholders are equal in respect of their power and influence in the planning process. A balanced representation is necessary, where all stakeholders enjoy mutual appreciation and respect. To this end, local communities in particular need to be empowered in respect of access to communication media, and thereby improved knowledge and understanding of the broad environmental context in which decisions are taken. Without educating the local communities, there is a high risk that government organisations and industry dominate, and the local communities lose interest and drop out of the participation process. As part of the education process, as proposed by the Ramsar guidelines, it is necessary to instil a widespread appreciation of the values of wetlands, replacing the previous notion of swampland as areas that had to be drained before they could be productive.

Mechanisms

Communication and collaboration mechanisms need to be established in a consistent and efficient structure to engage all stakeholders fully and equally in the participation process, and to allow open fora for public and international information and consultation.

A key mechanism in the public participation process will be regular progress and completion reporting giving an overview of the process, setting out:

- the communication plan
- who has been reached, their reaction, and overall degree of satisfaction with the process

- the resources expended on public participation, in relation to the overall planning process
- the lessons learnt, as input to future activities

Each river basin and its communities is unique, and there can be no tailor made solutions. It will be advantageous if all parties involved can view the exercise as a dynamic learning process, in which all participants are learning about the needs and views of the others, and through mutual trust, respect and overall transparency, learning to appreciate the others' positions, and adapt their stance accordingly.

It will be an essential part of the communication process firstly to assess the capacity of the stakeholder groups to engage in the participation process, to identify needs, and to arrange training sessions to educate the stakeholders.

Among the Ramsar guidelines on communication for wetlands are:

- fostering sustained national campaigns to raise community awareness of the ecosystem values of wetlands, both economic and social
- integrating wetland management into regional, national and catchment sectoral policies, strategies, plans and programmes
- communication operating laterally across the concerned sectors, and vertically between stakeholders and the government
- building a well informed decision making public constituency, leading to participatory multi-sectoral stakeholder participation in management
- adopting pilot projects to evaluate the range of approaches to communication: review case studies and existing programmes, document lessons learnt, draw findings and conclusions
- develop a web site open to all, with fora for consultation in the various sectors, and interaction among the various sectors, and incorporating a directory of expertise which participants may consult for additional information
- setting up a wetland educational centre, twinned across catchments and basins, to encourage the exchange of knowledge within the basin, and among river basins; the centre should comprise interpretive exhibits, with links to aquaria, botanic and zoological gardens
- establish systems to monitor the key hydrologic, chemical and biological parameters, involving local communities in the monitoring to the extent possible

Instruments

It is necessary to assemble a balanced set of instruments to address the needs of each stakeholder. The involvement of the stakeholders has to be organised and planned in a series of fora, comprising:

- Bilateral meetings, in which issues of relevance to the individual stakeholders can be separately discussed, and aspects raised which may be too sensitive to raise in fora with wider participation
- Sectoral advisory groups, in which those with wide expertise and local knowledge may come together on a regular basis to review participation progress relevant to the different sectors, and guide further activities in these areas
- Workshops in which all stakeholders come together to be informed on the planning progress, and to provide direct feedback, particular on key issues; workshops may also be designed to generate solutions to problem areas, with definitive measures to be undertaken

The Internet is sufficiently well established worldwide that it must be an essential and fundamental means for communication. Its universality makes it the perfect medium both to inform and receive feedback from stakeholders, the residents of the basin, and the international community.

In developing countries, the local communities cannot be expected to have ready access to the Internet, and this is certainly the case for communities in the inner delta, whose involvement is crucial to the management planning process. Alternative means of communication have to be established, and in this respect existing traditional communication infrastructure should be the first considered.

Basin management planning, and in particular negotiations over water allocation among competing uses has to be based on solid data and analysis, accepted by all participants. Existing knowledge of the phenomena governing the hydrologic patterns in the particular basin is often available for the management planning, but frequently this knowledge is expressed in qualitative terms, and open to dispute among stakeholders wishing to emphasise their particular views and opinions.

It is important firstly to establish reliable systematic monitoring of the hydrologic parameters, and build a solid reliable database as the bases of scientifically objective hydrologic analyses. The results which may range from desktop studies to sophisticated integrated hydrologic models can provide indisputable transparently objective data as the basis for crucial negotiations over water allocations. In particular hydrologic models can in addition to representing the present basin state may be employed to predict future states under different scenarios, such as water resource developments, and regional climate changes.

Implementation for Okavango Delta

Introduction

The Communication strategy for the Okavango Delta Management Plan (ODMP) explicitly recognises the invaluable contribution that can be made by the local communities to the planning process. Local people are constantly in direct contact with the natural resources of the delta, and most depend upon these resources for their livelihood. They have the most to gain from their proper management, and to lose from their mismanagement. As such local people are well placed to make informed choices in natural resource use and management which meets their present needs and future aspirations.

There is at present a particular lack of dependable information tools and communication mechanisms for the management planning process in the delta. Considerable work is required to develop and implement these. While hydrology is recognised as being fundamental to the behaviour of the delta, it is also necessary to develop a sound understanding of ecological, social and economic conditions, and linkages among these.

A further aspect is the dependence of the delta environment on the natural inflow from the upstream riparian states, Namibia and Angola. Owing to civil strife in these states, little significant water resources development has taken place to date but, as peace settles firstly on Namibia and then on Angola, this will change. It is essential that the upstream basin states are informed regarding the present state of the delta, and the possible consequences of upstream water resources developments, and engaged in discussion of these issues.

OKACOM

The Permanent Okavango River Basin Commission (OKACOM) was established in September 1994 with a declared political agreement to work towards joint management of the basin. Under the OKACOM Agreement, the riparian countries are working toward the implementation of an integrated management plan for the basin on the basis of an environmental assessment. UNDESA has been providing technical assistance to OKACOM since 1995 in preparing a transboundary diagnostic analysis of the basin and mobilising funding through the Global Environmental Facility (GEF) and other bi-lateral donors.

To date work towards joint management of the basin has been conducted to a degree by three previous basinwide projects, working through OKACOM:

- **Every River Has Its People** – the Kalahari Conservation Society in association with the Namibia Nature Foundation is running an awareness raising project for communities in and around the Delta; both countries have undertaken some baseline studies and the next step is to reconcile the findings with possible developments in the river basin, and allow people to be fully informed and consulted about future developments. ODMP anticipates utilising the baseline data as well as cooperating with the efforts of the project to establish effective lines of communication and consultation.
- **Water and Ecosystem Resources in Regional Development (WERRD)** seeks to improve and develop scientific methods that will facilitate the monitoring of fluctuations of hydrological and ecosystem variables of the Okavango River Basin; articulate local knowledge and relate this to other dimensions of knowledge; and link the components of the natural resource system to the socio-economic dynamics and to national and international policy.

- **Sharing Water** offers a platform, called collaborative learning, for collective resource inquiry and for negotiation about sharing water and related ecological resources. This approach is designed to build the commitment and knowledge base needed to manage ecological complexity and uncertainty.

And should be furthered by ODMP and TwinBas activities.

Outputs

The following are the basic elements of the communication strategy for ODMP.

- a communication strategy, widely accepted by all stakeholders and the public
- communication mechanisms: tools, training materials, meeting and workshop schedules and proceedings
- Training and capacity building for all stakeholders, with particular emphasis on the weaker stakeholders so they can participate in the development of the plan as equal partners alongside the more powerful and influential stakeholders
- Informed upstream riparians, understanding the potential impact on the delta of upstream water resources developments, and collaboration in data sharing.

The key specific outputs of the Communication component will be:

- (1) The identification of existing organisations and the projects they are undertaking.
- (2) An analysis of the stakeholders, including key target groups (local, national and international).
- (3) An assessment of stakeholder needs in respect of ODMP, training and capacity building programmes, and the implementation of scheduled activities to meet these needs.
- (4) The design, production and dissemination of communication tools: brochures, newsletters, press releases, radio and television programmes, magazine articles, etc.
- (5) Increased awareness, learning and participation among stakeholders.
- (6) Key linkages with local, national, regional, international networks related to river basin management.
- (7) Progress reports on the implementation of the communication strategy.

The foundation of the communication process will be stakeholder group meetings, comprising:

- (1) consultative meetings to develop national wetlands policy and strategy
- (2) technical workshops to compile major environmental threats
- (3) traditional community council (kgotla) meetings
- (4) Community Based Natural Resource Management (CBNRM), highlighting conflicts among stakeholders
- (5) Through the medium of OKACOM, whose secretariat will be established in Maun (the major town within the Ramsar boundary and the same location as the ODMP Secretariat).
- (6) A Sociological Survey of the Basin (from Every River)
- (7) Stakeholder Workshops to formulate the design of ODMP.
- (8) Face to face consultations among communities, NGOs and government departments.

Activities

Community Meetings

The administrative district for the Okavango Delta is Ngamiland. Ninety-seven percent of the district lies within the Ramsar Boundary, with a population of 121,661. Community meetings have been held in and around the delta, in all major settlements with a population greater than 500, and in remote communities with populations less than 500. The aims of the meetings were:

- To inform the communities about ODMP and its planned activities
- To conduct a presentation by the project management, with extensive question and answer sessions
- To identify major issues and potential areas of conflict

The meetings were attended by an average of 1.5% of the population. Traditional leaders expressed dissatisfaction with the low attendance, particularly by the educated youth of the communities, who should have shown a more active interest.

The gender ratio among those attending the meetings was 2:1 men to women. Of those speaking out, women were less than 1%. It has been the tradition that women and young people are neither encouraged to attend such meetings, nor to speak out. This is changing, as demonstrated by the appointment of a woman as Chief of Chiefs (traditional leaders) for the first time in Botswana in 2003.

Nonetheless, it is recognised that in this traditional society those who attend will pass on the information and discussion issues to other members of the community who did not attend. This may be supported by the fact that in the smaller communities the attendance percentage was higher.

Tourism Sector

The tourism sector is particularly important to the economy of the delta, and to the national economy. Tourism generates the third largest income after diamonds and cattle farming, and contributes around one sixth of GDP. Its development is a key component of the government's strategy to lessen the economy's dependence on diamond mining, which has finite reserves.

Tourism in the delta is managed by the Department of Wildlife and National Parks (DWNP), in the Ministry of Environment, Wildlife and Tourism. The main area is the national park, Moremi Wildlife Reserve, comprising around one third of the delta area. Other areas are let out to the private sector as concessions. The emphasis is on low volume high value tourisms, based on remote luxury lodges managed in an environmentally sensitive manner, to minimise adverse impacts on the sensitive environment.

A particular meeting was held for the tourism sector. One hundred and twenty companies were invited, of which 60 were represented. The meeting had the format of a presentation, followed by a question and answer session.

Feedback

The feedback from the community and tourism sector meetings may be summarised as follows. Remarks in brackets endeavour to clarify the issues were appropriate.

General

The provision of government services to the communities of the delta is inadequate. Twelve percent of comments related to shortcomings in the process of communication. Lack of communication and coordination among government departments was frequently observed.

While the plans for the consultation process were welcomed, providing an opportunity to discuss concerns, it was the expectation that opinions would not be taken seriously, there would be no feedback, and no apparent action. (An example cited was the planned hydropower development at Popa Falls in Namibia.) Preconceived plans had already been laid, based on the political aspirations of their proponents.

The government is more interested in the protection of the delta than in the well being of its inhabitants. The natural environment is in good condition, thanks to the role of traditional leaders in safeguarding the natural resource. Conservation regulations are contrary to traditional use. These should be available in Setswana (the local language for Botswana), and not just English (the language of government in Botswana).

Participation

There was a general appreciation of the of the consultation mechanism that has been initiated. Scepticism was voiced based on the fact that no action had been taken on issues raised previously in such fora. It was also felt that local opinions are not taken seriously by government officers who have already made their decisions, as there has been no feedback from the government departments. There was a clear lack of trust in the government.

Local land users have profound knowledge based on lifelong experience, and as such are better informed than the technical experts, but they do need more information and technical knowledge, through educational workshops, to contribute meaningfully. There is a need for a central data and research institution, focussing on well targeted research, with data and results readily accessible to all stakeholders.

Hydrology

There is a long term decline in flooding in the delta, and upstream dams have already reduced the water inflow to the delta, and the water pollution is increasing. (Both these perceptions are in fact incorrect, so far.) There is less rainfall over the delta. (In fact the rainfall over the basin, and the inflow to the delta, have been observed to have eighty and ... year cycles. The last ten years have seen less rainfall.)

Proper EIAs had not been carried out for the ground water abstraction along the western and southern margins of the delta. The clearance of vegetation blocking the flow of water through the channels of the delta is also a controversial issue among local communities.

Wildlife

Elephants pose the greatest threat to the person and livelihood of the delta's inhabitants. The compensation offered by DWNP for the damage caused by protected species is inadequate.

Vegetation

Fires destroy the vegetation. (Fires are started both naturally and deliberately by man. They are also part of the natural process of regeneration of the vegetation.) The natural resources are harvested as an important part of the livelihood of the communities, eg reeds to make traditional baskets. The government wants to stop harvesting. Outsiders are also coming into the area to harvest the resources. There a lack of enforcement by the government to prevent this. To manage the resources better, more responsibility should be given to local leaders.

Livestock

Cattle are the main livelihood for people living in and around the delta. It is anticipated that cattle farming will be limited by ODMP. The veterinary fence which rings the inner delta and separates cattle and wildlife (which harbours infectious diseases such as foot and mouth) is a major controversial issue. The fences are damaged (by wildlife and villagers?), and maintenance is adequate. Cattle found inside the fence are shot, and compensation is inadequate. The eradication of tsetse fly by aerial spraying has been good (allowing the existence of cattle and humans in the delta). Boreholes have been drilled in the outer delta areas, drawing water from the vegetation.

Flood recession (molapo) farming is a traditional activity, yet there is a conservation ban on farming within 500m of a watercourse.

Tourism

Tourism creates jobs and is a major income for the inhabitants in and around the delta. The communities should be more involved in its exploitation – there is a lack of transparency and the private companies are seen as removing a large part of the income from the area and the country. (It is reported that only one third of the income from tourism remains in Botswana.) Tourism is operating at its full capacity. Waste management at tourist camps both public and private is inadequate.

Hunting and Fishing

Hunting and fishing rights in the delta are restricted, though boundaries are unclear. (Permit based hunting is permitted in certain areas of the delta – a license to shoot an elephant and remove the trophy costs around USD10,000 – many people believe the area is overpopulated with elephant, though environmentalists may disagree.) there is a conflict between fishing for local subsistence (permitted outside the wildlife reserve) and fishing for sport. There is no proper control, and stocks are being depleted. Poaching is common.

Water Resources Working Group

Given the fundamental importance of water to the environment of the Okavango Delta and to the Okavango Delta Management Plan, it is proposed to form a Water Resources Working Group within ODMP. The group would comprise a water representative from each of the twelve ODMP components. The function of the group would be to foster a close interaction between the activities of the Hydrology and Water Resources component, and the water related needs of the other components.

Hydrology and Water Resources Component

Botswana has few sources of surface water, posing a constraint on national development. The largest of these sources is the Okavango Delta. The Hydrology and Water Resources component has the task of addressing the issues relating to the waters of the delta, their occurrence, distribution, state and utilisation.

The Hydrology and Water Resources component has two main tasks:

- Set up an improved monitoring programme for the delta
- Set up an Integrated Hydrologic Model of the delta

The basic output from the model will be grid maps and time series of the surface and ground water levels and flows throughout the delta. Additional outputs will include actual evapotranspiration and soil moisture.

Application to ODMP

The Integrated Hydrologic Model will be set up to represent conditions in the delta as they exist at present. The results from the model will provide information on the present patterns of flow and water levels, and on the water balance distributed throughout the delta.

The model may then be applied to simulate various scenarios for ODMP, among which are anticipated:

- Upstream water resources developments: dams, irrigation, water supply in Angola and Namibia
- Surface and ground water abstraction from the delta area
- Clearing choked channels by cutting reeds and dredging new channels
- Regional climate changes
- Other scenarios suggested by stakeholders

For each scenario and combination of scenarios simulated, the model will provide the impact in terms of water levels, discharges, etc. Appropriate grid maps and time series of inputs (inflow, precipitation, etc) will be prepared by the Hydrology and Water Resources component and applied to the existing state of the delta.

Based on the results of the basic scenarios, a set of scenarios representing the management plan will be prepared and through an iterative approach interacting with the stakeholders refined to the proposed plan. An essential part of the process will be training stakeholders in understanding the hydrologic processes at work in the delta, the mutual development of interpretation of the model results and the links between hydrology and the ecosystem, communities and biodiversity.

Specific stakeholder comments and concerns relating to the waters of the delta and their analysis, and the means taken to address these, are listed in Annex A.

Integration with Other Components

It is anticipated that the other six technically oriented components of the management plan will use the results of the model to assess the impact of these scenarios on their individual areas of concern. For example, given a scenario with increased abstractions for irrigation in upstream countries, the water levels and flows in the delta will be reduced. The model will provide these reduced water levels and flows throughout the delta.

The seven technical components may then assess what the impact will be on their particular sectors. The most feared, and perhaps also the most likely, impact of future development in the Okavango River Basin will be reduced surface and ground water levels, and extent of the swamp and river system. The results of the model may be used by the individual components to assess the impact, for example:

COMPONENT	POTENTIAL IMPACT
Hydrology and Water Resources	Reduced availability of surface and ground water supplies
Wildlife Management	Reduced availability of surface and ground water may result in fewer wildlife numbers
Vegetation Resources	Reduced water availability may result in increasing desertification in and around the delta

Fisheries Management	Reduced flows and levels may result in fewer breeding grounds and reduced fish stocks and varieties
Sustainable Tourism	Reduction in the flora and fauna numbers and diversity may result in fewer tourists to the delta
Waste Management	Reduced flows may result in reduced dilution of water borne waste products
Livestock Management	Reduced surface and ground water availability may result in fewer livestock numbers and production

The Integrated Hydrologic Model will provide the impact of development scenarios on the flow patterns in the delta. It will not provide the impact on wildlife, fisheries, tourism, etc. The impact on these sectors has to be estimated by these individual components. The Hydrology and Water Resources component does not have expertise in these areas.

The role of the Working Group will be to provide a forum:

- (1) in which the results of the hydrologic analyses may be presented to the other ODMP components
- (2) for discussion on how the results should be interpreted, with respect to accuracy, sensitivity, limitations, etc.
- (3) for discussion on the preparation of scenarios for the hydrologic analysis
- (4) for discussion on the analysis by the components of the impact of the present and potential future scenarios on their respective sectors.
- (5) For discussion on possible improvements to the model, in respect of accuracy, level of detail, extension to water quality features, incorporation of water resources developments, etc.

Annex - Stakeholder Concerns relating to Hydrology

Specific Concerns

Long term changes in flood regime, drying up of wetland, shifts in flood pattern

- (1) The hydrologic model will analyse the impact of the various scenarios, and present the results as time series, sections and plan views of surface and ground water levels and flows (and many other parameters) throughout the delta. Intercomparisons will be made among the scenarios.

Factors affecting accuracy of model

- (2) Hydraulic gradient – the surface and ground water components of the model are fully hydrodynamic, thus the hydraulic gradient is central to the model computations.
- (3) Dewfall – this is not significant for the water balance and distribution in the delta. Simulation of dewfall is part of the hydrologic model, but currently not utilised. The only effect would be a short delay in the evapotranspiration in the early morning. Over longer periods heat flux for condensation and evaporation will cancel each other out.
- (4) Flow bypass at Mohembo – two possibilities are available to address this: using the gauging station at Mukwe/Divundu as the upstream boundary, where the total flow is captured by the station (data are still being sought from DWA Namibia and NamPower); or assessing the amount of flow bypassing Mohembo, and including this in the inflow hydrograph.

Capacity constraints

- (5) Implementation of improved monitoring – this is a serious issue for DWA: the local head of hydrology is being transferred from Maun to Gaborone to manage the programme. Progress should be assessed to consider whether more resources are required to implement the programme.
- (6) Modelling technology transfer – also a major issue for the sustainability of the planning process; current assessment is that the transfer is proceeding well, despite the Modelling Unit being understaffed (four instead of five), and the staff being slightly less experienced than desired – the progress needs to be kept under review.

Contact with international research institutes

- (7) As a source of knowledge, information and data international research institutes can be valuable – the data have to be freely available to Botswana, and in a readable format (ie not requiring special software). In respect of hydrology, much valuable information has been provided by the Okavango Research Group in Witwatersrand University and by ETH in Zurich.

If other institutes have and are willing to provide data, DWA will request these for the information base. Much of the data have been obtained for specific research studies, and are limited in time and in space. Nonetheless, they can contribute to building up the overall picture, which is required by the management plan.

Observations by local land users

- (8) Given problems with access to the delta and security of permanently installed instruments, local land users can be valuable in offering a degree of protection, taking readings from manual devices or changing the memory of automatic devices, carrying out basic maintenance, and reporting problems. They may not be fully reliable, as they have other priorities which may at times take precedence.

Sectoral Water Requirements

An issue for the management plan scenario runs of the Integrated Hydrologic Model is the impact of existing and projected water abstractions from the delta. The input required by the model is how much water will be abstracted from which location when, for present conditions and future projections in say five or ten yearly increments for the next twenty or thirty years.

The supplies arise from domestic, industrial and agricultural demands in and around the delta. The information on present and future abstractions is available within DWA. The data for input to the model will be prepared by DWA for the various management plan scenarios as time series to be applied as surface and ground water withdrawals at specified locations.

The hydrologic model will analyse the impact of the abstractions, and present the results as time series and plan maps of surface and ground water levels and flows throughout the delta. Intercomparisons will be made among the scenarios.

Other sectors are not perceived as nett consumers of water, but may be affected by the water levels and flows under existing and plan scenarios. The model will output the surface and ground water levels and flows as grid maps and time series at any location in the delta. It will be the responsibility of the other components to determine the impact on their sectors (fisheries, wildlife, tourism, etc) of these changed levels and flows.

Concerns Related to Development Scenarios

The concerns expressed by stakeholders in relation to water resources development scenarios are summarised in the following table, along with the proposed analyses, categorised by:

- Upstream water resources developments
- In-delta water resources developments
- Channel interventions
- Climate change
- Non-hydrologic

CATEGORY	SCENARIO	STAKEHOLDER CONCERN	REMARKS	MODEL ANALYSIS
Upstream Water Resources Development	Hydropower	Hydropower plant in Namibia	Will not consume water, but will dampen the distribution from the flood to the dry period.	Can be fully simulated by model.
			Will trap coarser sediments, and may affect the water:sediment phasing.	Model will only simulate sediment in river channels. Results will need interpretation, and be correspondingly qualified.
	Irrigation	Increasing demand of upstream users	Will result in nett loss of water. Could result in major adverse impact.	Changes in upstream basin will rely on basin models developed by other projects for the impact on the inflow hydrograph.
	Water supply		Domestic and industrial use will result in nett loss, likely to be a minor adverse impact.	
	Interbasin Transfer		Proposed to Swakop River Basin within Namibia	
In-Delta Water Resources Development	Surface and ground water abstraction.	Proper EIA for water abstractions	Domestic and industrial use will result in nett loss, likely to be a minor adverse impact. Risk of long term depletion of resource.	Can be fully simulated by model.
Channel Intervention	Cutting vegetation and dredging channels.	Vegetation blockages Flow interventions by government	There are two aspects here: one is encroaching vegetation blocking an existing open channel, and the second clearing a blocked or a new channel.	If carried out on main channel, can be fully simulated by model, otherwise the impact will be less precise. The model cannot simulate the encroachment of the vegetation, only the hydraulic impact where and when it occurs.

CATEGORY	SCENARIO	STAKEHOLDER CONCERN	REMARKS	MODEL ANALYSIS
Climate Change	Various states of increased turbulence.	Lack of rainfall	Hydrologic model input data will be provided by the output from regional climate models (applied by other projects).	Changes over delta can be fully simulated with model.
	General increase in temperature, decrease in rainfall, etc.			Changes in upstream basin will rely on basin models developed by other projects for the impact on the inflow.
Non-Hydrologic	Invasion and spreading of alien species	Spreading of salvinia		The model cannot simulate the spread of salvinia. This can be assessed by the distribution of flow under existing conditions or future scenarios.
	Pollution	Increased boat traffic Poor liquid waste management		The model cannot at this stage simulate water quality, including the transport of substances in suspension or solution. This can be assessed by the distribution of flow under existing conditions or future scenarios.