Participatory analysis of tradeoffs between wetland ecosystem services in the GaMampa valley, Limpopo Province, South Africa. Lessons for resources management aiming at wetland sustainability

Clément Murgue

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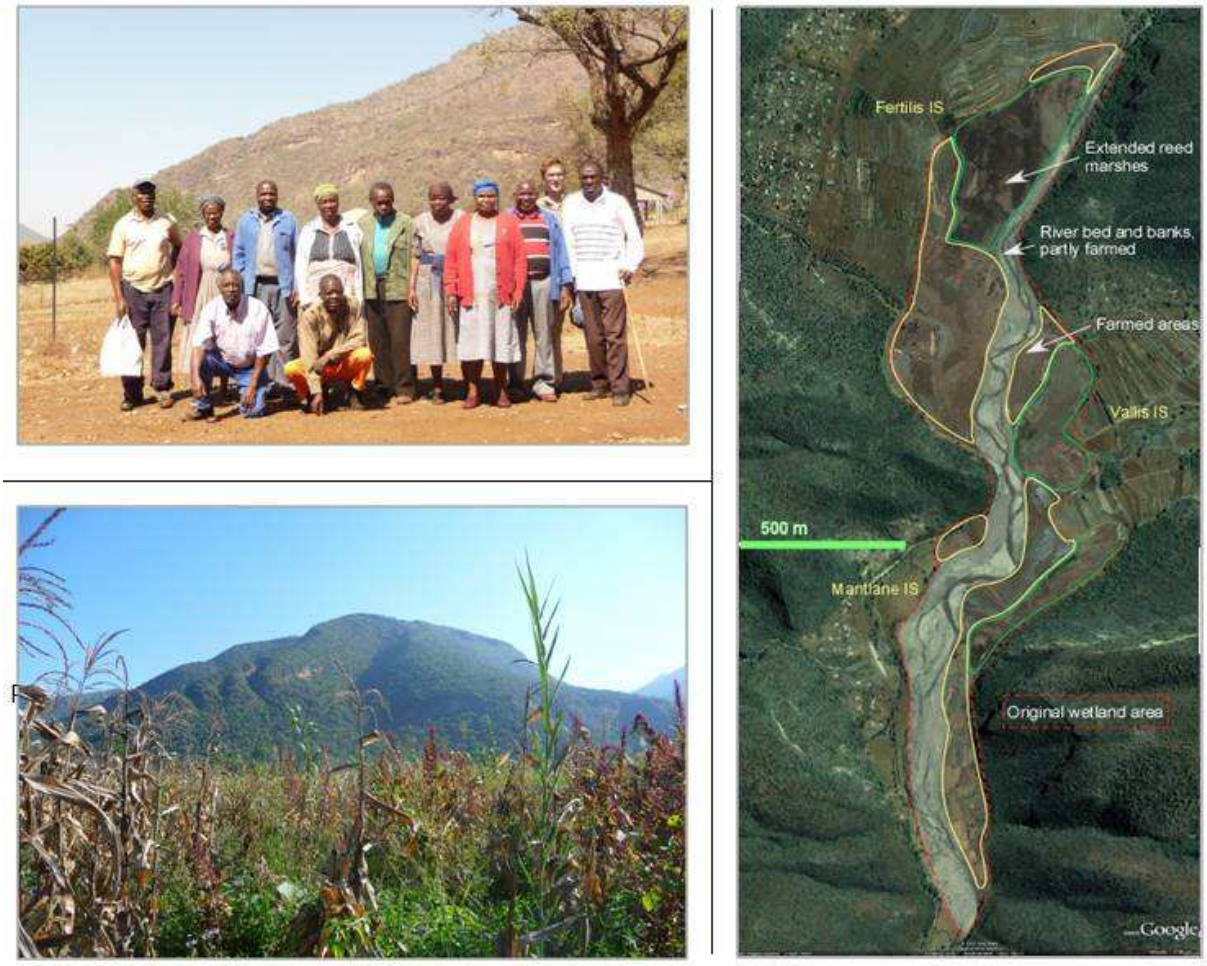

Presented by:

Clément MURGUE

For "Diplôme d'ingénieur de spécialisation en Agronomie Tropicale, option GSE, de l'Institut des régions chaudes-Montpellier SupAgro »

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Presented on December the 10th, 2010

LAYOUT OF THE DOCUMENT

ABSTRACT

The GaMampa wetland is located in the Olifants River catchment, in the Limpopo province of South Africa. It traditionally supports livelihoods, mainly through natural vegetation collection for food and raw materials provisioning. Since the 1990's, and most intensively from 2000 to 2005, it has been drained and its natural vegetation cut and burn for subsistence maize cultivation. Its ecological integrity is thus jeopardized. The sustainability of the biological and geomorphologic features, as well as traditional provisioning and contemporary farming opportunities, is questioned.

In a diagnosis of the situation, the research identified the reasons for this sudden change in wetland use, advancing that they originate in the institutional changes after the end of the apartheid regime, from top bottom state centered to community based management of resources. This, without a proper transfer process, resulted in local irrigation systems breakdown and a general abandonment of management policies.

Starting from existing data on the case study, mostly developed under the CPWF 30 project and the WETwin project, this study analyzed the possible management responses to the problems of the wetland, emphasizing the need for integration of the wetland to the GaMampa valley resource system and thus the need for a global management of the resources aiming at wetland sustainability. This report provides details on management options and their alternatives for implementation, developed through consultation of the stakeholders. It also proposes 4 sets of Management Solutions which can be used both by the WETwin project for future research purposes and the GaMampa valley decision makers to establish a management plan.

Keywords: Wetland ecosystem; Community resource management; Management Plan; Management Options; Management Solutions; Provisioning services; Irrigation scheme rehabilitation.

ACKNOWLEDGMENTS

Ke tla rata leboga batho ya GaMampa....
I would like to thank **all members of the GaMampa community** for their participation to my research. I sincerely hope that it has and will help in managing the natural resources of their beautiful land. I must also thank the chief of GaMampa and the Kgoshi of Mafefe for their hospitality on their land.

Ke tla rata leboga batho ya CRCE...
The people of the Center for Rural Community Empowerment made my work possible by having me in their office, and my stay enjoyable. I would like to thank **Ernest Letsoalo** and **Koketso Mphahlele** for this. **Tumelo Masilela** made this work possible not only by providing his knowledge of the Sepedi language but also helping very much the data processing and for this I am thankful, as much as I am to have him as a friend.
Bernard Mashavela was a great translator, informant, facilitator and an amazing friend. I will never forget what he and his family did for me. Thank you Baba!

I would like to thank the people in IWMI...
First I wish to thank **Robyn Johnston** for her involvement in my work and her everlasting positive attitude, I believe she is a great coordinator for the Olifants research team and learnt a lot from her. I would also like to thank her for her support and help which was very much appreciated.
I must thank all people in the Pretoria Office, especially **Luxon and Wanda**. Above all, thanks to **Karen Gunter**, for assisting me in all difficulties I encountered!

I would like to thank the people in France...
I would like to most especially thank Prof. **Sylvie Morardet**. I received both assistance when I needed and trust for responsibilities on the work we did together. I appreciated working with her very much and learnt a lot on her side, it was a great experience.
Marie Jeanne Valony and **Sylvain Lanau** made my second year in IRC interesting and useful. I appreciated the good relationship they keep with their students and am thankful for having them as supervisor; they really made everything nice and simple.

I wish to thank my mother and father, for always being behind me wherever I go, whatever I do. I thank them for these studies which made me, and I hope that they can be proud of my work.
Finally, I would like to thank Philippe and Véronique, for their hospitality but mainly for their care. This work would not be the same without them.

I dedicate my work to Lison,
may she, one day, see these animals that she loves so much already

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GLOSSARY

Kgoši: tribal chief
Headman: tribal chief, representative of the Kgoši at village scale

ACRONYMS & ABBREVIATIONS:

GSE : gestion sociale de l'eau
IWRM: Integrated Water Management
Cemagref: *Centre de machinisme agricole des eaux et forêts*
IRC: *Institut des Région Chaudes*
UMR: *Unite mixte de recherche*
GEAU: *gestion de l'eau, acteurs, usages*
IWMI: International Water Management Institute
CRCE: Centre for rural communities empowerment
GRET: groupe de recherche de recherche et d'échanges technologiques
DWA: Department of water affairs
LDA: Limpopo department of agriculture
LEDET: Limpopo department of economic development, environment and tourism
LADC: Limpopo agribusiness development corporation
AIR: African ivory route
AFDB: African Development Bank
UNDP: United nation development program
WWA: Wolkberg Wilderness area
LNR: LekgalaMeetse Nature Reserve
MWP: Mohlapitsi wetland project
IC: Irrigation Committee
WC: Wetland Committee
TCNR: traditional council for natural resources
WRMC: wetland resources management committee
MTTC: Mampa Traditional Tourism Center
DPSIR: Driving forces, pressures, state, impact, responses

MR: management response
MO: Management option
MS: management solutions
ToA: Trade off analysis framework
SH: Stakeholder
DoA: department of agriculture
TA: traditional authority
TAP: traditional authority paper
PTO: permit to occupy

INTRODUCTION

This introduction provides elements on the geographical context of the case study and describes the institutional context of the research

Map of South Africa and former provinces

1 INTRODUCTION TO THE GAMAMPA VALLEY

1.1 GENERAL GEOGRAPHICAL AND ADMINISTRATIVE CONTEXT

1.1.1 GAMAMPA IN THE SOUTHERN AFRICAN CONTEXT

The GaMampa valley is in Limpopo[1], the northern province of the Republic of South Africa, within 24°05' and 24°20' S and 30°00' and 30°25' E. It is located in the Wolksberg region of the Drakensberg mountain range, part of the South African Great Escarpment between the Highveld to the West and Lowveld to the East. **The Mohlapitsi, its main, perennial river, is a tributary to the Olifants River and falls in the transboundary Limpopo river basin**. Figure 1 localizes the GaMampa valley in its geographical context.

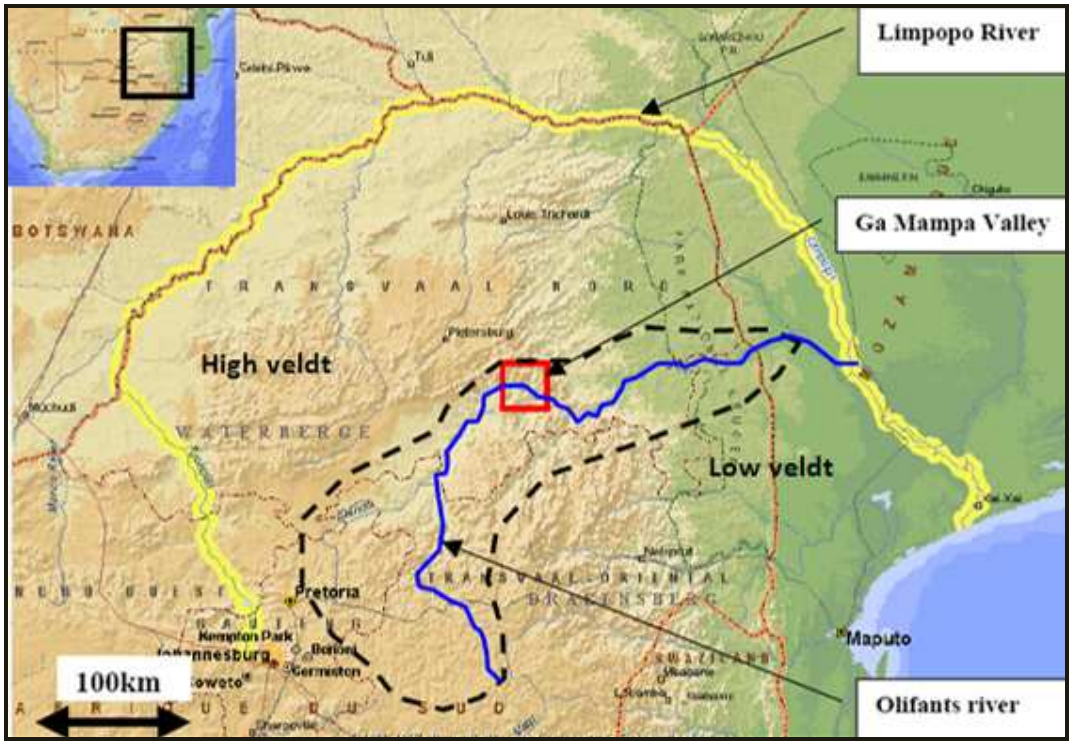


Figure 1 : Location of the GaMampa Valley, the Olifants and Limpopo Rivers in Southern Africa (Chiron 2005)

Box 1: Limpopo fast facts (www.southafrica.info)

Capital: Polokwane (former Pietesburg)
Languages: 52.1% Sesotho, 22.4% Xitsonga, 15.9% Tshivenda
Population: 5 355 172 (2006); 11.3% of South Africa population
Area: 125 755 Km²; 10.3% of total South Africa area
Population density: 43 people/km²
Gross regional product: R81.3-billion (2003); 6.7% of total SA GDP

[1] Formerly known as Northern Province

1.1.2 GaMampa in the Limpopo context

GaMampa is part of the Mafefe tribal land, under Kgoši Setlamorago Thobejane and falls into the governmental administration of the Capricorn district, LepelleNkumpi Municipality, Mafefe wards 23 and 24. It is about 70 Km from the province's capital, Polokwane, and can be reached from there after a 2 hours drive with a private car. The closest urban center is Lebowakgomo; it features the municipality and government department offices, as well as bank facilities. It can be reached after a 1 hour drive approximately.

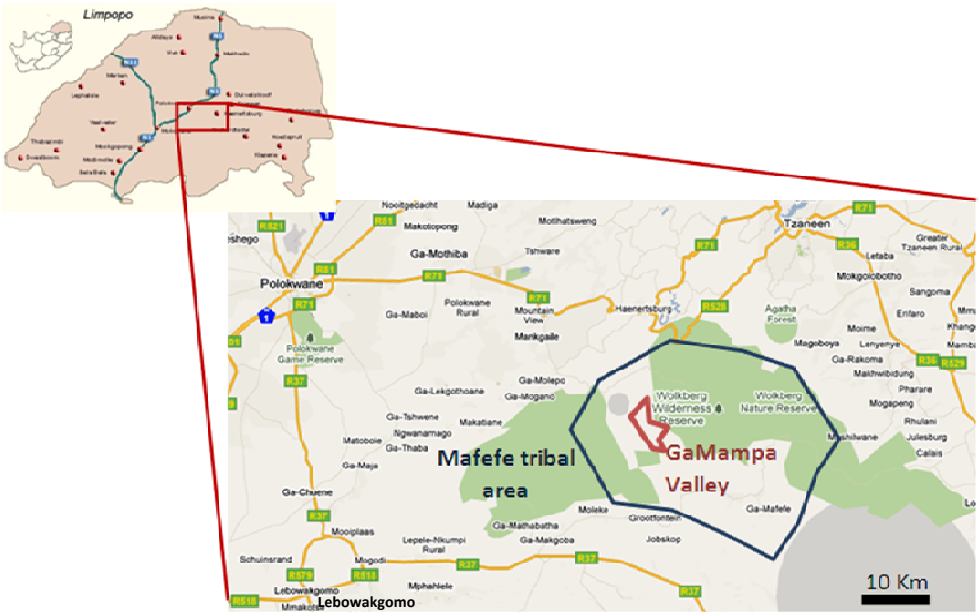


Figure 2 : Approximate extension of the Mafefe tribal land and GaMampa Valley areas in the Limpopo province context (from interview with tribal authorities, googlemaps)

2 INSTITUTIONAL CONTEXT OF THE RESEARCH

This work was possible thanks to collaboration between *Institut des Région Chaudes* (IRC), Cemagref, the International Water Management Institute (IWMI) and the Center for Rural Community Empowerment of the University of Limpopo (CRCE). The results shall benefit directly to Cemagref UMR-GEAU and to IWMI for their work in the WETwin project. This document should also be accessible to the CRCE and to the GaMampa community.

2.1 IRC – A RESEARCH EXPERIENCE FOR GSE

This research took place as a practical experience in order to validate Montpellier IRC Supagro engineer degree in tropical agriculture and rural development, with specialization in social management of water (GSE): *ingénieur en agronomie topicale de spécialisation en gestion sociale de l'eau*. The concept of GSE is further explained in part I.

The GSE chair of IRC Supagro requires students to experience social management of water in rural areas during 4 to 6 months. This internship took place with Cemagref, focusing on socio economic research for wetland conservation and rural communities' development.

2.2 CEMAGREF AND IWMI COLLABORATION - THE WETWIN PROJECT

Quote from WETwin.net:

"The overall objective of the WETwin project is to enhance the role of wetlands in basin-scale integrated water resources management (IWRM), with the aim of improving the community service functions while conserving good ecological status. Strategies will be identified for:

- *utilizing the drinking water supply and sanitation potentials of wetlands while maintaining the ecosystem functions*
- *adapting wetland management to changing environmental conditions*
- *integrating wetlands into river basin management*
- *improving stakeholder participation and capacity building"*

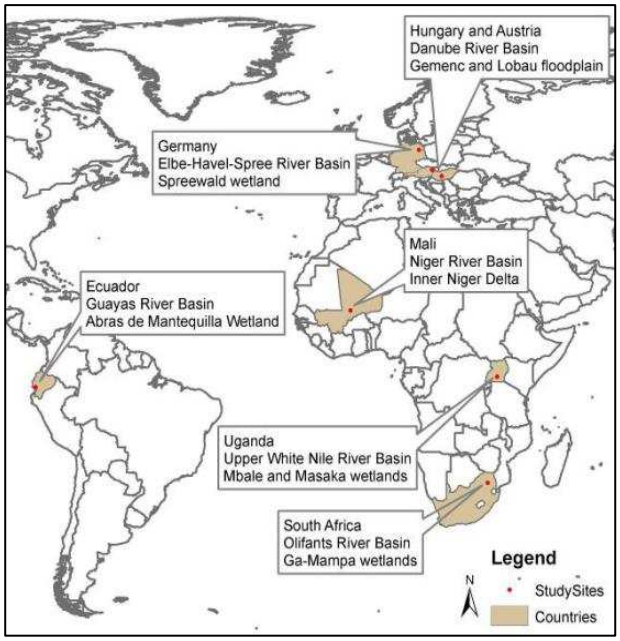


Figure 3: study cases of the WETwin project

WETwin is a European twinning project using 7 case study wetlands in Europe, Africa and South America, including GaMampa. It aims at finding management solutions to both improve the community service functions and conserve good ecological status of wetlands.

IWMI is the site leader for GaMampa wetland in South Africa. It provides coordination and financial support for the WETwin partners also involved in GaMampa, like Cemagref. Cemagref, specifically

the UMR-GEAU team, collaborates with IWMI in the WETwin project, investigating on the GaMampa study case.
Cemagref, under coordination of Dr. S. Morardet in Montpellier France, and IWMI, under coordination of Dr R. Johnston in Colombo Sri Lanka, provide funding, material and agents to lead the researches in the valley, to the benefit of both the WETwin project and their own research objectives.

2.3 COORDINATION ON THE GROUND: IWMI AND CRCE

As to coordinate their researches in GaMampa, IWMI and Cemagref have CRCE as a local partner. The CRCE, Center for Rural Community Empowerment, is based on the campus of the University of Limpopo. It was created by GRET and the University of Limpopo and contributes to rural communities' empowerment through capacity building of both students and local farmers, providing knowledge, and training in rural challenges.
CRCE is represented in GaMampa by Mr. B Mašavela and gives logistical support to IWMI and Cemagref actions in the valley (communication, translation). The CRCE also coordinates University of Limpopo students' researches in the valley, mainly on the WETwin project and the set up of a dairy goat farmers association. CRCE's involvement in GaMampa is of long term, and its main achievement is the set up of a Community Development Forum for the valley.
For this research, IWMI provided material support and funding for research expenses, as well as coordination for visits and meetings and office facilities in Pretoria. CRCE, through all of its members, provided facilitation for the research on the ground, and provided office facilities in the University of Limpopo.

3 LAYOUT OF THE REPORT

This report is divided in three parts.

- **Part I – Presentation of the research**

This part of the document gives an overall presentation of the research. It describes the conceptual framework, including that of the WETwin project, and provides the objectives, hypothesis and methodology followed during field work.

- **Part II – Diagnosis of the GaMampa wetland situation for trade off analysis**

This is a diagnosis of the GaMampa valley resources and management; it gives a presentation of the GaMampa resources system aiming at providing the necessary information for the analysis of tradeoffs in the wetland.

- **Part III – Study of the management options and solutions for the GaMampa Valley**

This part presents the results of the research and discussion on management options and management solutions. It is mostly for the use of the WETwin project WP8 for modelling of management solutions and Multi Criteria Analysis (MCA). It can also be used by local stakeholders for the set up of a management plan.

Part I - Presentation of the research

This part of the document gives the conceptual framework, including that of the WETwin project, and provides the overall objectives, hypothesis and methodology followed during field work.

View of a Sycamore tree in the GaMampa Valley (personal photo)

1 CONCEPTUAL FRAMEWORK

1.1 GENERAL CONCEPTS

1.1.1 WETLAND CONSERVATION AND RURAL DEVELOPMENT IN SOUTH AFRICA

The following paragraph is taken from (Masiyandima, McCartney et al. 2006)
"Wetlands in southern Africa support the livelihoods of many poor people through agriculture for both food production and income. They are used to mitigate the problem of low crop yields associated with low rainfall and droughts However, wetlands are complex and sensitive ecosystems, and they fulfill important environmental functions."

Numerous environmental and economic services can be attributed to wetlands (Millennium Ecosystem Assessment, 2005). Despite the international paradigm on protection of wetlands (RAMSAR Convention 1971) and despite the multiple functions that wetlands provide for ecology and society, many wetlands in South Africa are subject to degradation. **In many parts of the country, the need for food production challenges the sustainability of these ecosystems** through agricultural encroachment. Not only ecological but also traditional good provisions of wetlands decline in the context of globalization and modern lifestyles (e.g. Crafts, collection of wild plants and cultural practices). As Masiyandima and Mc Cartney explained in 2006, this applies specifically in South Africa where emerging farmers recently tend to intensify their use of wetland under pressure of climatic context.
Ecological functions and values of wetlands are crucial not just on local scale but also on basin-wide scale. Because of the multi-functional character of wetlands and their environmental sensitivity, wetlands should be integrated to river basin management.

Wetland conservation feeds environmental and development research often focusing on compromising agricultural use and ecosystem services. Several guidelines exist on sustainable wetland management and yet these are insufficiently implemented. The reasons behind this should be assessed precisely but may lie on the lack of communication between the world of research and development on the local scale. For example **in South Africa context, the legislative framework has taken into account the need to integrate water management at basin level and thus considers wetland conservation as a mean to sustainable water use** (Dos Santos 2009). Nevertheless, rural communities have long been using these ecosystems and the implementation of wetland conservation measures faces difficulties mainly due to the difficult rural socio economic context. At provincial and national levels, the context of water scarcity together with the multiplicity of water users in river basins adds to the difficulty of implementing sustainable water management policies.

In a context of wetland conservation and rural development, this research tries to assess the possible implementation of tradeoffs between human development and nature conservation.

1.1.2 GSE AND IWRM, GOVERNANCE OF RESOURCES

Gestion Sociale des resources en Eau is the French for social management of water resources. It falls under the paradigm that the use of water is a result of social processes and not just technical arrangements. Thus, regarding water management, researchers, decision makers and implementers should always work both on technical and social aspects. **For this study, referring to GSE implies developing a sound knowledge on the social setting in GaMampa to understand their consequences on water related decisions.**

Integrated water resources management (IWRM) refers to "*coordinated development and management of water, land and related resources in order to maximise economic and social welfare without compromising the sustainability of ecosystems and the environment* (Global Water Partnership). In terms of wetland management, it underlines the need to integrate the resource to the local and regional catchments water and land resources. **For this study, referring to IWRM implies that research on wetland management should integrate the environmental and social links between other resources and the wetland.**

This report emphasizes the need for institution crafting by the GaMampa community. This refers to the views of E. Ostrom[2] that an institution is made of an organisation and rules. The concepts linked to this process are described in Part III when applying them to the GaMampa case.

1.1.3 STAKEHOLDER PARTICIPATION AND ACTION RESEARCH

Collaboration between scientists and water/wetland stakeholder groups is crucial to address water management issues. It provides better insight for researchers and enables communication from research findings to decision makers. Action research refers to researchers' involvement in local development through their studies. For the case of this research, it refers to facilitation and communication of science based concerns to decision makers.

Science-based outcomes produced through participation are likely to provide direct benefits to society because they are **well adapted to stakeholders' need**. Stakeholder involvement also helps working towards **project buy-in and ownership of communities**. Since it falls under the WETwin conceptual and methodology framework, a special attention was put on stakeholder involvement in this study through interviews, group discussions, and stakeholder workshops.

Picture of the participants of a stakeholder workshop in GaMampa

[2] *Crafting institutions for self-governing irrigation systems, 1992*

1.2 THE WETWIN METHODOLOGY AND CONCEPTUAL FRAMEWORK

1.2.1 OVERALL METHODOLOGY OF THE WETWIN PROJECT

The WETwin methodology divides the project in tasks into 10 work packages (WP). This work is part of work package 8 (WP8), on determining management solutions for the study area (see figure 4). This WP makes use of a toolbox developed in the previous WP (WP7).

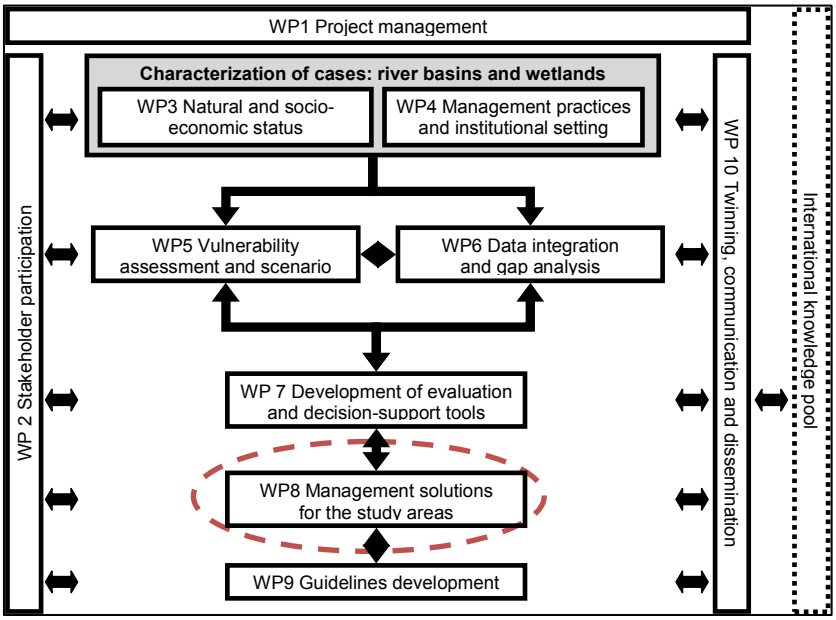
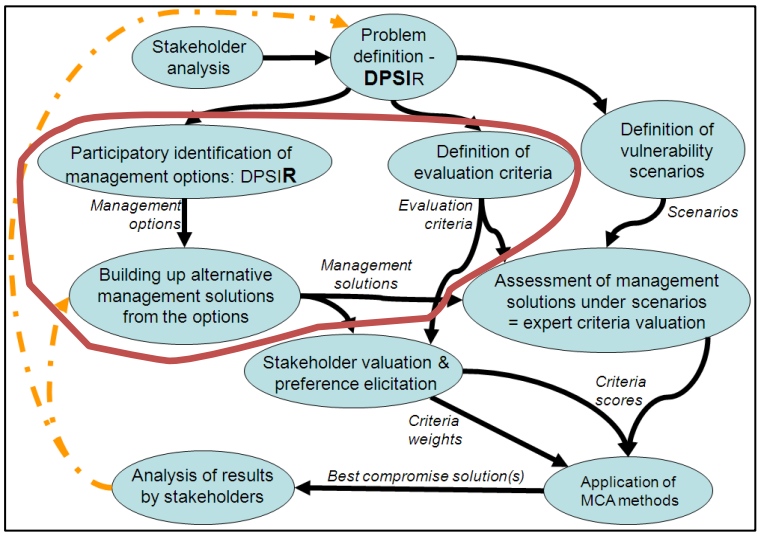


Figure 4: WETwin project flow and work package structure (Commission of the European Communities (2008)

WP8 aims at providing management solutions for the study areas

1.2.2 WP8: THE TRADE-OFF ANALYSIS FRAMEWORK



WP7 provided a toolbox to help decision makers and stakeholders in wetland management and planning, presented in figure 5 below, called the Trade off Analysis Framework (ToA).

Figure 5: General framework for trade-off analysis (István Zsuffa et al. 2010)

This study starts from existing data (Stakeholder (SH) analysis and Driving forces, Pressures, State, Impact (DPSI) diagram in figure 5). It aims mainly at identifying sustainable management solutions and thus focuses only on some of the steps in the ToA. They are circled by the red shape in figure 5. As shown on the figure through the black arrows, the findings of this study should provide input data for the next steps in the ToA: the assessment of the management solutions under scenarios and further application of multi criteria analysis methods.

1.2.3 CONCEPTS OF THE TRADEOFF ANALYSIS

The tradeoffs analysis (ToA) framework was developed in the WP7 as a toolbox. It is in fact still evolving according to the specifications of each case study. The concepts presented here are the ones which were used when applying the ToA to the GaMampa case study.

DPSI and DPSIR

DPSIR stands for *Driving forces, Pressures, State, Impact and Responses* (see Zsuffa et al. 2010). It is a conceptual framework to analyze the situation of an ecosystem affected by human activities. Concerning the GaMampa case, the DPSI part of the model was established based on previous studies and a first assessment of possible responses was made through a stakeholder workshop and expertise (*see 3.2. Hypotheses*). "Responses" of DPSIR lead to the list of management options which are further used in the analysis.

Management responses, options and solutions, stakeholder elicitation

According to the The Millennium Ecosystem Assessment (MEA), there are six main response types used in ecosystem management: Legal, Economic, Social and behavioural, Technological, or Cognitive responses. In the WETwin original conceptual framework, *management responses* (MR) from the DPSIR analysis are turned into *management options* (MO) as the research advances and potential management implementation processes are identified. They are then to be used in a *management solutions* (MS) analysis.

The identification of *management options* precedes the elaboration of solutions. Management options cover one or more of the above six management response categories and are orientations, actions or policies that can influence the management of wetlands. They are developed through consultation of the SHs and then validated by SHs workshops. The management options can have different implementation alternatives which are then used as a combinable set to build management solutions.

Management solutions are elaborated plans allowing the implementation of the management options. They imply a choice between several alternatives of one MO, and then a choice in the combination of these alternatives. As it often requires technical knowledge and expertise, the determination of management solutions was not only made through local stakeholder workshops but also required literature review and expert consultancy. Their elaboration implies choices in the future orientation of the wetland management. Management solutions are characterized by a list of MOs and their implementation alternative with a specific orientation.

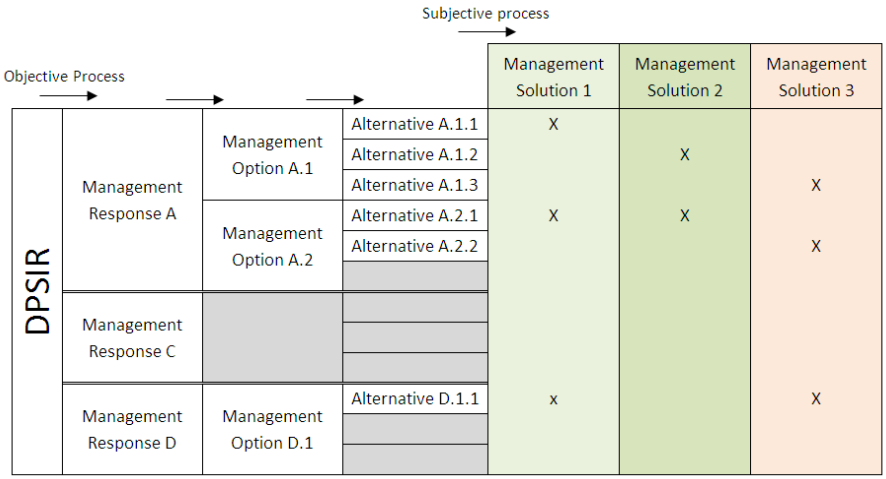


Figure 6 : Presentation of steps for identification of Management Solution

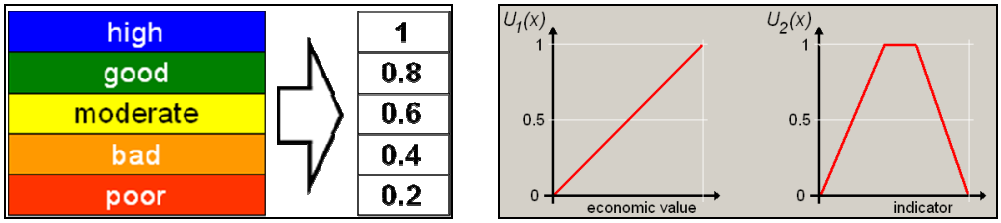
Figure 6 above shows that whereas MOs and alternatives are identified and validated by all SHs (*objective process*), the proposition of MSs implies choices in the management orientation (*subjective process*).

WETwin proposes to develop several MSs to reflect the diversity of interests between SHS and aims at finding sustainable tradeoffs. This is made by developing evaluation criteria and the use of models to assess choices in management solutions. This study proposed a final list of management options and alternatives, and provided insight for the WETwin research team to develop a list of generic management solutions after all their case studies.

Evaluation criteria

"*It is very important that stakeholders […] define their own criteria for the evaluation of alternative management solutions.*" (István Zsuffa 2010).

An evaluation criterion allows normative evaluation of management solutions. The criteria definition can be done through individual interviews or focus group discussions and the final list of criteria should be decided with a stakeholder workshop. This study identified criteria, and for each of them the optimal, acceptable and unacceptable values in order to be able to build the value functions.



a. b.

Figure 7: Examples for value functions: *a.*) for qualitative indicators; *b.*) for quantitative indicators (Zsuffa et al. 2010).

Assessment of management solutions under scenarios and MCA

This step of the ToA is not tackled by the study of management solutions. The present study provides inputs for the process presented in figure 8 below:

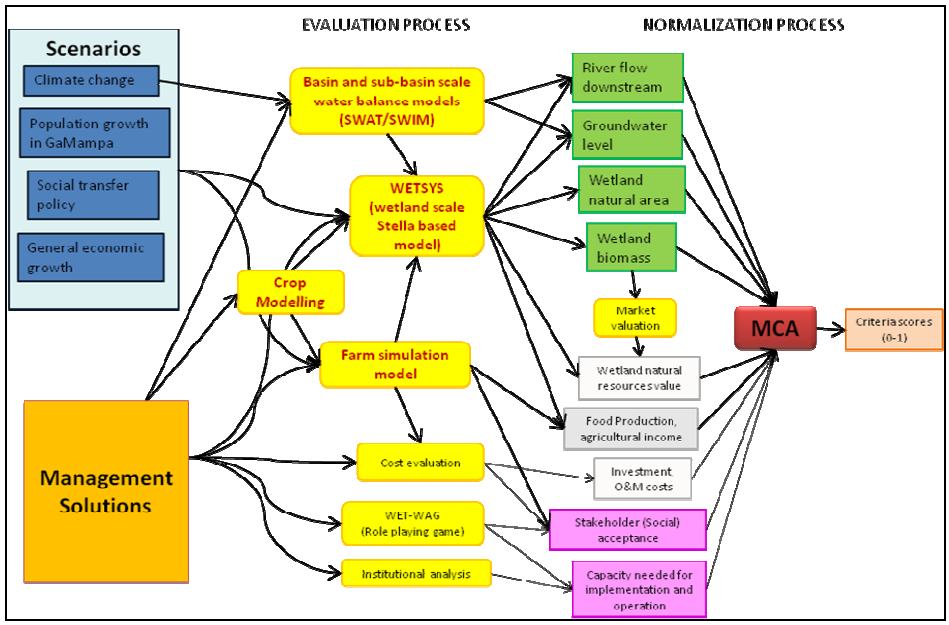


Figure 8: The assessment framework (Zsuffa et al. 2010)

In practice, at the time of the study, the assessment of MSs mainly refers to the integration of the MSs into the WETsys model, developed by Cemagref and IWMI. It works under the Stella platform and aims at modelling the links between hydrological and economic features of the valley. Both proposed MSs and local scenarios will be included in the model to provide insight on environmental and socio economic consequences.
A multi criteria analysis (MCA) will then be undertaken by the WETwin team for each case study using the mDSS in order to finally find a compromise solution (Zsuffa et al. 2010).

2 METHODOLOGY OF THE RESEARCH

The overall objective of this research is to provide material to support decision making processes in the future resource management of the GaMampa valley in order to guarantee wetland sustainability. In fact, in accordance to GSE and IWRM, choice was made not to focus exclusively on the wetland but to consider it as part of a system: the GaMampa valley resources system.
For more details on objectives, hypotheses, methodology of this research, annex XII provides the research proposal corresponding to the research (Murgue 2010):

2.1 RESEARCH OBJECTIVES

For future use by the WETwin project and sustainable development of GaMampa valley community, this research aims at:

- Adding to the existing knowledge on the management of resources, especially the wetland, in the GaMampa valley.
- Identifying future stakes in governance of the wetland, and understand how they link to local and provincial authorities.
- Validating management options identified by the WETwin project through participatory processes, and adding, if necessary, other options proposed by stakeholders, and identifying stakeholders' perception/position with regard to these options.
- Proposing management solutions to implement previously identified tradeoffs between ecosystem services, and collect necessary data to assess how they impact on the wetland
- Identifying the relevant evaluation criteria for the management solutions.

Given the identified stakes for wetland sustainability (see part II), this research broadens its focus to all resources of the GaMampa valley. The following question was used as guidelines during field work:

What are possible tradeoffs between wetland provisioning services that will guarantee wetland sustainability, what corresponding management measures are relevant, and how can they be implemented?

2.2 HYPOTHESES

2.2.1 PROVIDED BY THE WETWIN PROJECT

The WETwin DPSIR draft diagram established by Masiyandima and Morardet in 2009 provided starting hypotheses for management options. As a hypothesis, this diagram shows that not only wetland directly related driving forces; pressures or responses impact on the wetland status.

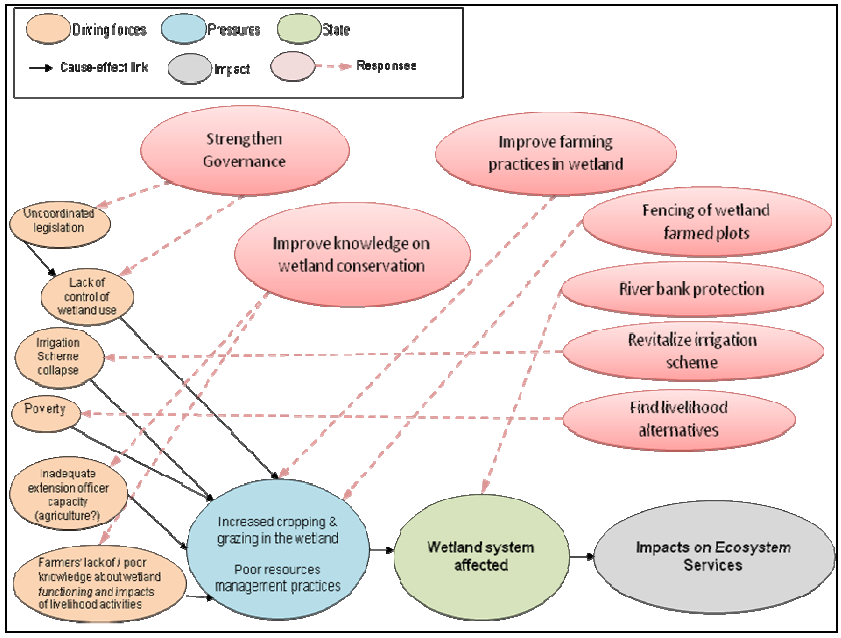


Figure 9: DPSIR draft diagram (Masyansima et al. 2009)

Figure 9 above shows that previous studies in the WETwin project pointed out the **rehabilitation of the Irrigation Schemes (ISs)**, the **improvement of agricultural extension methods** and a **clarification of the governance of resources** as the main management options to address the GaMampa wetland sustainability challenges.

2.2.2 PERSONAL HYPOTHESES

These hypotheses were developed through literature review and introductory observations and interviews in GaMampa. They orientated the research in the identification of management solutions.

- The **driving forces for wetland invasion have to be better assessed** in order to sustainably release pressure of agriculture.
- The **rehabilitation of the ISs is a key for sustainability** of both farming systems and wetland.
- The **management of resources in the valley has to be improved** through clarification of resources governance.
- **Farming practices** in the wetland should be more adapted to the ecosystem.
- **Diversification of livelihoods** can lower pressure on wetland cropping uses.

2.3 METHOD

2.3.1 DATA COLLECTION

The research used consultation taking the form of interviews, focus group discussions and stakeholder workshops. Language was a challenge and local workshops were usually facilitated by a member of the CRCE after briefing, whereas some discussion or external workshops could be lead in English. For interviews and group discussions, the use of material or mind representations of the discussion (specifically maps, schemas on paper board, land observations pebble scoring) allowed better understanding and communication between the facilitating team and participants. In general, it should be said that simple communication and participation methods were used. Sophisticated processes, making use of specific material were hard to set up because of the local conditions and because of the spontaneity of the meetings. Annex XIV gives a list of the main meetings, workshops and interviews which provided input data for the study.

Observations were used for data collection and took the form of field observations and measurements (GPS, flow measurements) and participation to meetings (Community meetings).

2.3.2 DEVELOPMENT OF THE RESEARCH

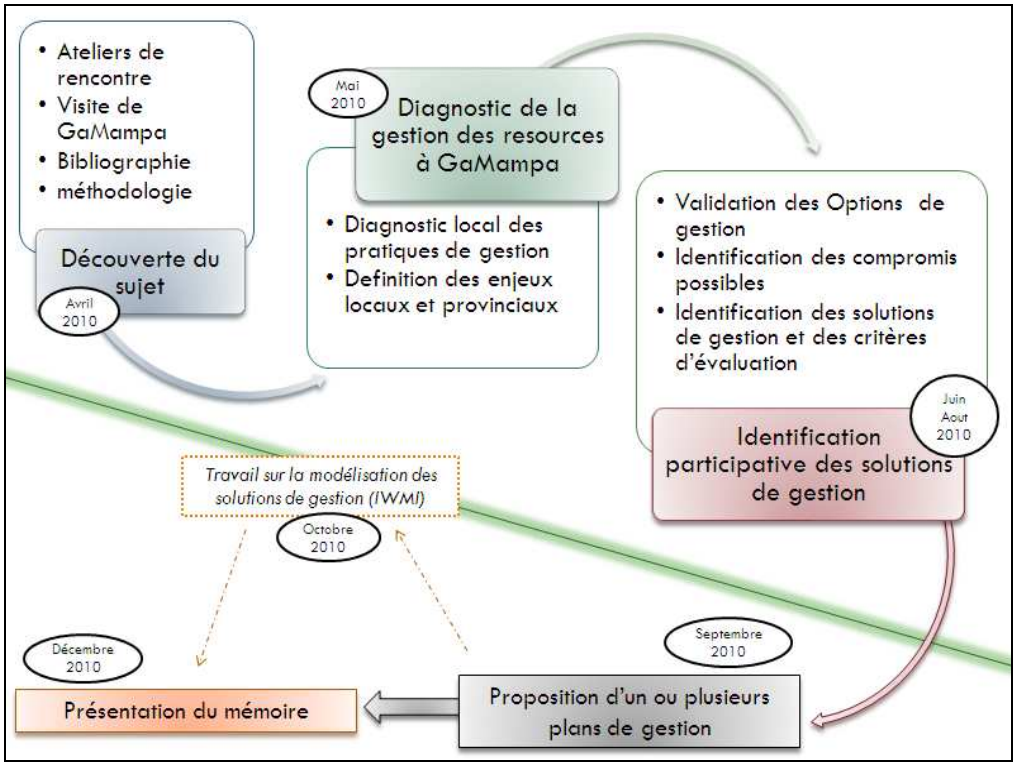


Figure 10: Work plan of the study (research proposal, Murgue 2010)

The Figure 10 presents the chronological development of the research. It was decided, after familiarisation with the field and topic that a diagnosis of resource management leading to identification of stakes would be a prerequisite for analysing tradeoffs opportunities and identifying management solutions for the GaMampa Valley.

Part II – Diagnosis of the GaMampa wetland situation for trade off analysis

This is a diagnosis of the GaMampa valley resources and management. It is a necessary step towards the "*Participatory analysis of tradeoffs between wetland ecosystem services in the GaMampa valley, Limpopo*" (see part III).
It was compiled through literature review, SH interviews and field observations.

It aims mainly at giving an overview of the local context for readers who do not have insight on the valley history and current situation. It is also an update of previous studies in GaMampa, focusing on the wetland, and identifying the main challenges and stakes in wetland conservation.

Picture of the Downs area in the high plateaus of the LekgalaMeetse nature reserve near GaMampa, formerly inhabited by local population and white settlers

1 RESOURCES IN THE GAMAMPA VALLEY

This first part of the diagnosis intends to present the wetland as part of the GaMampa valley environmental, historical and socio economic setting. It shows that challenges around wetland management are linked to both regional and local resource management issues in the GaMampa valley.

1.1 THE MOHLAPITSI RIVER BASIN

1.1.1 THE MOHLAPITSI RIVER BASIN IN THE REGIONAL CONTEXT

The Mohlapitsi River is about 50 km long and feeds the Olifants in its middle part, before it reaches the Lowveld area. It contributes for 8-10% of the Olifants base flow in average, and up to 16 % during the dry season (Masiyandima, McCartney et al. 2006)

The Olifants water is over allocated even to satisfy environmental flow, and water is even imported from neighbouring basins to satisfy economic activities (see annex I). Most human activities in the Olifants river basin (see annex I) take place upstream of Mohlapitsi contributing zone (figure 11). On the other hand, the downstream area of the Olifants catchment in the Lowveld, features the renowned transboundary Kruger National Park and the currently renovated Massingir dam in Mozambique which potentially feeds over 90 000 Ha of irrigated land (AFDB, 2009). The Mohlapitsi River fresh water stands out as a flow regulator and pollution dissolver in the Olifants river basin.

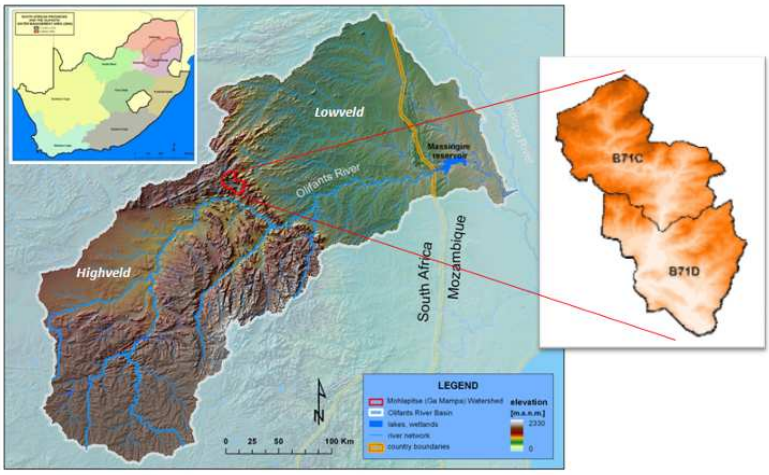


Figure 11 : Location of the Mohlapitsi River basin within the Olifants catchment (Debels P. 2010)

The Mohlapitsi river basin was divided in two quaternary catchments by the Department of Water Affairs (DWA): the B71C to the north, on which this study focuses, and B71D to the south, in the sedimentation area and confluence point with the Olifants. GaMampa is located in the Mohlapitsi river basin B71C (Masiyandima, McCartney et al. 2006).

According to the National Water Act of 1998, a Catchment Management Agency (CMA) should be formed to coordinate water management in the Olifants basin. Nevertheless until this study, it is still not functioning and although the Department of Water Affairs is responsible for water issues, no regional office is responsible of administrating the water in the Mohlapitsi basin. **Even though it is environmentally crucial for water users in the downstream parts of the Olifants basin, in terms of water governance in the region, the Mohlapitsi basin water is not currently monitored or officially administrated.**

1.1.2 OVERVIEW OF THE MOHLAPITSI RIVER BASIN (B71C)

Geomorphology

The Mohlapitsi catchment covers approximately 400km^2 (McCartney 2005) and is dominantly mountainous. The upper catchment features cliffy, mountainous landscapes with East to West dipping slopes. Elevation ranges between 650 meters to 1900 meters. The GaMampa valley stands out as the first large flat area (about 250Ha) along the Mohlapitsi river bed. Fragmented areas of reed formations and of water bodies occur in the valley, around the river bed, forming the GaMampa Wetland. Figure 12 shows the location of the GaMampa riverine wetland as its maximum extent before invasion (Sarron 2005).

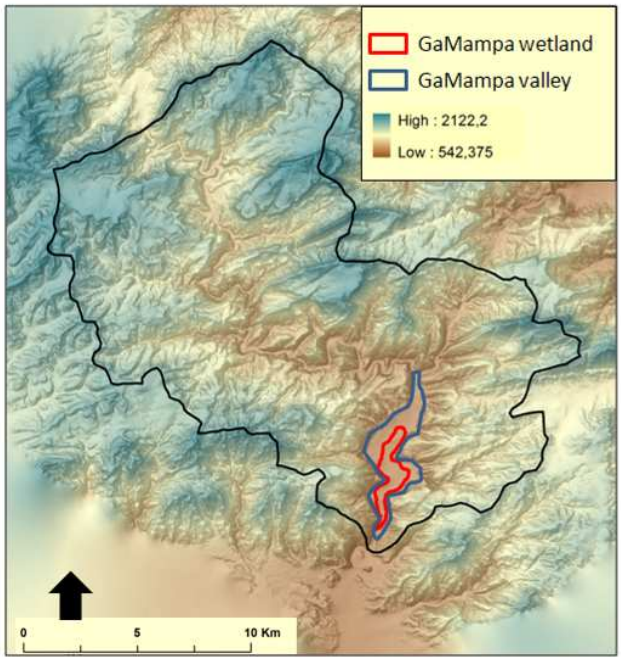


Figure 12 : Overview of the B71C Mohlapitsi River basin and location of the GaMampa valley and wetlands (Debels P. 2010)

The geology of the catchment is an assemblage of sedimentary and extrusive rocks. In the South and West, notably under the GaMampa valley, it comprises limestone (dolomite, chert). In the Northern and Eastern parts of the basin, extrusive rocks feature lava, tuff, quartzite, shale and conglomerate (council of geosciences, 2001).

Downstream of the valley, in B71D, the landscape opens up towards the river's confluence with the Olifants.

Climate

The area experiences a **semi-arid climate** with seasonal rainfall during the summer months, from October to April, and dry periods from May to September. The mean annual rainfall is 771 mm but varies with altitude: it is about 500 to 600 mm in the valley bottom and over 1000 mm in higher parts of the catchment is (McCartney 2005).

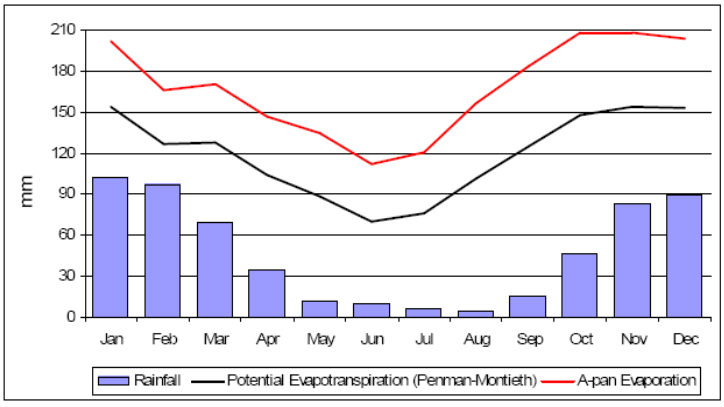


Figure 13 : Mean monthly rainfall, Penman-Monteith potential evaporation and A-pan evaporation in mm (Mc Cartney 2005)

Daily average temperature is highest in January and December (22°C) and lowest in June and July (12°C). The mean annual potential evapotranspiration (i.e. Penman-Montheith) is 1428 mm and the mean annual open water evaporation (i.e. A-pan) is 2014 mm as average across the catchment (McCartney 2005). Montly precipitations are always lower which explains the need for irrigation over the year.

The land

The land of the B71C falls under the Mafefe traditional land, owned by Kgoši Setlamorago Thobejane. The Headman of GaMampa traditionally owns most of the northern catchment land and even past its boundaries. The Headman of Mantlane rules over the land in the southern part of the catchment and in the mountains surrounding it. The mountain area is dominated by enclosed nature reserves: the Wolkberg wilderness area (WWA) and the LekgalaMeetse Nature Reserve (LNR), which are managed by the provincial government.

1.2 THE GAMAMPA VALLEY RESOURCES SYSTEM

The GaMampa valley is the first inhabited area along the Mohlapitsi River. Most of the natural resources used by the people of the GaMampa valley originate from areas within the Mohlapitsi basin. Neighbouring areas, past the physical boundaries of the basin, also provide the community with the same type of resources, mainly grazing and hunting.

1.2.1 THE PEOPLE OF THE VALLEY: USERS OF THE RESOURCES

There are 2 main villages: GaMampa and Mantlane constituted of sub villages. 394 households occupy these lands, constituting 18% of the Mafefe ward[3] population. The Statistics of South Africa classify 90% of the people in very poor, poor and vulnerable (Tinguery 2006). The main livelihood activity is small scale agriculture, centred on maize production for subsistence, practiced by old men and women. Subsistence agriculture is always completed by hunting and wild plant collection for food. Unemployment is high and the few local job opportunities come from government or NGO programs. Most households largely depend on social grants (43 to 76% of household budget in Chiron 2005). Male youth is often inactive in subsistence farming and often migrate to urban centres to look for cash income

1.2.2 THE MOUNTAINS

The mountains are the main resources provisioning area for the GaMampa community. Historically, many of the families now settled in the valley were living in the mountain plateaus, through mixed hunting/gathering with little cultivation of the mountain slopes.

Geomorphology, hydrology, vegetation

The mountain area is predominantly made of sedimentary material with high ground water storage capacity (Masiyandima, McCartney et al. 2006)). Their discharge is continuous and revealed through ever flowing springs scattered around the mountains and the valley. The soil is generally shallow and stony in the slopes with deeper soils formations on the flat mountain tops (the plateaus). The Wolkberg Dolomite Grassland vegetation (Mucina 2006, p.413) covers the mountain plateaus and adjacent slopes in higher altitudes (>1200 m). The slopes in lower altitudes (600-1200m) are covered with forested grassland and bushveld vegetation, which provide extensive grazing areas all year round. Forested areas occur, around ever flowing resurgence springs[4]. The water is used by livestock, wild animals and the GaMampa community through pipes.

[3] The Mafefe ward comprises mainly 5 village:s GaMampa, Manthlane, Mahlatsane, Gwaname, Dublin

[4] These springs have not been pointed out in previous studies and should be given attention for they widely contribute to livelihood of the GaMampa community. The use of mountain spring water is completely informal and contributes to sanitary and agriculture needs

Mountain resources use

The GaMampa community largely relies on natural resources from the mountains. Mountainous areas, even in the nature reserves areas, provide the following livelihood opportunities:

- Livestock grazing

Livestock from GaMampa and other areas in Mafefe occupies the mountains during long periods of time in the wet season (summer), concentrating in wetter areas (valley bottoms) during the dry season (winter). Statistics or surveys for livestock are not available[5]. Voluntary bush fires before the rainy season stimulate sprouting of grasses and limit the development of forests.

- Hunting/pouching

Most households use hunting as a source of protein. Men use dogs and homemade traps (collar). No specific quantification is available but a personal survey in Marulatsipi, a sub area of Mapagane, showed that 80% of the families consume wild meat at least once a month, which is about the same frequency as domesticated meatµ.

- Wood collection

All households in the valley use wood for cooking food and heating during winter. No specific quantification is available.

- Wild plant collection

Collection of wild vegetables and fruits for household consumption occurs mainly in wet season, and is reduced during dry season. Other plant collection occurs for medicinal use, craft production or religious beliefs.

Historical evolutions

Figure 14: Picture of the abandoned terraces in the plateau area of the LekgalaMeetse nature reserve

Historically, from about 1900 to 1970, the mountains were cultivated extensively in the flat grassland plateaus and locally in the bushy slopes. Commercial cropping systems featured vegetable production and orchards on the plateaus (figure 14), under white farmers ownership and supervision. Slash and burn techniques with long fallow periods were used by black populations to produce cereals, mainly in the slopes.

After the creation of the nature reserves in the 1970's during the apartheid, black populations were forced to migrate to the GaMampa valley in the *Bantoustan* area. Cultivation in the mountains is now limited to illegal Marijuana fields. As part of the Land claim process, parts of the LekgalaMeetse Nature Reserve are used for harvest of revitalized avocado orchards and wild animals keeping[6].

[5] In 2005 Chiron cites 250 cattle, 80 donkeys and numerous goats.

[6] These claims associate former occupying families, including people of the GaMampa valley as well as emigrated white and black people in urban centers. They share the benefits from the profit made from selling avocadoes and reintroduced zebras.

1.2.3 THE VALLEY

The valley bottom is North to South oriented, narrow (6000x500m in (Kotze 2005)), and flat (0.6% slope according to Kolgebauer 2010. It is a sedimentation area and the river bed has dug into the valley over time, leaving sediment terraces. The landscape can be divided in:

- The foot slopes
- The terraces
- The river bed and riverine wetlands

The following figure is a 3D picture from GoogleEarth database. It gives an overview of the GaMampa valley and division of the landscape. A map in section 2 of Part II gives more details on the original extent of the wetland.

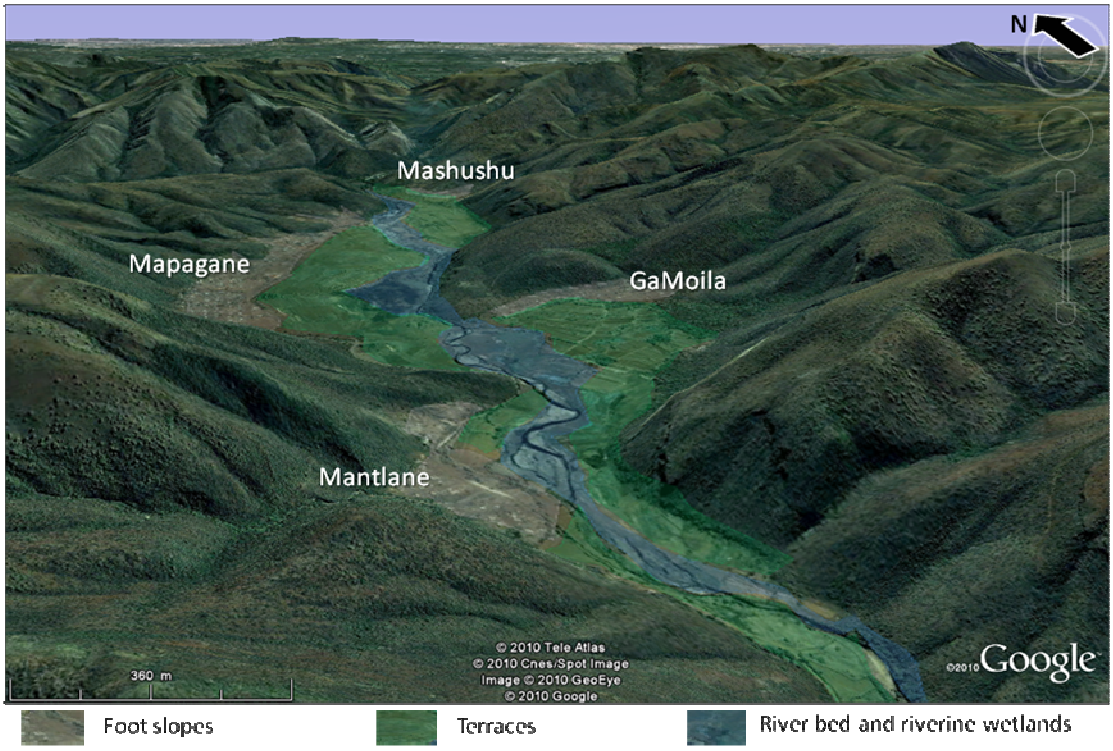


Figure 15 : View of the GaMampa valley relief. Localization of the villages and geo morphological areas (source: googleearth)

Foot slopes – living areas

The foot slopes overlook the valley bottom and soil formations are overall thin and rocky. They are occupied for settlement in 4 main villages (Mashushu, Mapagane, GaMoila and Mantlane).

Each household spreads over a piece of land varying in average from 300m² to 600m². The homesteads sometimes feature a garden and/or a kraal[7]. Gardens are sometimes intensively grown, planted with mixed cropping (vegetables, fruit trees, sugar cane) and orchards throughout the year, under irrigation from the mountain springs or government tap system.

[7] Name given to an enclosure in the homesteads, made for keeping livestock

Terraces – cultivation areas

The soils are sandy in the very upstream terraces (Mashushu area), and become gradually loamy around Mapagane and GaMoila, to poorly drained loamy soils downstream around Mantlane (Chiron 2005).

There are four irrigation schemes spreading on the river terraces. From upstream to downstream: Mashushu, Fertilis, Vallis and Gemini:

- Mashushu (45.74 ha with about 45 farmers), in Mashushu
- Fertilis (99.13 ha with about 88 farmers), in Mapagane
- Vallis and Canyon (45.34 ha; about 26 farmers), in GaMoila
- Gemini (11.54 ha), in Mantlane. It is not irrigated anymore but farmed and grazed.

Only the Vallis IS does not divert water from the Mohlapitsi but feeds from a sub catchment perennial river. They all use gravity distribution systems and infrastructures are generally in bad state (see water resource).

During wet season, the ISs are cultivated mainly for subsistence maize production associated with squash, and to a lesser with ground nut for both subsistence and commercial objectives. During dry season, only few farmers can access irrigation water and farm vegetables on smaller plots. In the past decade, there has been a strong decrease in both wet and dry season production. In Fertilis IS nowadays, only about 10% and 50% of the land are cultivated during dry and wet season respectively. The coriander cultivation, still mentioned in Chiron 2005, has fully disappeared, but also the maize cropping in the IS decreased since 2005, because it requires monetary and social investment, higher than those necessary for wetland farming.
Generally speaking, because of a change in government regime and climatic variation, the IS are not farmed[8] according to their potential. The reason behind this is that maize subsistence farming in the ISs has lately become more capital intensive, technically difficult, risky, and requires more social investment for water management relatively to new wetland farming opportunities. For more details see box 2 on the history of the GaMampa ISs p. 33.
Orchards occur sporadically and were planted during the second part of the 20th century. They are harvested but not pruned and maintained.

The river bed

The river bed is an alluvial silicate formation and features stony to sandy soils. It is overall quite straight and well channelled; set 1 to 2 meters below the river banks in most of the valley. Contrarily to what is said in Kogelbauer 2010, its width varies from 10 m to 30 m in the valley and does not get wider. Important flooding events made the river bed move twice since 1950, leaving rocky areas dry between Mashushu and Mapagane and giving the impression of a large river bed. The river bed is used for fishing and leisure activities.

[8] only at 30% of their potential (model 2 in Chiron 2005).

Wetlands

Riverine wetland formations are located along the river channel. They originally covered an area of approximately 1km^2 both in the river bed and the surrounding valley floors (Sarron 2005).

The wetlands traditionally provide livelihoods opportunities for drinking, hunting, plant collection for crafts, wood collection, food and medicinal, and livestock grazing during dry season. Since 2000 especially, the wetland is extensively used for subsistence maize farming.

In 2006, O. Adekola quantified the ecosystem wetland services for the GaMampa community. His study provides insight on the major wetlands in the valley, but omits services from riparian forested wetlands upstream of the villages, which according to field observations and interviews with local SHs provide large quantities of fuel wood and grazing services. These areas can be seen on the valley map in Annex XV.

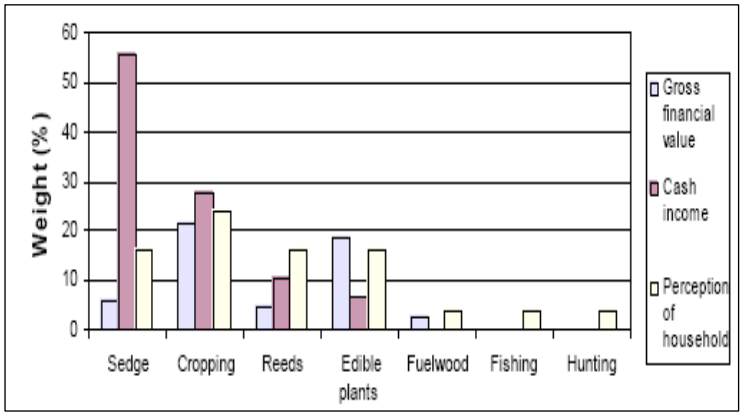


Figure 16 : Relative importance of economic value (gross financial value and cash income) of wetland services in percentage of total wetland economic value, compared with their relative value as perceived by stakeholders, (Adekola, Morardet et al. 2008)

In figure 16 above, one can see that cash income from sedges is higher than any other wetland use. Nevertheless, the perception of the community for this service is lesser than cropping and edible plant collection. This is because wetland users generally do not seek cash income from the wetland but appreciate its provision for subsistence aspects.

In addition to these services to the community, the wetland provides environmental services, including[9]:

- Hydrological regulation (flood attenuation, stream flow regulation)
- Geomorphologic regulation (sediment trapping, erosion control)
- Nutrient and pollution regulation (phosphate trapping, nitrate removal, toxicant removal)
- Carbon storage
- Maintenance of biodiversity by provision of habitats

[9] : D. Kotze in 2005 gives precision on these ecosystem services

1.2.4 THE WATER

Overview of the water resources

Water in the GaMampa area is available from ():

- The **Mohlapitsi River**. It is ever flowing and people do not complain about the quality of water.
- **Ground water**. 2 community boreholes take the water from underground streams coming from the surrounding mountainous terrain.
- **Mountain springs**. There are many springs in the mountains (at least 4 only in the Mapagane area) but people complain about the high calcareous charge. They are fed by underground water reserves in the sedimentary rocks (karts). Most of them are perennial.
- **Wetland springs**. There are many springs sprouting out at the border the wetland. The water quality is said to be excellent. They are mainly fed by underground water resurgences flowing from the mountains and possibly by irrigation water infiltrations in the canals and plots.

Domestic water

Domestic water is mainly provided by groundwater extraction from the underground river bed flows. There is a borehole in the valley, feeding in a reservoir thanks to an electrical pump. Water is then distributed to communal taps situated every 100m in the area of Mapagane. The Mashushu and GaMoila also benefit from government boreholes but water is pumped in smaller, plastic reservoirs and taps are not so many as in Mapagane.

Areas of the valley which are to high or far from the boreholes do not have access to the water from government boreholes. These areas use river water but mainly rely on spring water from the mountains. These families use pipes to fill up drums for sanitary use and garden irrigation.

Water for homestead gardens and domestic animals

Irrigation water for the home gardens and domestic animals is provided either by tap water from the boreholes or from mountain spring water. In other words, irrigation water for gardens is the leftovers from domestic water from taps and mountain spring.

Irrigation schemes

Water for the Irrigation schemes is provided by surface water from rivers, diverted with gabion weirs. Flood irrigation is a general practice at plot level. The schemes' infrastructures are all in a bad state and some actually do not carry any water to the schemes (Mantlane case).

This restriction in water availability does not limit wet season maize production in normal climatic settings since the irrigation water only accounts for 10% of the theoretical water requirements in an average rainfall year (Chiron 2005). Nevertheless, with the higher variability of climatic events, farmers find it risky to plough maize in the ISs. In any case, the water shortage in dry season only allows insignificant plantation of dry season crops in the ISs.

In 2010, the Fertilis irrigation scheme is actually at stake because a project coordinated by the Limpopo Agribusiness Development Corporation (LADC) aims at its rehabilitation for development of commercial farming in GaMampa. Specific focus was put on irrigation water efficiencies from the Fertilis IS, in order to reflect on its rehabilitation. It reflects the integration of the ISs to the surrounding environment and hydraulic system. Annex II presents the detail of the water balances summarized in table 1:

water balance (L/s) for Fertilis in its actual state of exploitation												
Irrigation requirements (agriculture use)	4	19	17	13	-4	1	0	0	1	2	1	1
river intake requirement	130											
leakages in head canal	52											
total leakages in main canal	23											
infiltration at plot level	15											
left for irrigation purposes	23											
surface runoff ("extra water")	19	4	6	10	27	22	23	22	22	21	22	22
total water diverted to wetlands / groundwater	126	111	113	117	134	129	130	130	129	128	129	129

Table 1 : Personal evaluation of the water balance for Fertilis IS, in its actual state of exploitation (Dry season: sweet potatoes 6%, Onion/beetroot 0,7%, tomato 0,3%, cabbage 0,3%; Wet season: groundnut 6%, Maize 83% of the IS area). Columns are the month of the year from January to December.

The table shows that since the breakdown of the infrastructures in Fertilis 10 years ago, and generally since its creation and before cementation, the diverted water actually goes back to the environment (groundwater infiltrations and surface runoff). Evaporation from open channels is here neglected but should be insignificant because most of the canals are covered by vegetation.

1.2.5 Conclusion on the GaMampa resource system

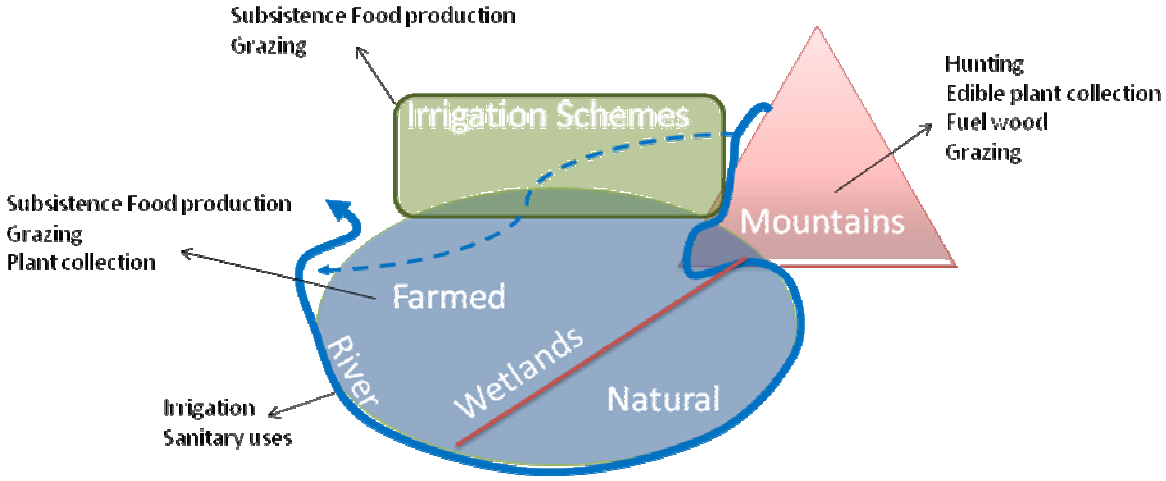


Figure 17 : schematic presentation of the GaMampa valley resource system and uses

Figure 17 is a summary of the resource system of the GaMampa valley. It shows that the wetland is integrated to the rest of the system through:

- Its hydrological link with the mountains ground water system, the river, and with the ISs (infiltration and runoff)
- Its socio economic link with the community (provisioning, cropping) and all resources in GaMampa through grazing.

1.3 GOVERNANCE OF RESOURCES

This part intends to point out the main characteristics of the governance of resources and rural development. This is to provide the relevant information to identify the stakes in future implementation of management options.

In the GaMampa valley, three governance entities are responsible for local resource management:

- **traditional authorities** (local and regional chiefs),
- **community based organizations** (the Mampa Development Forum or Community Development forum (CDF))
- **administrative institutions** (ward councillor, municipality)

In addition national, government departments are responsible for providing support in the different fields of development through local representatives of the municipal offices (departments of agriculture, of home affairs, environment, development and tourism, water affairs).

1.3.1 TRADITIONAL AUTHORITIES

"The headman should be seen as our father".

This sentence was taken from an interview with Bernard Mašavela. It reveals that a headman should be aware of everything happening on his land and is legitimate to settle conflicts.

There are two local chiefs (*Headmen* or *Mokgoši*) in the GaMampa valley. They report to the chief of the Mafefe community, *the Kgoši*, and are advised by a *traditional council* made of older men in the community, and can be represented by a *royal council* made of family members. The responsibilities of the local headmen are:

- **To keep track of the use of land-related resources**

The land belongs to their family and they are legitimate to give the right of using the land[10]. Money is always given to the headman in recognition. There are traditional rules concerning the use of land related resources and the headman is responsible for enforcing them (e.g. seasons for tree cutting and plant collection[2]).

- **Conflict management** and **communal law enforcement**

In case of criminality or land related conflicts, the headman is relevant for rending judgment and giving a fine (paid in cash) from which he personally benefits.

- **To report to the central traditional authorities**

Only the headman is relevant to directly communicate with the central traditional authorities of Mafefe.

We can conclude that consulting Headman consultancy is a **traditional formality to guarantee the success of resource related projects,** but **they are not a mean to manage resources**. In fact, Headmen are relevant bylaws enforcers, but are not able to make decision over sustainable development since they lack knowledge in this domain. In the field of wetland farming for example, both headmen recognise that they do not have a sound knowledge in the management of wetlands since it never occurred extensively in the past generations.

[10] An interview with the GaMampa headman revealed that decisions regarding land in the irrigation schemes are to be made by the department of agriculture with farmers and validated by him

1.3.2 COMMUNITY BASED DEVELOPMENT ORGANISATIONS

The Community Development Forum (CDF)

The CDF or Mampa Development Forum (MDF) was created in 1995 for the GaMampa communities, supported by the CRCE. Today, Manthlane communities are still not involved in it because the Manthlane people are not part of the Mampa original family, and thus should not be involved in GaMampa located initiatives. The CDF is not formally linked to the traditional authority but to the ward councillor. It is responsible for passing on the GaMampa community's concerns to ward level so that they can be expressed in the municipality, especially in the IDP[11] process, and to the state departments. The Forum is formally meant to be an umbrella body, with representatives of subcommittees. In 2006, N. Tinguery cited 12 thematic committees[12] (see Figure 18**Erreur ! Source du renvoi introuvable.**). During the study, most of them do not meet on a regular basis and the representatives are not elected but spontaneously take responsibility when needed.

The CDF is going under difficulties because it is a relatively new entity for the community which does not traditionally follow this democratic oriented system. For example, traditional customs do not involve women in formal discussions; they do not base representativeness on election, they require meetings only in case of need, decision makers do not attend discussion but are reported to and give their opinion on the conclusion of the meetings. Also, the forum challenges the traditional council's supremacy. Thus, even if it is meant to be a holistic arena for discussion with regular consultancy:

- Decision power lies in the hand of few influential people in direct relation with the ward councillor
- Plenary meetings are few and the community leaders do not attend them. They prefer to be reported to
- There are no formal written functioning rules and no formal follow up to the CDF decisions and activities

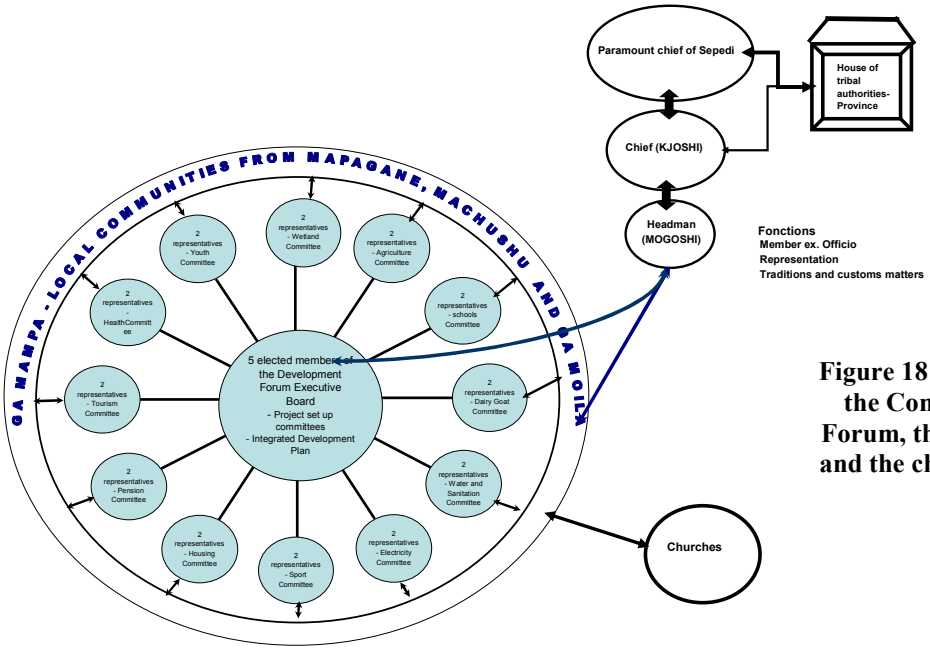


Figure 18 : Relationships between the Community Development Forum, the traditional leadership and the churches (Tinguery 2006)

[11] The Integrated Development Plan or IDP will be further developed in Part III of this document

[12] Electricity, Tourism, Pension, Water and Sanitation, Housing, Primary and Secondary Schools, Agriculture, Dairy Goats, Sports and Youth, Wetland, Health

During the study, the main functioning committees worked on government service delivery issues to coordinate them locally[13]. They function independently, with generally few people leading, male and influencial.

The wetland committee (WC)

The WC was created in 2003 as *Koidomela* "Hardwork" committee, during the main invasion of the wetland. It was exclusively a wetland farmers' platform because they needed representation on local level to justify their move in front of the community. In 2007, under pressure of external SHs[14], the wetland farmers committee turned into the WC to involve other wetland users. In 2009, the DoA coordinated the Mohlapitsi Wetland Program (MWP) through UNDP funding, and the WC has gained power and influence in the CDF sphere. The program was set up as a mean to take action for wetland conservation.

Today, the committee is still composed of the oldest wetland farmers and focuses on protecting wetland cultivated plots by enclosing the wetland areas under the MWP. There is no representation of other users and elections of representatives, nor formal meetings. In practise, The Wetland Committee attributes are:

- Legitimacy to settle problems between wetland farmers.
- Communication with external wetland SHs, mainly the department of agriculture for MWP

Strengths of the wetland committee	Weaknesses of the wetland committee
▪ The existence of the committee ▪ The fact of being part of the CDF ▪ The recognition by the wetland farmers ▪ Existing record-keeping capacity (the secretary has a meeting notebook). ▪ Financial contributions for functions (e.g. contributions to celebrate the Farmers' Day) ▪ Protection of the ponds inside the wetland ▪ Follow up of the application of common rules such as the interdictions to cut trees, to dig canals in the wetland …	▪ The committee is not formally registered and therefore cannot manage funds. ▪ The committee is "temporary" because in case of a flood, and if there is no more farming, the committee has no more reason to exist. ▪ Limited capacities to deal with partners that they do not know very well. ▪ Diverging points of view with Mondi Wetland Programme and representatives of the department of Environment.

Table 2 : Strengths and weaknesses of the wetland committee (Tinguery 2006)

In table 2, N. Tinguery points out that the simple fact of existence of a WC is strength for future management of the wetland. In fact, even though it currently focuses on the protection of cultivated areas from livestock trampling, the WC and its members do recognize the need for wetland future protection and a more holistic management of wetland resources.

The Committees for water issues

There is a blur on what committees exist or actually function on the issue of water management. Whereas there used to be an irrigation committee at the scale of the valley, under supervision of homeland government, there is no functioning arena at present to discuss irrigation water issues at

[13] pension, electricity, water and sanitation, housing, schools

[14] The Mondi Wetland Program, later energetically refused by the wetland farmers, required the wetland committee to involve all wetland users.

valley or villages scale. The people of GaMampa have moved from a centralized management of water in the old regime, to small scale local initiatives to address their needs in water. In general, these initiatives, both for sanitary and irrigation purposes, tend to be independent. They are privately initiated at the scale of household, neighbouring households or small association (e.g. private pipes for spring water).

Until the government sanitary water project in 2007, there was a water committee in charge of mountain spring water management. For irrigation, there was an irrigation committee in charge of water distribution in each IS. It was responsible for fence maintenance and penalties (for details on irrigation water management, see Chiron 2005).

In the example of Fertilis, the irrigation committee gradually lost its purpose and is not functioning. In 2006, under the initiative of CRCE, P. Ramatsobane worked on forming water user associations (WUAs) to take over the management of water. The initiative was not followed up by the community, hypothetically because of the lack of interest in irrigation water due to wetland farming opportunities, and its try to group together water users from all ISs in GaMampa. Nevertheless, in the case of Fertilis for example, legitimate representatives of water users are appointed even if they have not met since 2007. Water management in the irrigation scheme (Fertilis) is left to arrangement between remaining users.

Conclusion on the CDF

It is clear that the only functioning committees in the CDF are those which have a good reason to be, usually because there is money influx from government departments or NGOs program (see figure 19 XX). The CDF challenge is to mobilize community representatives without providing financial compensations for the time involved, thus committees and forums will be functioning only if the people really need them.

To support this, the WC was lately the centre of attention in the CDF since most farming activities take place in the wetland and wetland sustainability was given focus through the MWP and IWMI intervention. In 2011, with the LADC rehabilitation of Fertilis IS, there might be an opportunity for people to engage in irrigation management.

1.3.3 Administrative coordination of resources management

The ward councillor is responsible for communicating community concerns through an official document to the municipality. The municipality is then responsible for writing the IDP (integrated development plan), which is a planning document for development projects, and a way to provide financial resources to local communities. In writing the document, the municipality intend to match communities concerns and the government department projects.

In reality, the flow of information (bottom up) is very much short cut by informal relationships. In GaMampa, the CDF is not active and its representatives express concerns to the ward councillor with poor participatory processes.

Parallel processes thus take place, linking the community organizations directly to government departments and NGOs. In the case of the wetland committee, the MWP is taking place under UNDP funding and technical support of the department of agriculture. The MWP will be integrated to the municipality IDP next year, after it has been running for one year already.

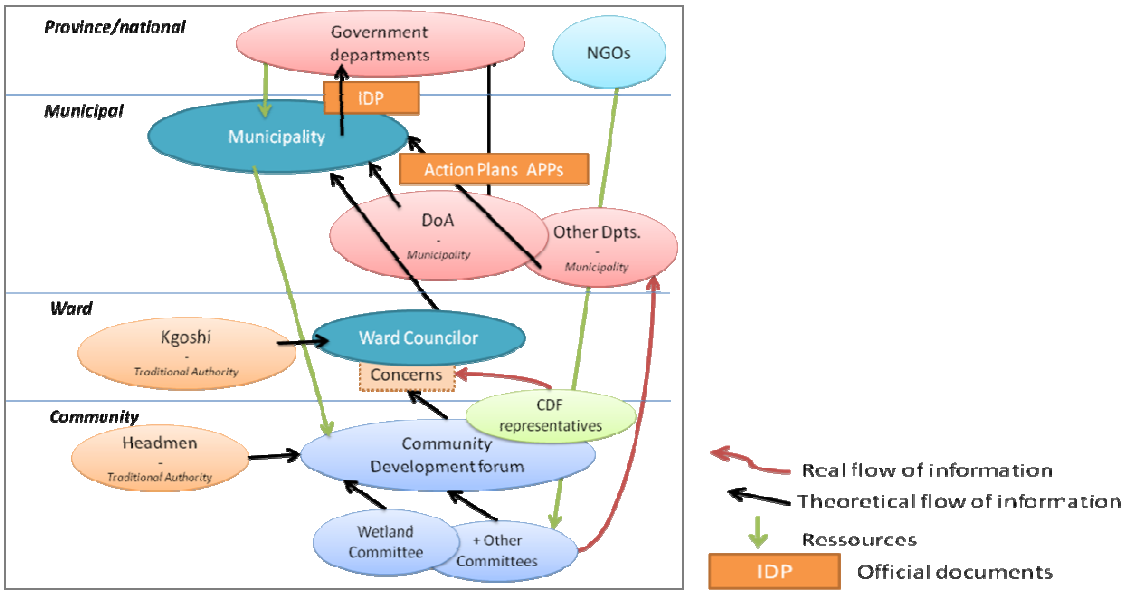


Figure 19 : Overall institutional framework for the governance of resource in GaMampa

Conclusion on actual traditional and community resource management

The CDF and other community organizations are a result of new governmental policies, set up at the end of the apartheid. Resources management used to be in the hands of the homeland government and has been passed to traditional and community organizations on behalf of community management of resources concepts, without actual transition process and sets of objectives. This led to a move from a hierarchical and organized management of resources under the apartheid setting to a disappearance of rules at the end of the apartheid.

Around 15 years later, this induced the breakdown of ISs and the invasion of the wetland, as well as the multiplication of governmental and nongovernmental projects. The concept of community based management of resources is not questioned but its implementation in the case of GaMampa is not well adapted to the traditional and social context, resulting in a blur in resources governance. This remark is often made in the South African context (Pollard et al, 2006).

2 FOCUS ON THE GAMAMPA WETLAND INVASION

Two studies focused on GaMampa wetland area (land cover): C. Sarron used satellite images from 1996 and 2004 and Rebelo et al. used GPS mapping in 2007. On ecological health, Kotze in 2005 studied the wetland vegetation, geomorphologic and hydrological integrity. In 2006, Morardet et al. focused on the general hydrology of the wetland and in 2009, Ilse Kogelbauer worked on groundwater flows within the wetland original area.
This study gives a typology of the wetland and intends to analyse the reason and dynamics for the recent wetland invasion which resulted in the current challenging ecological status.

2.1 A TYPOLOGY FOR THE WETLAND

Although it is often referred to under the umbrella name of *wetland* in previous literature, this study advances that there are different types of wetland formations in the Mohlapitsi riverine area, mainly differentiated by their hydrology and vegetation. These differences were made according to literature review, field observations and mapping workshops held with wetland farmers. They shall enable a better understanding of wetland invasion dynamics and provide better insight for future wetland management.

This typology makes a difference between extended reed marshes, riparian forests and localized wetland marshes and grasslands.

2.1.1 PHRAGMITE MARSHES

The main wetland areas, as they are qualified in previous studies, are extended tall and dense *phragmite* marshes (*Phragmites mauritianus)* covering the sides of the Mohlapitsi River. After investigation on their localization, pedology and hydrology, this study advances that there are actually two major types of reed marshes in the wetland. They are presented in figure 20 below.

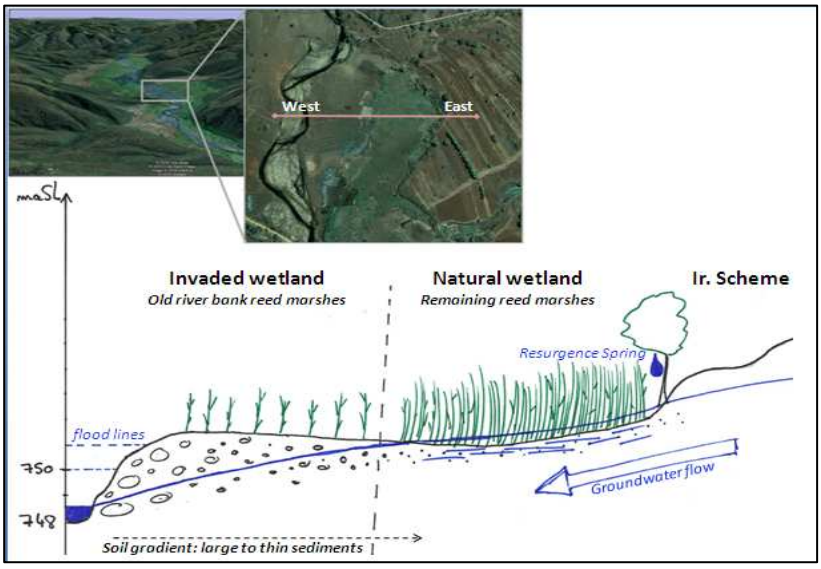


Figure 20 : transect of the GaMoila river banks and wetland area

In Mapagane and in GaMoila, extended reed marshes are made of two pedologic and hydrologic types depending on their localisation relatively to the river bed and the resurgence springs.

This transect shows that cultivation occurs mostly in naturally drained areas thanks to the soil characteristics, more than in remaining reed marshes which on the contrary are directly submitted to perennial water flow from the groundwater.

***River bank marshes* "cultivated wetlands"**

They are located within the river bed or on the river banks, higher than the water level in the river. The soil is naturally drained, made of silicates (sandy to loamy).

The water table there is above ground only seasonally during heavy rainfall events (see Annex III on groundwater levels, Kogelbauer 2009). Flooding frequency can vary according to changes in climate between the years. Nevertheless, year round groundwater inflows maintain the water table between 0,5 and 1 meter from the ground level (Kogelbauer, 2009).

Due to general moisture of the soils, they can take the form of extended reed formation under natural conditions. They can also easily be drained and farmed for maize production, leaving only the lowest, wettest parts as marshes and meadow vegetation. Today, they are mostly used for maize production.

The middle part of the GaMampa valley, between Mapagane and GaMoila (portion 4 and northern part of portion 2 in annex IV Kotze 2005), could be classified as belonging to this typology. Whereas the river bed used to spread out and seasonally flood large areas, interviews with the community revealed that the recent 2000 flood event channelled and lowered the river bed, leaving the soils naturally drained.

***Submerged basin wetlands* "Natural wetlands"**

They are set back from the main channel and just above river bed level, with very little slope. The soil is predominantly fine-textured, poorly-drained (loamy to clay).

The water table is always above ground (annex III), fed mostly by groundwater resurgences and underground flows from the mountain and surrounding terraces. However, they can also be fed by annual flooding to a limited extent (see annex V on flood lines, Vela VKE studies 2009,). Permanent saturation due to low infiltration rates and drainage capacity maintains high organic contents and nutrient availability (Kotze 2005).

Their use for agricultural purposes is limited since drainage is impossible in the core area for topographic reasons. To this day, they remain extensive natural areas of reed marsh formations.

These areas, in Kotze 2005, are portion 1 and 4 and southern parts of part 2 (annex IV Kotze 2005)

2.1.2 OTHER WETLAND FORMATIONS

Else than reed marshes, **other wetlands occur in limited areas around the river channel**, under the form of grasslands, meadows and small marshes. They are shown in annex XV.

In addition, field observation for this study has pointed out the existence of perennially wet areas of forested wetland ecosystems around cliff bottom springs (resurgence) in the upstream part of the valley bottom, as well as around irrigation canals in the Mashushu and GaMoila areas, partly due to canal leakages.

The map in figure 21 presents a general mapping of the wetland typology proposed by this study. This typology of the GaMampa wetland formations was compiled through the results of local SH workshops and observations. It aims at easing the understanding in wetland invasion dynamics and can be used for future land use planning in the implementation of a wetland management plan.

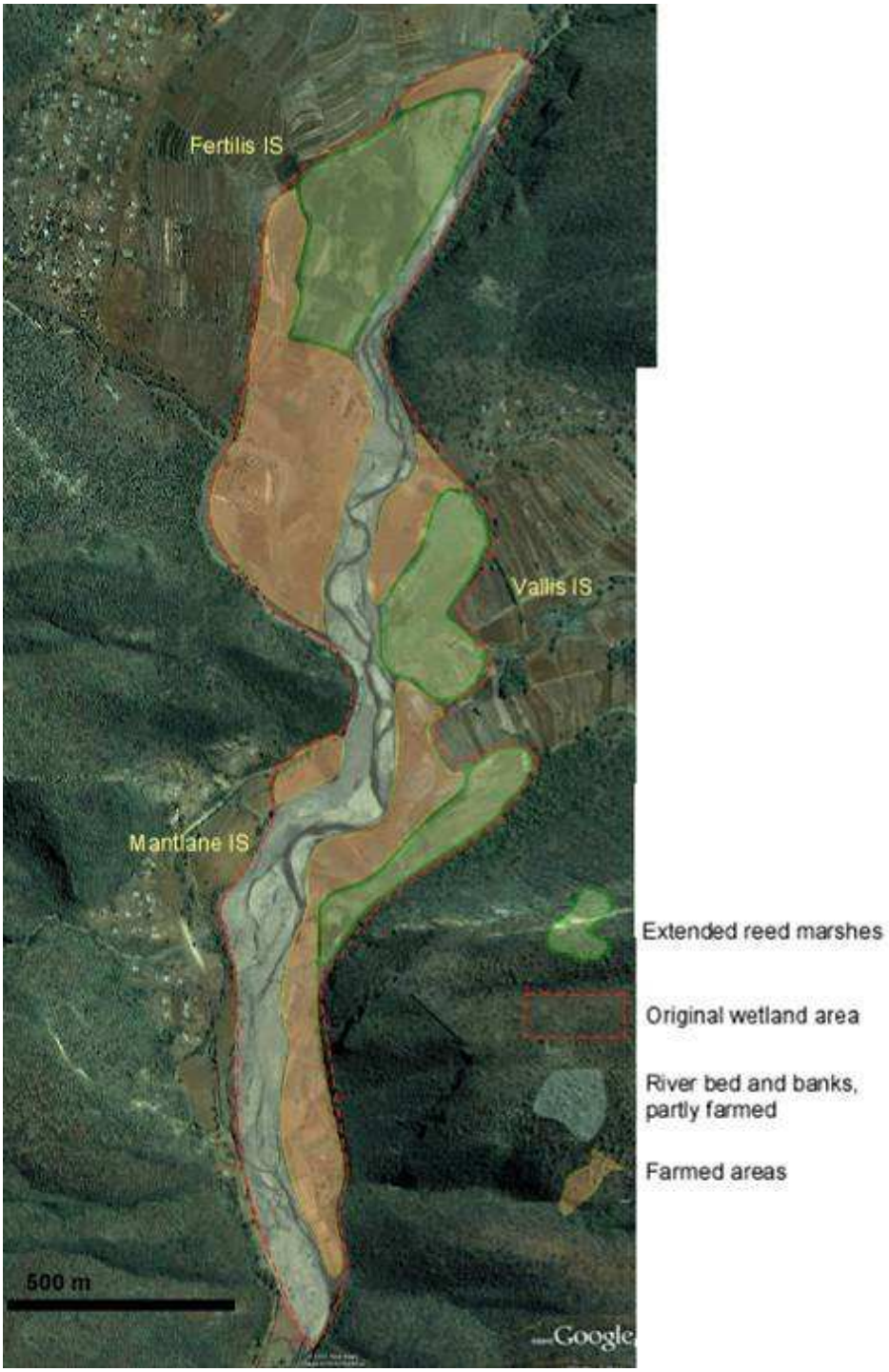


Figure 21 : Mapping of GaMampa wetland typologies

2.2 LOGIC AND DYNAMICS IN WETLAND INVASION

2.2.1 THE REASONS FOR WETLAND INVASION

It is almost perfectly accepted by all SHs to say that there is a direct link between ISs breakdown in 2000 and wetland invasion. This report wishes to emphasize that the breakdown of the ISs is a sign of the general changes in resources management, rural extension, farming systems and climatic variations in GaMampa, and only adds to the pressure on the wetland.

In fact, the invasion of the wetland is in phase with ISs final breakdown after the 2000 flood, but takes its roots in deeper issues in the agrarian system of the valley (box 2 gives an overview of recent historical changes in the agrarian system of GaMampa).

Box 2: GaMampa terraces: from irrigated to dry lands

"These were difficult times in the cities, but at least here, our land was used and we could eat well" – quote from a historical interview with Franck Mampa.

Historically, during the apartheid, the local homeland government provided **technical support** (rural extension), **financial eases** (loans), **managerial (**bylaws and enforcement) and **market availability** for the farmers. The ISs were farmed for subsistence maize during wet season and commercial crops during dry season (see Chiron 2005).

At the end of the apartheid in the 1990's, the centralized management of resources and rural affairs disappeared. The paradigm of community based management of resources was desired but was not implemented because there was no transfer process under the laisser-faire policy of the contemporary liberalism paradigm. Relatively suddenly since 1994, both management and maintenance of the ISs was passed on to the community without training.

Both distribution management and scheme maintenance quickly disappeared, leading to an infrastructure breakdown and a poor organization of the farming community. As a benchmark, the 2000 flood event left the irrigation infrastructure almost unusable, especially in Fertilis, and was never repaired. In addition, lack of rules over the management of resources increased livestock pressure on the ISs and stimulated farmers' lack of interest in cropping activities.

Simultaneously, the welfare system generally improved nationally and the development of social grants lowered the need for the GaMampa people to seek for agricultural income. In 2005, only 6% of a household income came from irrigated agriculture. This induced lack of interest in commercial irrigated farming and a move from semi commercial farming to exclusively subsistence farming.

These governance and socio economic phenomena were coupled to the augmentation of climatic variations (floods and drought periods) since the beginning of the 90's. As a result, the farming community in GaMampa generally limited its activities to subsistence farming, facing the difficulty and risks of commercial farming in the ISs (water shortage, management difficulties, livestock pressure). The plots in IS are now only partly cultivated in wet season, rarely irrigated and grazed because of a lack of livestock control, poor maintenance of fences, and farmers' lack of interest in their field.

The following sentences are taken from farmer interviews and reveal what stimulates the lack of interest in irrigation scheme management.

"The government left us, they should help us farm"

This sentence expresses the habit for local farmers to be supervised in their production and their expectations of governmental intervention.

Since the end of the apartheid, the government does not support the maintenance and management of the IS scheme. The GaMampa community was never used to self management of water and land resource and this sudden change was not followed by training. Therefore, the required social organisation required was never set and this lead to the breakdown of IS infrastructure, symbolized by the 2000 flood events.

"There are too many goats now, these small ones can go through the fences"

This sentence expresses the difficulties farmers face with livestock control.

Livestock control is rarely pointed out as a reason for ISs breakdown. It is in fact one of the major changes in the agrarian system of GaMampa since the end of the apartheid. Even though there are no quantitative facts on the matter, it is clear that there was an augmentation. Under the former regime, the white government put restrictions on livestock number per household and applied rules over management of the cattle between kraals and grazing areas (Ferrand 2004). Nowadays, there are no such restrictions which put pressure on the ISs plots. This holds a large responsibility in the farmers' lack of interest in irrigated farming in dry season as they fear that animal will destroy their crops.

"The place of the reeds15***, at least, is always wet"***

This sentence expresses the relative advantage of wetland areas on ISs.

Irrigation provides only up to 10% of the water requirement for maize production (Chiron 2005). Local people say that there has been more variability in rainfall events over in the past 20 years, augmenting the risk in maize production in the IS. The wetland areas provide natural soil moisture and thus less risk of drought. The farmers, during a workshop focusing on risk in maize production, pointed out that risk for flooding in the wetland are lesser than risk for drought in the ISs.

"We just take chances to feed our family"

This sentence expresses the general attitude towards maize cropping in GaMampa.

The farming systems of the GaMampa valley are nowadays based on subsistence maize farming and farmers have limited investment capacity for their farms. As wetland farming requires less investment but also less care (weeding and irrigation), it is more adapted to actual farming systems' capacity than maize production in the IS.

In conclusion, the historical evolution led to a specialisation of farming systems towards maize subsistence farming. It happens so that the wetland is more attractive for the actual subsistence farming systems than the IS because:

- It requires less investment in money and time (Chiron 2005);
- It does not require difficult and unusual social organisation for water distribution and maintenance of the infrastructure;
- It presents less risk in the case of dry climatic event.

[15] The Sepedi language refers to « the place of reeds » for notion of wetlands

Finally, it is important to point out that similarly to what Harding described as the *tragedy of the commons,* farming in the wetland is in farmers' interest at the scale of their farming system even though it is not in the interests of the community as a whole.

2.2.2 DYNAMICS OF WETLAND INVASION

For more information on this topic, see report on wetland mapping in Fertilis Mashushu and GaMoila in June 2010.

Before the 2000 flood: land for the landless

The invasion started after the end of the apartheid because environmental surveillance declined, on the eastern border of the Fertilis irrigation scheme. Drainage canals were dug by people who did not have access to plots in the IS. The plots were small because there was not much room between the IS and the wet areas. The plots were not fenced because cattle do not access the area thanks to dense wetland vegetation.

After the 2000 flood: intensification of the invasion

In 2000, the flood event had two consequences o the GaMampa valley water and land resources:

- The ISs infrastructure were badly hurt and important reparations were required for the following planting season
- The river bed had locally moved in areas where it is not directly in contact with surrounding mountains, mainly between Mapagane and GaMoila (see figure 13)

Some GaMampa farmers looked for planting opportunities in the wetland because they had noticed the natural moisture and relative good drainage of some areas. The main invasion started in naturally drained marshes formations. Yields were good and the following year, invasion intensified. Local farmers refer to mimetic logic between people and the rush to secure family's future access to land outside of the IS.

During the years 2000, the Mondi company came with its environmental care program to finance the safeguard of the wetland by proposing a full ban of wetland use by the local community. This started an opposition movement in the wetland users which triggered the creation of a Wetland Committee (WC) in the CDF to counter the Mondi program. The invasion was therefore formalized through the WC, as well as distribution of the Traditional Authority Paper (TAP).

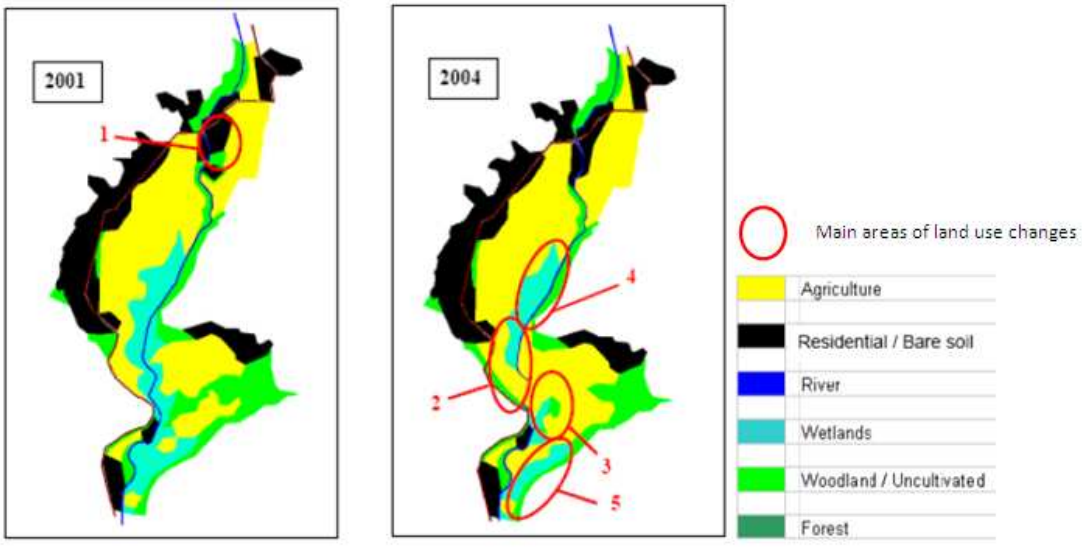


Figure 22 : Evolution of land use in the GaMampa valley (Sarron 2005)

Figure 22 shows the drastic land use changes in GaMampa between 2001 an 2004. We can see that the main changes are located on the river banks of the river, because they were naturally drained (see transect in figure 20).
A local stakeholder mapping workshop in july 2010 gave the indication that the point of entry for wetland invasion was mainly the area between Mapagane and GaMoila after the 2000 flood event had channelled the river bed and left the place suitable for cultivation. The river bed changes and invasion dynamic are illustrated in figure 23 below.

Figure 23 : Dynamics in wetland invasion after the 2000 flood

Up to 2005, most areas under the river bank marshes wetland typology were cleared and cultivated with maize.

Stabilization since 2005: "We have invaded all we could"

The GPS mapping in 2007 (Rebelo et al. 2010) shows that in contrast to preceding years, there was no major changes in wetland extent after 2005. The result of the mapping workshop held with farmers confirmed this and partly gave explanation for this.
Both north and south, the invasion was stopped because new farmers who tried to clear the reeds and drain the soil found some areas were unsuitable for maize cultivation. These areas refer to basin wetland type (e.g. the "eye" of the wetland near Fertilis, part of reed formations near GaMoila and in the southern left bank of the river). In fact, the GPS mapping in 2007 revealed that these areas are left uncultivated.
Since 2005, wetland farmers have tried to secure their plot and invest in them. For example, private fencing of the plots occurred generally in small groups of neighbouring plots in order to share the costs (4-5 farmers). In addition in 2010, the MWP was diverted from its original purpose of preventing further invasion of the wetland and switched to the enclosure the wetland area. It is said to aim a preventing cultivation but in fact since cultivation already exists, it is used to further secure wetland plots from animal roaming.

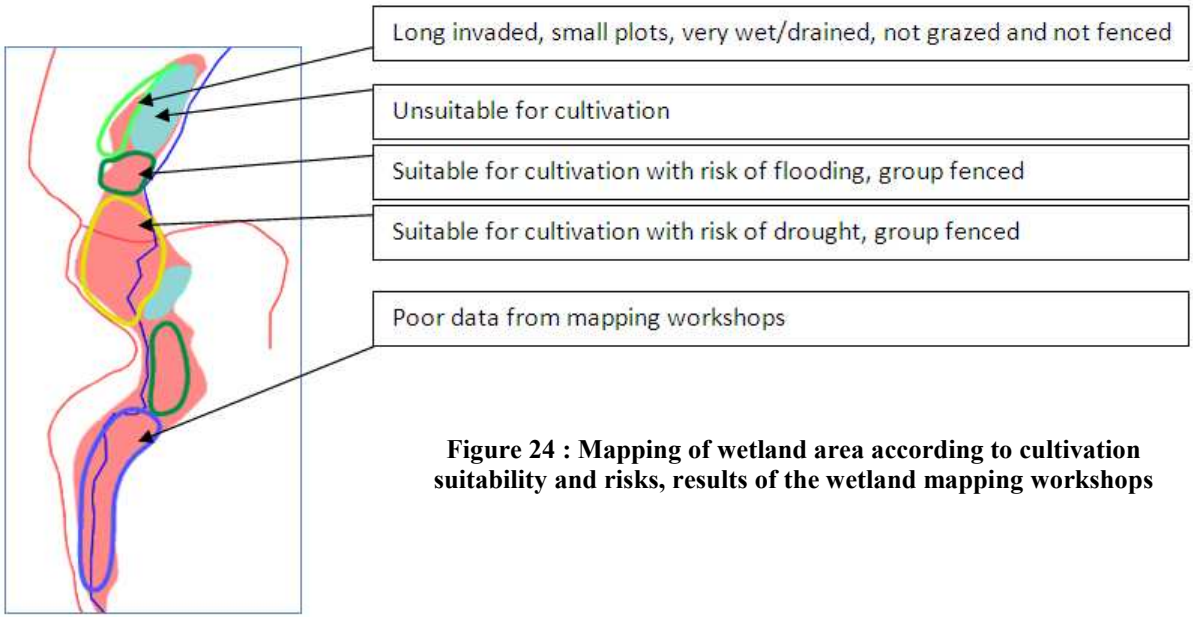


Figure 24 : Mapping of wetland area according to cultivation suitability and risks, results of the wetland mapping workshops

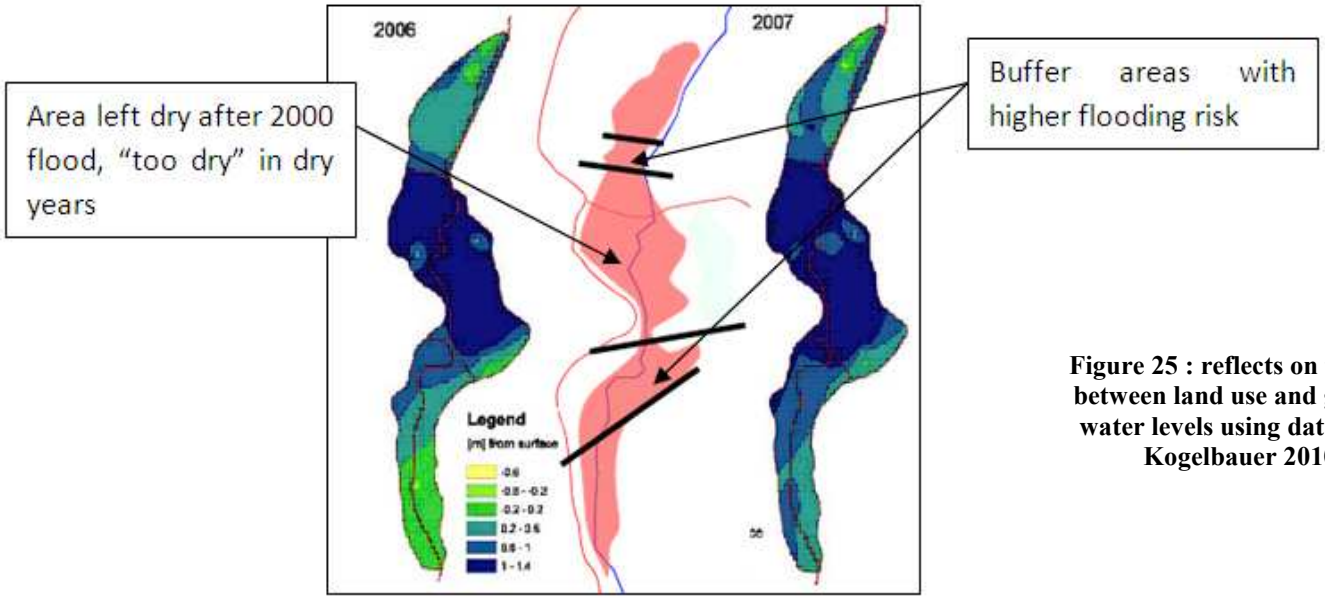


Figure 25 : reflects on the link between land use and ground water levels using data form Kogelbauer 2010

The results of the mapping workshops of the mapping workshop shown in figure 24 are compared to the map of groundwater levels from Kogelbauer in figure 25.

The groundwater levels in 2006 and 2007 show that in the cultivated parts of the wetland, the water table level is lower than 0,6m deep, even in wet season. The water table in the rest of the wetland area is +0,2 to -0,2m leaving it unsuitable for maize cultivation. "Buffer zones" areas feature water table levels between -0,2 to -0,6m depending on the rainfall, leaving the land farmable with high risk of flooding.

2.3 THE WETLAND INVASION, A CHANGE IN THE GAMAMPA RESOURCE SYSTEM

2.3.1 CONSEQUENCES OF WETLAND INVASION

The consequences of wetland invasion do not only include ecological impact but also socio economic challenges both at the valley level and in its local and regional context.

Consequences on wetland vegetation, geomorphologic and hydrological integrity

The environmental and hydrological integrity of the wetland was assessed in 2005 by D. Kotze. His findings can generally be applied to the 2010 situation since there has not been much extension of wetland use for maize farming. In the following table, Kotze assesses the extension of wetland invasion to 65% of its original area, and presents the current situation as having mainly impacted the environment through changes in vegetation.

Component of integrity	Different land-use scenarios			
	Current situation – 65% extent of cultivation	Continued cultivation of existing extent (i.e.65% extent)[1]	Continued cultivation with expanded extent of cultivation – 80%	Rehabilitated with reduced extent of cultivation – 40%
Hydrologic	**65%**	**65%**	**54%**	**70%**
Geomorphic	**69%**	**38%**	**28%**	**70%**
Vegetation	**33%**	**33%**	**24%**	**45%**

Health classes	Natural (>89%)	Good (70-89%)	Fair (40-69%)	Poor (<40%)

Table 3 : Hydrologic, geomorphic and vegetation integrity of the wetland under different land-use scenarios (Kotze 2005). % indicate the status in comparison to natural stats (100%)

The impact on hydrology is moderate and mainly caused by artificial drainage. It alters the distribution and retention of water in the wetland soils, in different proportions according to location, and especially in the area around Fertilis where drains bring water straight from the resurgence springs to the river bed. Nevertheless, the drains are only 25cm deep in average (field observations) and their impact on groundwater flows is limited[16]. The site characteristics (moderate humification of soils, low rainfall and natural drainage) impact more on hydrologic flows than the artificial drainage (Kogelbauer 2009). The river flow is not significantly disturbed by artificial drainage because the natural flow from the catchment is predominant. This isusefull for future modelling of the valley's hydrology under WETsys because it would justify not including the drains.

Interviews brought out that some wetland farmers complain about dry conditions and lack of water in the older cultivated areas of the wetland. This should be investigated to assess whether it is due to a depletion of soil organic matter as Kotze hypothesised, thus confirming the evolution towards a poor geomorphologic status in the case of continued cultivation (column 2 table 3). In any case, geomorphologic integrity is affected by depletion of soil organic matter because of desiccation and soil cultivation practices (yearly tillage and burning). Both will reduce soil organic material as well as its oxidation capability shifting in poor geomorphologic state.

[16] : this is confirmed by Kogelbauer's study on groundwater in 2009

In conclusion, even though the extent of cultivation was quasi unchanged since 2005 and vegetation is not further threatened, intensification of wetland farming may induce geomorphologic and hydrological qualitative consequences.

Consequences on Wetland services

A table in Annex VI presents the impact of wetland invasion on ecosystem services provision. Overall, in the past decade, with the wetland invasion, services to the community have increased and environmental services have decreased.

The wetland services to the community have increased through the development of maize farming (Adekola, Morardet et al. 2008) while other uses of the wetland for community provisioning have decreased without apparent concern from the community. In fact, edible plant collection is not limited by wetland farming while reed collection is not in the community's interest neither economically nor culturally since people rather use tin roofs. Currently agricultural activities provide the greatest direct benefit to the local community.

On the other hand, environmental services are challenged by wetland agricultural practices. The effectiveness of the wetland to assimilate nitrates and toxicants has been reduced through artificial drainage and cultivation, even though it is likely to still be relatively effective. However, if the agricultural activity in the surrounding lands was to increase with the return to irrigated commercial cropping systems and production increases with population, then this service would become increasingly important. The current extent of cultivation might limit the potential purification service in the future.

Researchers recently proved that changes in wetland uses do not significantly influence the Mohlapitsi dry season river flows (Kogelbauer 2009, McCartney et al., 2010). Nevertheless, the impact on water quality should be assessed in the future, especially if cropping systems intensify after rehabilitation of the Irrigation schemes. Instead of focusing on GaMampa wetland purification capacities, we point out that the recent farming practises in the wetland (e.g. the use of fertilizers and chemical crop protection) impact on water quality and the purification capacity (e.g. nutrient traps) of the riverine wetlands have reduced

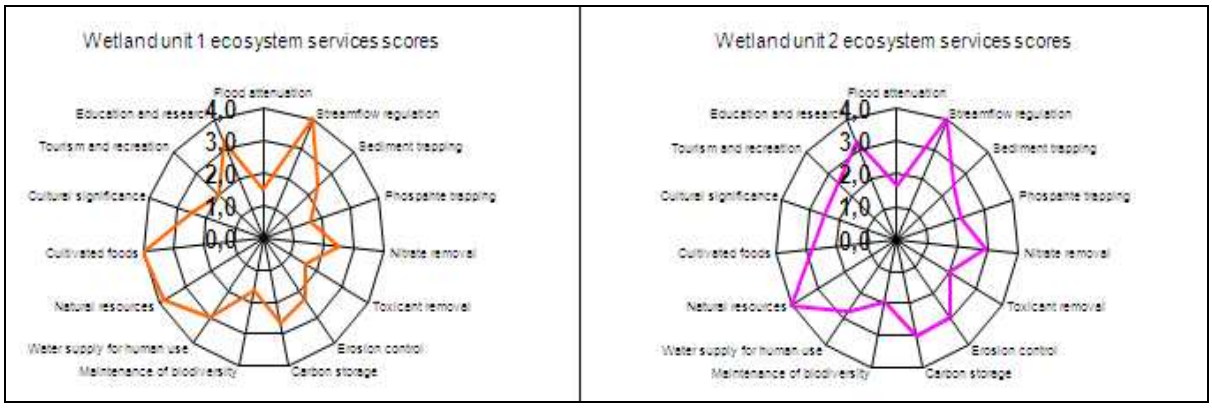


Figure 26: Comparison of wetland ecosystem services in the actual extent of farming (Unit 1) and without cultivation (Unit 2), under the assessment of WET-Ecoservices tool (Johntson, 2010)

The comparison of the spider diagrams in figure 26 shows that the impact of wetland farming is not significant on hydrological regulation but concerns mainly other regulating services

(phosphate/sediment trapping, nitrate and toxicant removal, erosion, biodiversity). It is not surprising to see that when human economic services are higher, environmental services are lower.

Consequences on the agrarian system of GaMampa

The invasion of the wetland fed the changes in the agrarian system as much as these changes intensified the extension and use of wetland for farming purposes. This shows the integration of wetland to other resources in the valley, mainly livestock breeding and irrigated agriculture.

The pressure of the livestock on the IS was partly fed by the cultivation of the wetland by reducing grazing opportunities in this part of the valley. By cutting the reeds, the harvesters left natural grassland formations available for livestock in dry season. With the reduction and actual disappearance of this practice, the livestock puts pressure on the IS areas to compensate. The reduction in use of natural wetland products was not caused by cultivation, rather by changes in lifestyles, but the cultivation has now reduced potential harvest quantities and limited grazing.

On one hand, the difficulty of irrigated cropping in the IS has given the will to farmers to cultivate the wetland. On the other hand, the opportunity of wetland cultivation is not responsible but has increased the phenomenon of disinvestment in irrigated cropping systems, feeding the breakdown of both irrigation infrastructures, social management of irrigation water, and livestock control in dry season to prevent trampling of dry season irrigated crops.

By reinforcing the lack of interest in irrigation scheme maintenance and augmentation of livestock pressure in dry season, the wetland cropping phenomenon is partly responsible for the abandonment of semi commercial cropping systems in the IS and the reduction in livestock control. This description of the wetland invasion on the agrarian system of GaMampa was schematized and is presented in Annex XVI as the “wetland invasion loop”.

Consequences on external SHs involvement and awareness

The invasion of the GaMampa wetland triggered interest in the area for many institutions both on local, regional, governmental and non governmental institutions.

As it is pointed out above, in hydrological terms, changes in the Mohlapitsi flow (Masiyandima, 2006) cannot significantly be attributed to on wetland conversion to cultivated land. Nevertheless, both locally and regionally, SHs point out the recent invasion as being responsible for hydrological changes (WETwin SH workshop in April 2010). This is a challenge for the IWMI research team to pass on the recent findings, as well as for the GaMampa community to deal with these accusation even though there are not scientifically proven.

Environmental concerns have triggered much attention and involvement in the research community of South Africa. This is a challenge for the GaMampa community since tradeoffs between conservation and agricultural provisioning must be found in order to satisfy all SHs. The community has already strongly opposed environmental intervention[17] , and compromises must be found to implement rehabilitation of the wetland.

[17] : in 2007, the Mondi wetland program intended to exclude farming activities from the wetland. The community was opposed and won the conflict.

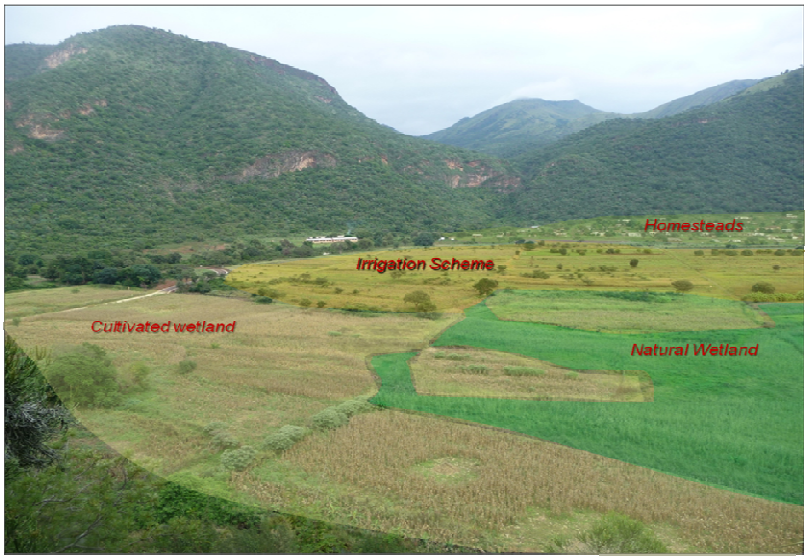
2.3.2 CONCLUSION ON WETLAND INVASION

The **main pressure on wetland environmental sustainability comes from the rapid extension of maize cultivation**. This phenomenon is due to the socio economic setting and general resource management system in GaMampa. It directly impacts the wetland environmental integrity and challenges its potential in water quality regulation. Even though its importance on the regional quantitative hydrology appears to be insignificant, the wetland is in danger of losing both environmental and community services on the local scale.
In addition, we saw that the invasion of the wetland also impacts the use and management of other resources in the valley (mainly the ISs, irrigation water, grazing areas), and contributes to changes in the farming systems from semi commercial to exclusively subsistence.

On the topic of wetland sustainability and future ecosystem rehabilitation, it is important to say that:

- Whereas ISs were neglected in the last decade; wetland plots were secured through fencing, are cultivated and chemical fertilisation started to occur on a yearly basis. This shows that **wetland use for farming goes further than just to compensate climatic or socio economic events** (buffer effect) and might be partly ongoing even after a successful IS rehabilitation.
- Second, wetland farming is merely subsistence farming through maize production and exchange with the milling company. It is not a source of income for households of the valley. Wetland farming thus cannot be forbidden or lowered if other, more interesting maize farming opportunities are not proposed in the IS in the short run. In the long term, wetland maize production can be lowered by providing extra income to households (agricultural or non agricultural).
- There is no coordination in the exploitation of wetland resources among wetland users, especially in farming and grazing activities. It relies on private decision making and therefore there is no reflection on the ecological management of the resource to maximize economic profits and environmental sustainability.

These conclusions from the description of wetland invasion dynamics, logic and consequences will enable us to identify the stakes in future wetland management.



This photo, taken at the end of the wet season, shows the cultivated wetland (maize residues) in the front and the uncultivated irrigation schemes in the back.
The front, right hand side of the picture shows the natural reed marshes vegetation of the wetland in the basin topography.

3 CONCLUSIONS ON THE DIAGNOSIS, ORIENTATIONS FOR THE DEVELOPMENT OF MANAGEMENT OPTIONS

3.1 STAKES IN WETLAND MANAGEMENT

The diagnosis of the GaMampa resource system and specifically the wetland issues showed that wetland sustainability is both a local and regional stake.

At local level, the sustainability of the wetland involves the sustainability of the local traditional provisioning services of the ecosystem, which have important cultural and economic value. I addition, it also involves the sustainability of the more recent provisioning services of the wetland: subsistence food production. The stakes at local level are thus mainly socio economic, through the support of livelihoods in the future.

We saw that stakes for wetland sustainability at regional level are not exactly clear, especially on the question of low flow regulation. However, even though they have not been scientifically assessed, these stakes are already in the mind of decision makers, governmental and nongovernmental organizations. They are environmental stakes at regional level, which were already built in recent history even though they have not proven to be significant.

3.2 DPSI ANALYSIS

Starting from the DPSI provided by previous studies in GaMampa, this diagnosis gives another version, which does not have to be seen as a WETwin research result but sets the context of the later tradeoffs analysis. The version below is simplified and more details on the DPSI diagram are presented in annex VII.

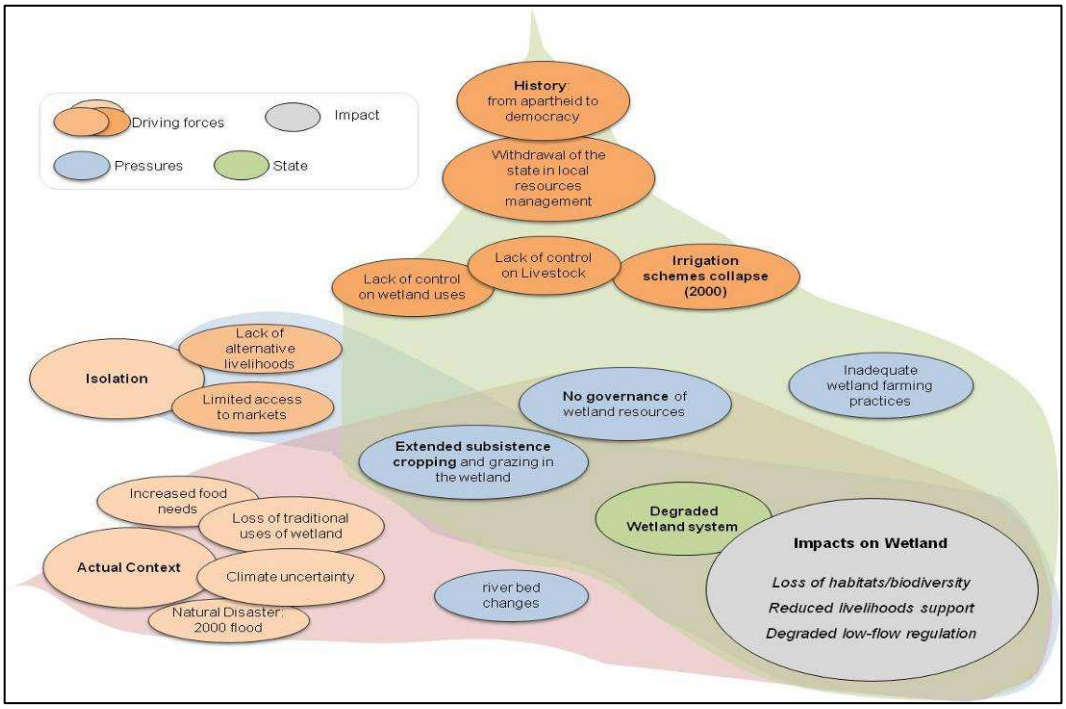


Figure 27: Personal version of the DPSI, October 2010

In the DPSI diagram, one can see that three main chains of pressures on the wetland system were identified, resulting in technical (extension of subsistence cropping, inadequate farming practices), but also as institutional pressures.

The main pressure is the **extension subsistence cropping in the wetland** because it challenges the wetland ecological integrity (vegetation, hydrology and geomorphology). It is caused by both historic and actual context:

- The shift in IS governance at the end of the apartheid which led to their infrastructure and organizational breakdown,
- The current isolation of the local communities, which limit commercial farming and alternative employment opportunities, and enhances the need for subsistence production
- The need for secured cropping systems in relation to water in a context of climatic variation, which the wetland is able to provide.

Wetland cropping is even more problematic for the environmental integrity of the ecosystem since farming practices are not adapted to wetland context. Maize requires draining of the area and cropping system do not feature long term fallows and present management of the fertility.

In addition to maize cropping, and this is not explicitly part of the initial DPSI analysis (April 2010) of the WETwin project, this study advances that the **lack of resource governance in the valley** is also an important pressure on the wetland because it reinforced the IS breakdown and does not allow the local control of wetland uses.

Finally, the changes in river bed, although natural, had a strong impact on the wetland use. This was recently proven by the channelling of the river bed which led to the natural drainage of the middle part of the wetland.

3.3 WHAT POSSIBLE TRADEOFFS: MONO USE VS. MULTIPLE USE

We saw that the main pressures on the wetland are the recent extension of maize cropping activities and lack of resources management in the valley. As to guarantee sustainability of the wetland, future tradeoffs, which will be implemented through MSs, should tackle these issues.

We also saw that traditional provisioning services of the wetland are not harmful to the ecological integrity of the wetland. These traditional services are many and diversified. While some actually depend on the ecological integrity (reed harvesting), others are facilitated by the recent expansion of cropping (edible plant collection).

"I wish this wetland would not exist anymore and we can farm everywhere"

This sentence was pronounced by a woman wetland farmer when asked to say what she hopes for the wetland in 20 years. It shows that in the current situation, the community members consider that their direct personal economic interest is to farm the wetland. Natural vegetation collection (reed, sedges) is not significant in household economy anymore. Wetland farming households were former users of the wetland who chose to access only a small piece of the ecosystem for farming instead of communally access it for multiple collection activities.

It is thus a complex system where the GaMampa community currently finds more advantages in "mono use" of the wetland, maize cropping, than in keeping the ecological integrity of the wetland and using it for diverse uses.

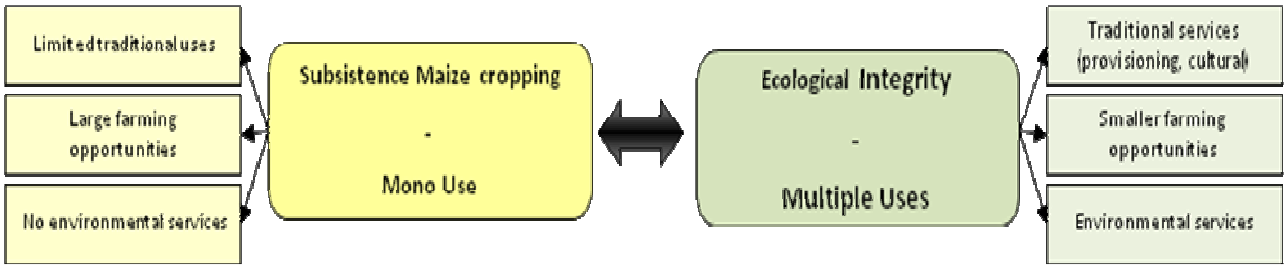


Figure 28: illustration of the principal trade-off between ecosystem services which is to be tackled by wetland management

The previous studies by IWMI and Cemagref identified three tradeoffs (Masiyandima, 2009):

- Crop production Vs. livestock grazing and natural vegetation production
- Crop production Vs. hydrological functioning
- Crop production today Vs. tomorrow

This study advances that ecological integrity of the wetland can guarantee sustainability of both environmental and provisioning services. Therefore the 3 proposed compromises were narrowed to one only one compromise between mono use for maize subsistence cropping and environmental integrity for multiple uses.

The diagnosis showed that extension of subsistence maize cropping, even though it puts wetland sustainability at stakes, is very much necessary for the local community and cannot be abandoned. The proposed management options which follow (Part III) therefore focus on compromising solutions to enable both maize cropping and ecological integrity as it is the only potentially successful direction. **In short a simple, mono use of the wetland for farming is not sustainable, risky and challenges environmental and cultural aspects of the wetland, whereas multiple uses of the wetland, including maize cropping, can guarantee satisfaction of all SHs and durability of the ecosystem and its services.**

3.4 MAIN CHALLENGES FOR FUTURE WETLAND MANAGEMENT

In order to address the above tradeoffs and propose a sustainable management of the wetland, three main challenges stand out:

- **<u>Irrigation scheme rehabilitation to intensify commercial production</u>**

The rehabilitation of the ISs is a key element to guarantee wetland sustainability. It can trigger the return of some farmers from wetland to ISs, and thus release pressure on the wetland. Also, by potentially providing relatively intensive production opportunities, it might partially tackle the issue of poverty in the area and thus also release pressure on the wetland for farming.

It is not only a technical but mainly a social and economic challenge. As described in this diagnosis, the breakdown of the IS is mainly due to poor irrigation management transfer which triggered lack of interest in the IS. **The challenge lies in buy in of the community to bring in social and economic investment in its maintenance and operation, as well as in guaranteeing its capacity in collective action**. The rehabilitation outcome should provide better farming opportunities than the wetland, while fulfiling the current need for subsistence cropping, and capacity building.

- **Integrated management of resources to turn grazing into an advantage**

The lack of governance of resources in the valley is both one of the causes and accelerating factor of maize cropping extension. Establishing sound governance of resources is a prerequisite to implement future tradeoffs between wetland uses, specifically the set up of local rules concerning livestock control to release the effect of straying animals on cropping systems.

The challenge is for the community to craft relevant and legitimate institutions (organisation and rules) concerning wetland integration to the valley resources. This implies coordination of human activities between wetland and other resources so that they benefit of each other. The main challenge lies in making use of grazing activities to the advantage of fertility in wetland plots and the set up of fallow periods for grazing and natural vegetation regeneration.

- **Guarantee community uses in a privatisation context**

The land tenure system is complex in GaMampa, especially in the wetland, where the land does not belong to the user and people only own the right to use the land. The recent invasion introduced a new possibility for wetland soils to be privately used under traditional authority official compliance (TAP[18]). Before invasion, the wetland was used by the community as a whole, with equal access and rights of use; it was the perfect example of a common resource in the theory of Hardin[19]. Privatization not of the land but of its use is undergoing, symbolized by the enclosure of plots by groups of wetland farmers, physically limiting the use of the areas by the community for grazing, collection of plants and gleaning.

Tensions occurred already because of a lack of control in land use distribution. The economic interest of the traditional chief makes him distribute rights without real control, and it is in each user's interest to get as much land as possible. This, first of all, challenges the traditional authority and it is a problem in a context of increasing need for control over the resources. Also, as Hardin pointed out, private interests develop at the expense of common interest and environmental sustainability.

The challenge lies in the set up of a concerted land use planning process that will bear in mind the need for communal uses and work with seasonal changes in vegetation and needs so that wetland farmers can keep their right of uses. A land reform, whether at local, regional or national level is not imaginable in the current liberalistic paradigm in use in the country.

[18] Traditional Authority Paper, bought from the local chief for a varying price, to own the right of use in a wetland area.

[19] *Tragedy of the commons*, 1968

Part III – Contributions to the trade off analysis for sustainable management of the GaMampa Wetland

This part of the document follows the tradeoffs analysis framework of the WETwin project and proposes a list of Management Options and Management Solutions

Picture of a laundry activity using water of the gravity infrastructure of the Fertilis Irrigation scheme in dry season

1 IDENTIFICATION OF THE MOS AND EVALUATION CRITERIA

1.1 CONCEPTUAL FRAMEWORK FOR THE DEVELOPMENT OF MOS

As developed in part I of this report, MOs were identified by selecting the relevant management responses (MR) and identifying their implementation process, through SHs consultation.

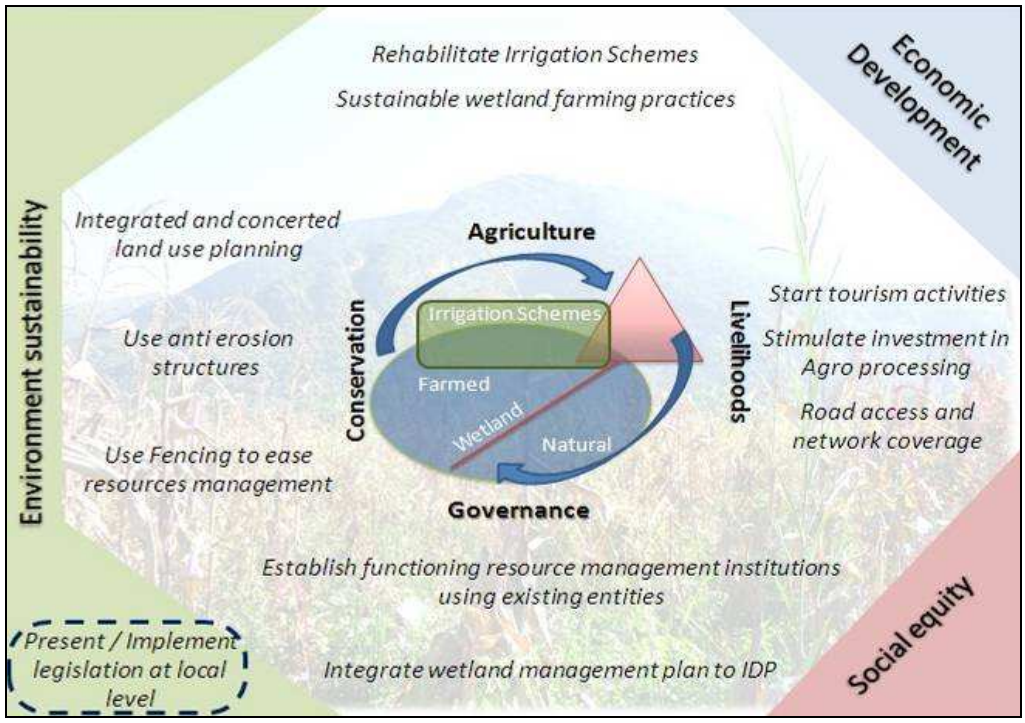


Figure 29: Management responses for the GaMampa Valley, July 2010

The diagram in the above figure gives the 11 MRs for the GaMampa valley as they were last validated in October 2010. It also provides the conceptual framework under which they were developed:

- **Sustainable development** (environmental sustainability, economic development, social equity),
- **Integrated resources management** (integration of the wetland to the GaMampa valley resource system),
- **Development targets** (conservation of natural resources, improvement of governance, economic development and livelihoods and agricultural systems).

1.1.1 WETLAND USE FOR SUSTAINABLE DEVELOPMENT

MOs can be classified along the three principles of sustainable development (environment sustainability, social equity, economic development). They were developed as steps to work towards:

- **Economic development** of the GaMampa community which corresponds to the use of wetland and other resources services for improving the livelihoods of the local community (e.g. farming, natural resources collection, tourism and all economic services)
- **Ecological sustainability** of the wetland ecosystem (e.g. conservation of all environmental services)
- **Social equity** in the management of resources, so that the people of the community can equally access them (functioning equitable governance system)

This dimension of the research is reflected through the 3 external features of the MOs diagram in figure 29.

1.1.2 DEVELOPMENT OBJECTIVES AND MANAGEMENT RESPONSES

MOs were first identified as management responses (MRs) to the DPSI diagram and were organized in 4 groups according to the four development objectives for the GaMampa valley:

- **Agricultural development (A).** This aims at using agricultural production to guarantee the economic development of the community, as well as the sustainability of farming resources, specifically the wetland.
- **Conservation of natural resources (C).** This aims at the sustainability of natural resources, including the wetland, by making use of relevant resource management practices, infrastructures, and management institutions.
- **Livelihood opportunities (L).** This aims at developing alternative livelihood opportunities for the economic development of GaMampa community in order to release pressure on natural resources and specifically the wetland.
- **Governance of natural resources (G).** This aims at developing a governance framework to coordinate conservation and economic development while guaranteeing equity among local SHs.

In figure 29, MRs are classified according to the development objective they target. In the following listings, the first letter of each development target gives their denomination code to the MOs (see part 1.3).

1.1.3 INTEGRATED RESOURCES MANAGEMENT

The identification of stakes for wetland sustainability highlighted that pressures on the wetland take their roots in issues outside of the wetland. Thus, as shown in the MOs diagram, the management options tackle not only wetland centred issues but also deal with the GaMampa valley resources system as a whole, with for example the rehabilitation of the ISs. **These aspects of the MOs aim at integrating future wetland management into the agrarian system,** symbolized by the central part of the MOs diagram in figure 29.

1.2 THE IDENTIFICATION OF MANAGEMENT OPTIONS AND ALTERNATIVES

1.2.1 WETWIN TWINNING WORKSHOP

The discussion on MOs for the GaMampa wetland started within the WETwin project before this study, from an analysis of the DPSIR diagram (reference pages)[20]. For this study, the participatory identification of MOs started with an external SHs meeting[21] during the WETwin consortium meeting in April 2010. The following figure shows that the brainstorming at this stage came up with a similar approach in addressing pressures on the GaMampa wetland in comparison with the list of MOs finally chosen for trade-off analysis. In comparison, they are broader and not well contextualized, that is they should still be seen as potential Management Responses.

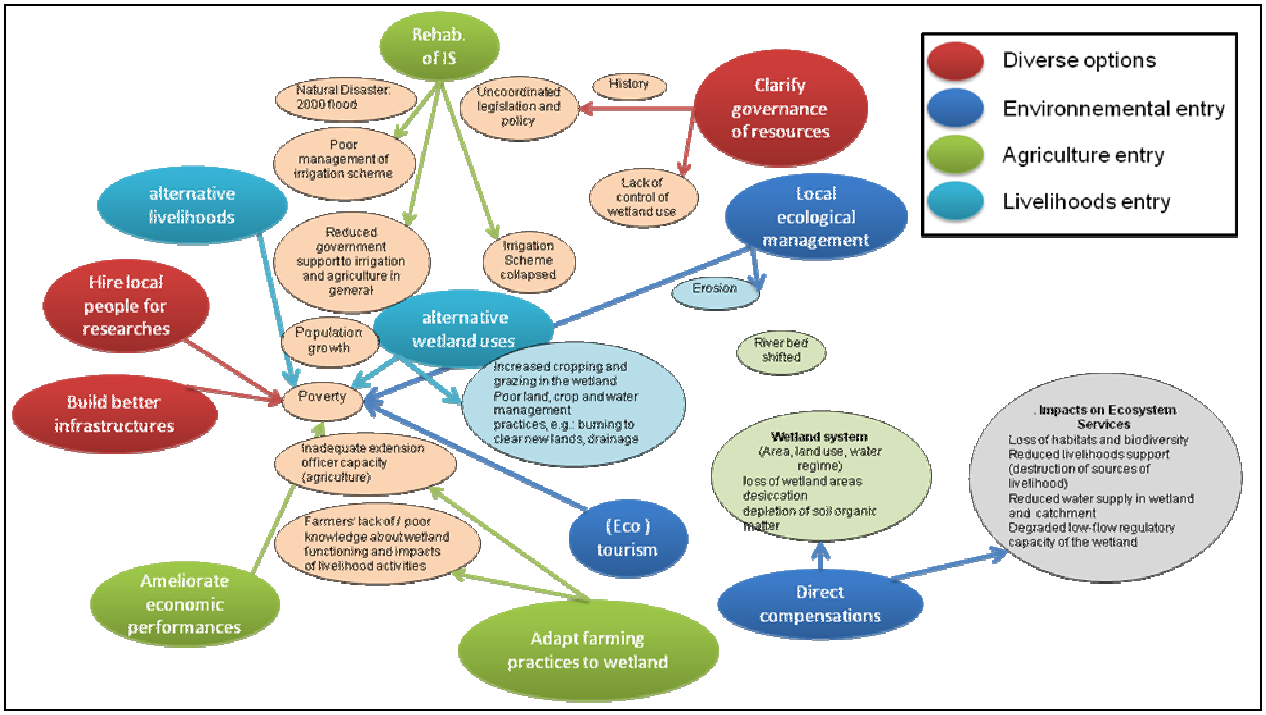


Figure 30: DPSI diagram for GaMampa wetland with responses developed during the WETwin workshop, April 2010 (source: WETwin DPSIR analysis for the GaMampa case study and workshop activities)

[20] See DPSIR diagram in WETwin Decision Support Framework v24, Zsuffa et al. 2010

[21] See report on Twinning workshop

1.2.2 LOCAL AND EXTERNAL STAKEHOLDER WORKSHOPS, FROM MRS TO MOS

The diagnosis of stakes presented in Part II of this report aimed at providing precisions on the WETwin DPSIR diagram and identify a relevant organization of the MOs to be presented to all SHs of the GaMampa wetland.

In July 2010, two workshops were held at the University of Limpopo and in the GaMampa valley. Their aim was:

- To validate identified management options with stakeholders
- To work on finding evaluation criteria for the management options
- To identify responsibilities and priorities in carrying out management options
- To get ideas for implementation of the management options
- To make SHs meet and discuss on management options.

In terms of MO validation, the discussion led to reformulate those which did not suit all SHs, but the general aims (development targets) were validated without disagreement by presented a diagram similar to the one in figure 29. The discussion provided an orientation for future research on the implementation alternatives of each MO, and priority scoring allowed to identify which MOs were most important or challenging for the community. The scoring was performed for each set of MOs grouped according to development objectives. Table 4 below shows the results of the MO validation and priority scoring.

development objective	MO	Priority score
Conservation	1. Integrated and concerted land use planning	24%
	2. Use Fencing to ease resources management	20%
	3. Use cheap, easily maintained anti erosion structures	20%
	4. Introduce legislation to local level	16%
Governance	1. Establish legitimate, resource management institutions building on existing entities	60%
	2. Integrate wetland management plan to IDP	40%
Agriculture	1. Rehabilitate Irrigation Schemes	35%
	2. Intensify irrigated agriculture towards commercial farming	30%
	3. Use sustainable wetland farming practices	20%
Livelihood	1. Start tourism activities	16%
	2. Establish farmer organizations to access market	28%
	3. Stimulate investment in Agro processing	28%
	4. Road access and network coverage	36%

Table 4: List of MOs after validation, with priority scoring within each development target, (internal report on SHs workshops for MO validation, July 2010)

An internal report was provided to present the results of these SHs meetings. It was identified that the most important MOs for SHs were those related to the economic development of the community (agriculture and tourism), and the most challenging but however relevant in addressing wetland degradation were those touching the governance of resources.

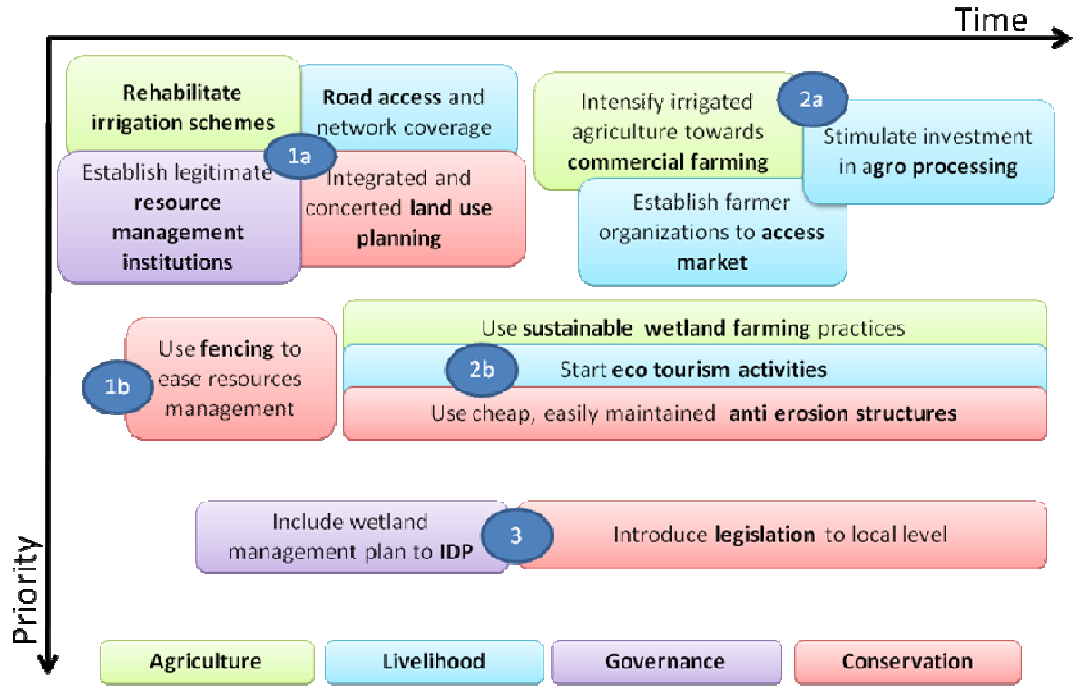


Figure 31: Activity Model for the validated management options after external SHs workshop 07-07-2010

The concept of activity model allows setting management options in order of logic and priority. The activity model in figure 31 was built after the external SH workshop. It shows which methodology was used to identify priorities and chronological logics in MO implementation. MOs are located with regards to two axes: the priority axis reproduces the scoring of MOs by the stakeholders. MOs are organized along the time axis in a logical succession of implementation without giving a precise time of implementation.

Annex VIII provides pictures of the working material for these SH workshops. Reports from these workshops are available from the research team.

1.2.3 Group discussions for identification of MOs and their alternatives

After these WSs, the validated MOs presented in table 4 and figure 31 above were to be further elaborated as to provide an analysis of their feasibility in the GaMampa context. The aim was to provide a list of MOs and alternatives, selecting the MOs identified during previous workshops according to their relevance and easiness of implementation.

This was made through private discussions (open interviews) with local and external SHs, expert consultancy, and focus groups. All development targets were found to feature relevant and implementable MOs, but only the following MOs were studied in greater details due to time and data constraints (referring to priority scoring):

- Rehabilitation of the irrigation schemes
- Integrated land use planning and wetland resources management
- Eco tourism activities

1.3 PRESENTATION OF THE MOS, ALTERNATIVES AND EVALUATION CRITERIA

1.3.1 FINAL LIST OF IDENTIFIED MOS

The list in box 3 presents identified MOs and alternatives developed from the DPSIR, Not all were then used in the MS analysis because some were then identified as not relevant or not adapted to the current context of the GaMampa Valley.

Box 3: List of MOs chosen for further analysis (trade-off analysis framework) is as follows:

Agricultural development

A.1 - Rehabilitate the irrigation schemes

Technological alternatives

1. Improved gravity system
2. Pressurized system + drip irrigation (LADC proposal) in Fertilis
3. Gravity + drip irrigation (2 systems with 2 management ; or coupled system)

Governance alternatives

1. Establishment of institution and governance transfer
2. Selective and progressive, community based governance system

Economic alternatives

1. 50% subsistence – 50% commercial farming (wet season / dry season)
2. 100% commercial farming

A.2 – Use sustainable wetland farming practice

1. Improved wetland agricultural practices (package)

Nature Conservation

C.1 Integrated and concerted land use planning

1. Zoning of the wetland and definition of possible land uses
2. Rotation between cultivation / grazing/ natural vegetation

C.2 Use fencing to ease resources management

1. Living fencing
2. Artificial fencing

C.3 Use anti erosion structures

1. Gabions
2. Re-vegetation of river banks

Alternative livelihoods for economic development

L.1 - Start tourism activities

1. Independent community management at municipal scale
2. Partnership with private company, community management at municipal scale

L.2 - Stimulate investment in agro processing

1. Public private investment in packaging/storing of cash crops
2. Public private investment in transformation of cash crops

L.3 – Road access and phone network coverage

1. Government investment in road construction to Mapagane
2. Public-private investment in phone network

Governance

G.1 Establish functioning resource management institutions using existing entities

1. Committee for wetland resources management
2. Committee for natural resources management
3. Committee for livestock control

G.2 Integrate wetland management plan to IDP

G.3 Present / implement legislation at local level

1.3.2 PRESENTATION OF THE EVALUATION CRITERIA

This table presents a list of indicators for the assessment of benefits and successes of a MO, developed during a SH workshop in the community.

	Evaluation criteria	measured value 1	measured value 2
Irrigation	% of area that is irrigated	%	
	Irrigation water per plot (flow and time)	Q (L/s)	time
	principal canal flow capacity	Q (L/s)	
	frequency of access to water	days/month	
Agricultural production:	crop yields	Kg/ha	
	Quantity of valley production (ex. Kg)	Kg	
	% of income from farming in a household	%	
	types of crops and share in cropping systems	crop orientation (food/cash)	%
Market and commercial farming	% of crops sold on local market	% ($)	
	% of crops sold to external market	% ($)	
	% of production sold	% (Kg)	
	Product price (R/Kg)	R/kg	
Communication infrastructure	km of road built	km	
	Cell phone network coverage	yes/no	
Eradication of poverty	% of household under poverty line	%	
	income per household	$	
	number of jobs created in agricultural production	number	% of unemployment
	number of jobs created in agro processing	number	% of unemployment
Agro processing	factory built	yes/no	running
	added value to natural products (ex. R/Kg)	R/kg	

Table 5: Evaluation criteria and corresponding measuring values, Local SH workshop, July 2010

This list was then further elaborated based on expert judgment, to develop a list of evaluation criteria and corresponding indicators, to which weights can be added. The following table provides a list of these evaluation criteria and corresponding indicators, which was then used in the initial expert judgment of the proposed management solutions and should be further elaborated during future SH workshops. The categories of evaluation criteria were inspired from M. Mahieu work on the ToA of the WETwin Ugandan case study. This should be further discussed and coordinated to achieve a common methodological basis for evaluation of the MSs between all WETwin case studies.

Evaluation criteria	Indicators	Weights
Ecosystem	Drinking water supply eco-service	*0*
	Water Quality regulation eco-service	*3*
	Hydrological health	*9*
	Geomorphologic health	*5*
	Vegetation health	*8*
Direct costs	Costs of implementation of management option	*17*
	Costs of maintenance and operation	*8*
Benefits and positive impacts	Number of beneficiaries	*8*
	Increase of income from economic activities	*8*
	Labour requirement	*2*
	Food security	*7*
Success factors	Need of capacity building program	*4*
	Energy requirements for M&O	*2*
	Risk of technical and economic failure	*4*
Context dependence	Economical wealth	*3*
	Policy preferences	*4*
	Need institutional capacity	*4*
	Community acceptance	*4*

Table 6: list of evaluation criteria and indicators for evaluation of the MOs and MSs

In the table, evaluation criteria are an aggregation of indicators and thus difficulties occur when using them, mainly because within each evaluation criteria, individual indicators may vary in the opposite way for evaluation of the same MO or MS. For example, a pressurized irrigation system will not be costly in terms of capital investment but will be costly for operation and maintenance compared to a gravity system.

To overcome this problem, evaluations should be done based on the incomplete list of indicators with different SH groups allowed to put different weights and give different judgment. This will then enable comparison of MO or MS according to different point of views.

2 DESCRIPTION OF MOS AND THEIR ALTERNATIVES AND SELECTION FOR MANAGEMENT SOLUTIONS' ANALYSIS

The analysis of MSs (section 3.1) uses only a selection of the identified MOs and alternatives. This selection was made with the objective of providing a limited number of functional, realistic MS to submit to stakeholder assessment and multi-criteria analysis:

- **For further analysis in the WETwin project;** this includes using the MSs in the WETsys model
- For inclusion in a proposal for the **GaMampa wetland management plan**.

The following section describes the MOs alternatives and the rational for selecting the most relevant ones for further analysis. Each MO and corresponding alternatives are presented with details on implementation process. In general, choices were made according to what the participatory investigation process revealed. For example some of the MOs were clearly prioritized by stakeholders (see Activity model in figure 31). Other MOs seemed easier to implement. Finally some MOs were identified as prerequisites for the implementation of others, and are thus presented in a separate category.

Box 4: Historical background for an context adapted rehabilitation of the Fertilis IS

The Fertilis IS land was bought from a white farmer in the late 1950s by the Lebowa homeland government. It was to be used by a small local community and 21 resettled family clans from the mountainous area. From then on, the population worked in agriculture under total supervision and financial support from the local government. Every input was provided and production was directly bought through the extension officer.

The Fertilis IS was constructed in 1959 to a high standard of workmanship. However contrarily to other small scale ISs in the world, **the community did not initiate the construction of the irrigation infrastructure, but was forced to build and maintain it**. Therefore, contrarily of many community ISs in the world:

- The amount of land and water distributed is not related to the amount of work that the family invested during the construction,
- The infrastructure was never under the responsibility of its users until the end of the apartheid and therefore there is no sense of responsibility in terms of management

When the apartheid system finished in early 1990's, the responsibility of resources governance and therefore of irrigation was given to the community. This was a failure because there was no existing communal rule to control the livestock, to maintain the irrigation infrastructures or to prevent cultivation in natural vegetation areas (also the community did not have the financial resources to manage the IS and farmers were not prepared to pay to use the scheme). This resulted in an abandonment of the infrastructure and management of the IS. Instead, th**e population took advantage of the institutional gap to favour their private benefits at the expenses of the infrastructure and other resources**. Since the end of the 1990's, farmers preferred to farm the wetland rather than invest socially in the management of the IS. Infrastructure was further damaged by the 1995 and 2000 floods.

The consequence of this is huge and results not only in today's degraded state of the irrigation infrastructure and governance system, but also to the overall degradation of natural resources integrity and their management.

2.1 SELECTED MOS WITH POTENTIAL ALTERNATIVES

2.1.1 REHABILITATION OF THE IRRIGATION SCHEMES

Challenges in IS Rehabilitation

As much as it is an economic opportunity, The IS rehabilitation is also a major challenge for the rural community of GaMampa because it touches economic; social and environmental issues.

Community empowerment for IS management

This study argues that the major challenge in IS rehabilitation is social, namely the empowerment of the community to take responsibility in the governance of the IS (see box 4).

The South African policy is to implement community based governance of agricultural infrastructures and natural resources, but the general failure of the management transfer process at the end of the apartheid proved that it is challenging and requires a proper transfer process.

In the case of GaMampa, people were denied any form of self-determination and collective action during the apartheid. At the end of the regime, people were not ready to make compromises required by collective action and instead look for their own individual advantage in the system.

Therefore, community based management of the ISs is not possible in the case of GaMampa, as in many other places in South Africa, without transfer and support from the government local representatives (municipality agriculture, environment and water affairs department), especially in the case of a new infrastructure which requires operational and maintenance costs. Transfer should include training in new agricultural practices, technical irrigation management and water distribution management, as well as in the field of commercialisation of agricultural produce.

In addition, as Ostrom pointed out in 1992, there is no buy-in if the community does not have interest in the project. Therefore the stakes are high in adapting the infrastructure to the social context in order to guarantee community's interest in it, and thus its social investment.

Recent developments and local political dynamics: the LADC project

A rehabilitation project is currently undertaken by the Limpopo Agribusiness Development Corporation LADC[22]. It looks at developing commercial agriculture by providing a new irrigation infrastructure and inputs for the first cultivating season, and commercial contracts.

At the time of this study in winter 2010, the organization had decided to build[23] a drip irrigation system, but was still developing a business plan[24] concerning crop production, social organization and financial conditions. The type of infrastructure was chosen before the exact definition of what it would be used for and how it would be managed, and without consulting the local community.

The local farming community has a difficult history in relation with the IS rehabilitation. In 2005 farmers strongly refused a provincial governmental project[25] to build a pressurized floppy irrigation system. Local group discussions revealed that the main criticisms were that:

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[22] Parastatal organization, financed by LDA and working in collaboration with the municipal LDA office in Lebowakgomo and consulting companies.

[23] Through the consultancy of *Vela VKE company* (former Malaka Munyai) and the engineering department of the LDA in Polokwane

[24] In collaboration with the Agri business section of the Lepelle Nkumpi municipal LDA offices

[25] The RESIS program intended to provide a pressurized system with floppy sprinkler irrigation.

- It was not adapted to what farmers technically required and are able to manage (gravity system with flood irrigation),
- It did not ensure technical and management support for transition,
- It was oriented towards commercial farming, leaving no room for farming maize for subsistence.

These criticisms remain valid for the ongoing LADC project. The farming community criticizes the poor participation in the choice of infrastructure and cropping systems. They fear that there will not be any support in future management of the scheme and marketing of production. This project will bring business opportunities at local and regional levels, through the tender system. Accusations of corruption already exist in the community where SHs are aware of the economic stakes for provincial private companies. Another criticism, made by farmers of the valley outside of Mapagane, is that the project only concerns the Fertilis IS and not the other three smaller schemes of Gemini, Mashushu and Vallis.
At the same time, political representatives at local and regional levels (ward and municipality) push the implementation of the project, arguing that it is a development opportunity that should not be missed.

Commercial farming vs. subsistence farming:
The rehabilitation of irrigation schemes is an economic challenge because the livelihoods of the community depend largely on agricultural production. On the other hand, the local community currently relies on subsistence maize production and thus expresses the will to sustain it in the near future. For the IS rehabilitation project to be successful, with positive impacts on wetland management, it must enable subsistence farming in addition to commercial farming.

Environmental relief and hydrological integration:
The IS rehabilitation process is seen as a major incentive for wetland farmers to leave their plots in the wetland and thus to provide a window for wetland health recovery. This is only partly true because many wetland farmers do not have access to a plot in the Fertilis IS and no land redistribution is foreseen in the rehabilitation process.
Even though the existing hydrological data is not sufficient to provide scientific quantification of it, this study argues that the hydro environmental characteristics of the wetland are partly influenced by the gravity irrigation systems. Not only they bring water to support livelihoods, but they also buffer the flooding events and reduce erosion of the river channel by abstracting and diverting some of the water to the terraces of the valley.
Computation of water balance in the Fertilis irrigation scheme proved that the infiltration and runoff towards bordering wetland areas are important relatively to the river inflows to the wetland.

In conclusion, to guarantee the success of the IS rehabilitation project, not only infrastructural measures are to be taken but the project should also focus on economic (farming systems orientation) and governance aspects (infrastructure and water distribution management).
This study proposes technological, governance, and economic interventions, each coming with different potential alternatives. The economic alternatives are presented first because they orientate the decisions in terms of infrastructure and management. Technological alternatives are then presented as ways of implementing economic orientations. Finally governance alternatives are proposed as coordination tools between economic orientations and infrastructure management.

Economic alternatives

The economic alternatives in rehabilitation of the ISs refer to the orientation of the farming systems after rehabilitation of ISs. This study identified two possible contrasted orientations for sake of simplicity:

- *100% commercial farming* ***(E1)***
- *50% subsistence – 50% commercial farming (wet season / dry season)* ***(E2)***

100% commercial farming (E1)

This alternative is built in reference to the LADC initial commercial strategy. It proposed a business plan orientating farming systems towards **full commercial cropping** (E1). It requires establishing one economic entity for the Fertilis area and other areas in Mafefe ward, with synchronized cropping systems and limited diversity of crops to ensure big scale production sold to one trading entity (LADC Business plan draft, 2010).

This vision trusts that commercial benefits can, by themselves, lead the community towards good management of the scheme, collective investment in production means and produce relevant governance institutions.

Figure 32 below shows a schematic representation of E1. The whole scheme is used for intensive cropping which is exported to long distance urban centres. The economic benefit is potentially high but governance and environment challenge are also high. The neighbouring wetland is farmed in order to maintain its subsistence maize production.

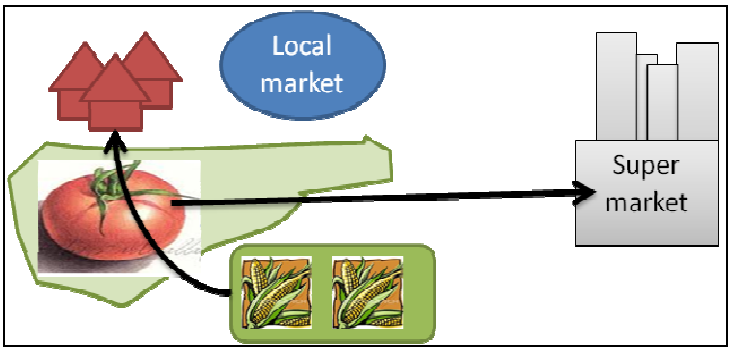


Figure 32 : Schematic representation of E1

Even though decision on infrastructure was already taken, the business plan is still not officially published and this alternative should not be seen as fully representative of the LADC project.

On the topic of economic orientation, the farming community is very reluctant to the LADC initial vision. Farmers claim that maize subsistence farming is so important for household livelihoods that it must also be possible to crop maize in the irrigation schemes after the rehabilitation project. This point, it seems, is a major prerequisite for the farming community to accept whatever form the LADC project takes. Second, farmers claim that they wish to be independent farmers, both from other community farmers and in terms of market orientation (i.e., decide what to crop). Finally, they claim that economic benefits, if they do happen, will not be sufficient to allow the emergence of a good governance system. The farming community expressed fears that most influential people will be in position to manage large amounts of money thus potentially corrupt the collective profits. Farmers have not pointed out the risks induced by a homogenous production at the scale of the Mafefe area

(both in terms of prices and crop yields), but this drawback should not be omitted when judging this alternative.

50% subsistence – 50% commercial farming (wet season / dry season) (E2)

Discussions showed that farmers do not refuse commercial farming but are aware that moving to fully commercial cropping system as one economic entity requires investment and labour capacity, involves high economic risks and needs good coordination at IS level. Farmers argued that none of these are actually available in GaMampa and that they do not trust that any state agency can help set them up.

Focus groups led to propose a **mixed subsistence and commercial cropping alternative**, with respect to seasonal changes. The logic is that wet season is more adapted to maize cropping without or with little irrigation requirements; whereas dry season irrigation enables vegetable production with market opportunities. Choices in cropping strategy would be left to each farmer independently, according to his/her investment and labour capacity. The use of existing local market opportunity[26] is an easier, less risky economic orientation.

Figure 33 below shows a schematic representation of E2. The Fertilis IS used for both subsistence and commercial production, sold on local markets, possibly exported to urban centres. The economic benefit is potentially high but governance and environment challenges are also high. The neighbouring wetland is farmed in order to maintain its subsistence maize production.

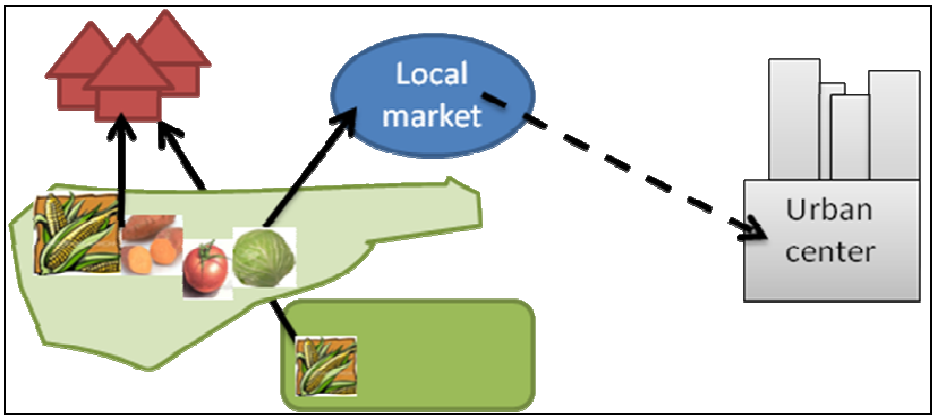


Figure 33 : Schematic representation of E2

[26] Local market here refers to the Mafefe area, and to a limited extent the Lebowakgomo urban centre.

Technological alternatives

In terms of technological alternatives, the rehabilitation of the irrigation scheme can potentially take many forms, ranging from simple repairing of the existing infrastructure by the community, to the introduction of modern pressurized systems with new abstraction and field irrigation methods. To ease the consultation process, the study of IS rehabilitation focused on the case of Fertilis IS since it is currently at stakes.

The field study and SHs consultation showed that 4 technological alternatives could possibly be implemented in the near future, depending on the community's organization and the LADC project orientation.

Restoration of the gravity system (T1)[27]

This alternative refers to the restoration of the existing infrastructure by the community with financial support from the provincial or municipal government. It is oriented towards small intensification of irrigated agriculture.

Four key restoration works were identified to address the lack of water in the IS:

- Raise the water level behind the diversion weir, and provide a controllable output into the principal canal. This can be done by restoring the gabion weir.
- Repair all canals to reduce seepage losses (cleaning, minor and major repairs, localized complete reconstruction)
- Line the existing earth canals with concrete
- Change the orientation of furrows in the plots to improve field irrigation efficiency

The table below gives an estimation of the implementation costs of such a project. Costs were updated from 2006 to 2010 prices by using the South African yearly inflation rates.

	costs are in Rands (2010 value)	**Implementation costs**	
Government	Supervision[28]	168,000	*21%*
	Restore weir	252,800	*31%*
	Reconstruction of canals	297,600	*37%*
	Lining of earth canals	384,000	*47%*
	subtotal government	*1,102,400*	
Community	Secondary Canal major repairs	41,600	*5%*
	Primary Canal major repairs	60,800	*8%*
	Secondary Canal minor repairs	56,000	*7%*
	canal cleaning/verge levelling	24,000	*3%*
	Gates	9,600	*1%*
	subtotal community	*192,000*	
	Subtotal for project	*1,294,400*	
	Contingency (10%)	80,900	
	Prime cost items (10%)	80,900	
	Total estimated implementation costs (Rands)	**1,456,200**	
		15,828 /Ha	

Table 7: Implementation costs for restoration of the infrastructure in 2010, adaptation and update of Papenfus 2004

[27] This alternative is an adaptation of the proposal made by N. Papenfous in 2004

[28] The supervision costs planned for the turnkey engineer reached R35,000/month in 2004, which, in the opinion of the writer, is over estimated.

Table 7 also gives a proposal of costs sharing between the government and the community itself. The costs for the community could also be presented in days of work since they do not require much input (only concrete). The cost for the government reach about R1 million and should also be largely redistributed to the community by hiring local labour.
The capital costs and irrigation costs (maintenance, operational and renewal) are estimated in table 8 below:

costs are in Rands	**Capital costs[1]**	**Maintenance costs /year[2]**		**Operational costs/year[3]**	**Renewable costs/year**
Restored weir	252 800	9 543	*36%*	15 800	2 528
head canal	297 600	4 271	*16%*		2 976
Main canal	-	7 857	*29%*		
Secondary canal	384 000	5 099	*19%*		3 840
sub total	*934 400*	*26 769*		*15 800*	*9 344*
Contingency (10%)	93 440				
Prime cost items (10%)	93 440				
Total estimated costs	1 121 280	26 769		15 800	9 344
	12188 /Ha	291 /Ha		172 /Ha	102 /Ha
		total irrigation costs		**51913 Rands/year**	
				564 Rands/Ha/year	

1: Capital costs indicated are the investment made by the government for restoration of the weir and reconstruction of canals and cementing of earth canals. They are over estimated since they include the labor force.

2: Maintenace costs are taken for the estimation made in T2 since the infrastructure is similar.

3: operational costs are estimated as the work of one full time salary for canal management (farming minimum wage of SA in 2011, mywage.co.za)

Table 8: Estimated Capital costs[29] and irrigation costs for T1 in 2010

Improvement of the gravity system (T2) [30]

The improvement of the gravity system can be done through full financial support from the state for construction costs. It is oriented towards the intensification of agriculture and sustaining of subsistence farming. This alternative best matches the community's demand because it envisages the implementation of a renewed infrastructure with no or little work from the community.
The following works should aim at improving the conveyance and irrigation efficiencies:

- Replacement of the abstraction structure from gabion to cemented weir.
- Restoration/replacement of the conveyance infrastructure (head canal and principal canal)
- Restoration/replacement of the distribution system (secondary canals)
- Field levelling for changes in irrigation methods
- Roads, New fence, Storm water structures.

Implementation costs are not available for this alternative because no data was found on labour requirements and costs. However, table 9 presents the capital and irrigation costs of this alternative:

[29] Capital costs in table 8 are lower than implementation costs in table 7 because they do not include labour.

[30] This technical alternative is adapted from a proposal under the RESIS program (Munyai Malaka engineers 2005)

costs are in Rands	Capital costs[1]		Maintenance costs /year		Operational costs/year[2]	Renewable costs/year[3]
New concrete weir	663 426	*15%*	9 543	*22%*	15 800	6 634
head canal	348 959	*8%*	4 271	*10%*		3 490
Main canal	711 173	*17%*	7 857	*18%*		7 112
Secondary canal	436 136	*10%*	5 099	*12%*		4 361
Infield (levelling)	1 110 000	*26%*	5 400	*12%*		
Storm Water	528 000	*12%*	450	*1%*		
tracks	210 150	*5%*	4 203	*10%*		
Fence	288 750	*7%*	7 220	*16%*		2 888
sub total	*4 296 593*		*44 042*		*15 800*	*24 484*
Contingency (10%)	429 659					
Prime cost items (10%)	429 659					
Total estimated costs	5 155 911		44 042		15 800	24 484
	56043 /Ha		479 /Ha		172 /Ha	266 /Ha
	total irrigation costs		**84326**	**Rands/year**		
			917	**Rands/Ha/year**		

1: Capital and maintenance costs were estimated by the Malakay engineers for RESIS in 2005 and actualized using a 10% year inflation rate/year. They do not include labor costs.

2: operational costs are estimated as the work of one full time salary for canal management (farming minimum wage of SA in 2011, mywage.co.za)

3: Renewable costs are estimated per year and life expectancy was estimated to 100 years if maintenance occurs

Table 9: Estimated Capital costs and irrigation costs for T2 in 2010

The costs of T2 is estimated at about R5 million for full capital costs. Irrigation costs (maintenance, operational and renewable costs) reach about R85 000, that is around R 1 000/Ha/year. It is important to note that:

- The levelling of the fields participates up to 26% to the capital costs. This work is, in the opinion of the author, not a priority in comparison to conveyance.
- The fence maintenance goes up to 16% of the irrigation costs, which could be reduced by institutional measures on livestock straying (see other MOs).

Introduction of a pressurized drip irrigation system (T3)

This is the LADC proposal under initiative and full financing of LDA. It is exclusively oriented towards commercial agriculture, with the argument that drip irrigation is more adapted to the South African water scarcity context than gravity. It requires the destruction of the actual gravity system and a reorganization of the plots.

This alternative requires the introduction of new irrigation infrastructures:

- New weir
- Pumping station
- Pumps and filter
- Main pipeline
- Distribution pipes
- 3 phases electrical power lines to GaMampa

The costs for this alternative are not available because it is still being designed. The reference document of LADC shall be used to evaluate the economic impact of the project.

Coupled gravity and drip irrigation system (T1+T3),

This alternative was developed during a group discussion with local irrigation SHs, including the municipal LDA extension officer. It refers to the introduction of state supported drip irrigation scheme (T1) pumping water from the river, without destruction of the gravity system.

In addition, the community should be allowed to restore the gravity system (T3) at its own expenses.

This alternative is oriented towards sustaining wet season subsistence farming making use of existing gravity infrastructure and introduction of dry season commercial farming thanks to drip irrigation.

Technical adjustment would be required to couple the two systems and many specific alternatives can be chosen when coupling the two infrastructures.

Governance alternatives

Theory on irrigation systems governance applied to the local context

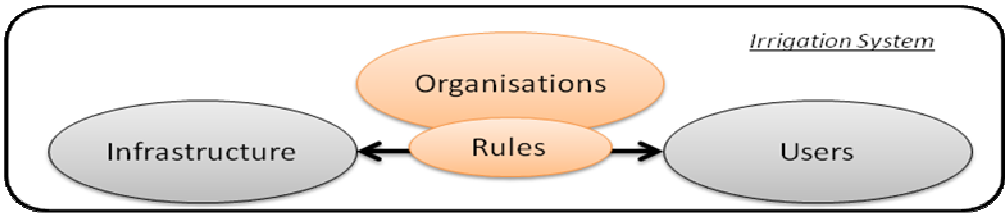


Figure 34 : Schematic representation of a sustainable irrigation system, according to Ostrom 1992

Figure 34 above shows that governance, through institutions (social organizations and rules), allows coordinating infrastructure and users for sustainability in an irrigation system. Fertilis IS is in a state of depletion with damaged infrastructure, abandonment of rules and organizations, and very limited activity of irrigation farmers. There is a large institutional gap resulting in inexistent governance of the resources (man-made and natural). Therefore, the main challenge of the rehabilitation process, more than introducing an infrastructure, is to address this governance gap.

Today, facing infrastructure and institutional degradation, the farming community claims that it is the responsibility of the state to set up rules and to enforce them. Yet the state is not in political and economical power of doing this anymore. On the contrary, the contemporary South African paradigm is that of community empowerment and responsibility in resources management. This concept is quite unclear about the institutional design of the governance system and leaves two alternatives: either the community itself builds up the institutions, possibly with financial and capacity support from the state, or the community is given a set of institutions and uses them.

In 1992, Eleanor Ostrom specified that one major condition for the success of an irrigation project is precisely the conception phase of the institutional setting (Ostrom 1992), because it conditions the success of the governance system. Her findings showed that in order to produce a working, sustainable IS, the very users of the infrastructures should be the ones responsible for *crafting*[31] the institutional framework of the schemes.

According to Ostrom, community-based governance of resources is possible under four conditions:

1. Farmers have long term perspectives with the IS
2. Water is scarce enough to motivate users to invest socially in its management
3. Farmers are convinced that improving the organization will enhance economic returns on their farming system

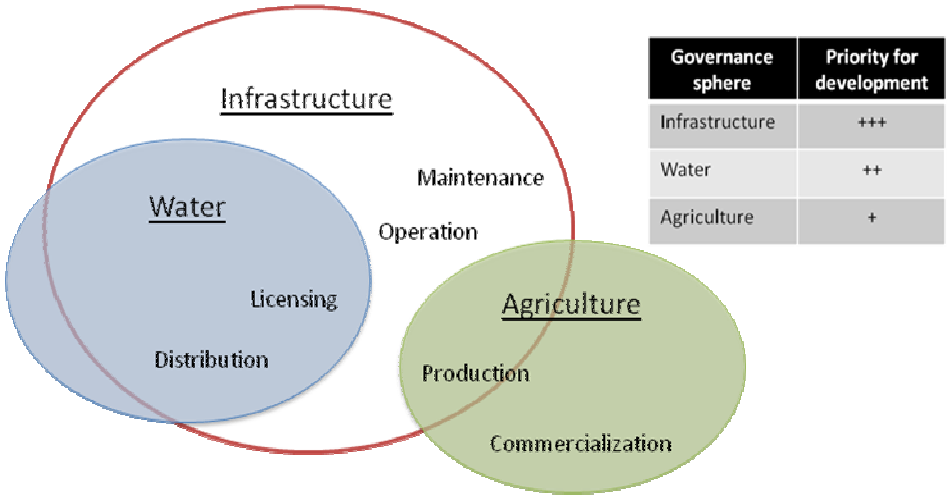
[31] For E. Ostrom, the word *crafting* refers to the use of traditional and progressive processes to build up an adapted institutional framework.

4. The irrigated system is central to the local farming systems

Of these four conditions in GaMampa, none are currently important enough to have triggered self impulse community management, whereas state support through welfare system and rehabilitation projects leaves the community lying in wait of state regulated systems. Nevertheless, wetland farming now reaches its maximum extent and leaves alternative water opportunities limited and risky (condition 2), consequently challenging the central subsistence maize cropping systems (condition 4). In addition, farmers look for cash opportunities and realize that investment in the IS is required to trigger economic returns (condition 3). The current challenge is thus for the community to find incentives to invest in social organization rather than wait for external investment through government projects.

Spheres of governance

This study identified the local governance spheres to be addressed in the IS rehabilitation, presented in the figure below.



Governance sphere	Priority for development
Infrastructure	+++
Water	++
Agriculture	+

Figure 35 : Participatory identification of governance spheres in Fertilis irrigation scheme and pebble scoring on priorities by the farming community.

Figure 35 shows that agriculture was identified as a governance sphere as well as infrastructure and water. This can be explained by the local history of a holistic management of the ISs as one production entity during the apartheid. At that time, agriculture and water management were under supervision of the same governmental entity (Ferrand 2004). This concept of holistic management is also actualized by the LADC project to normalize cropping practices, infrastructures and irrigation systems in the GaMampa area. However, and it is a key challenge for future governance of the IS, the GaMampa community does not weigh the 3 spheres equally, but puts agricultural coordination lower in terms of importance (see table in figure 35). This reflects the farmers' will to stay independent in terms of farming practices even after rehabilitation of the IS, and the need for a selective and adaptive process in setting up governance, that will first aim at addressing the operational, maintenance and water distribution issues.

This study proposes two governance alternatives to tackle the institutional gap in the IS rehabilitation process. The first solution is for the provincial government, through the LADC project, to establish local institutions for the governance of water, land and agricultural production, and then leave the community to implement them. Another alternative is on the contrary for the government (possibly through LADC) to give water users the crafting responsibility according to their needs and objectives

but providing long term financial, technical and legal support. These two alternatives are applied to the case of Fertilis IS and described below.

Transfer of a governance package to the community (G1):

The concept of irrigation management transfer (IMT) described below is the orientation that the LADC rehabilitation project gives to the governance of the new infrastructure they will provide. This description gives an extreme scenario of a top-bottom designing process that may not be the actual process the LADC will implement.

This alternative proposes the establishment of a holistic organization to deal with irrigation water distribution, irrigation scheme maintenance, production and commercialization of the agricultural products. This organization, would potentially be a farmer cooperative called *Fertilis Primary Cooperative* (LADC business plan, October 2010). It will mainly focus on market management but would have the secondary role of addressing water management issues.

The role of the Provincial government would then be to set up the organization and take care of the legal processes at creation. It would accompany the organization during the first few production seasons by establishing contact with the relevant external organizations (DWA, ESKOM, agro business companies) and supporting the negotiation phases to achieve long term farming inputs and production commercialization contracts. After the first experiences, the community should be able to keep the organization running with the help of the local LDA representatives, thanks to the benefits made through the marketing of the agricultural production.

This governance alternative aims at future community management through the transfer of a governance package (in addition to the technical package). The main advantage is that it enables a rapid use of the new infrastructure to its full potential. However, the experience of the post apartheid era was quite similar in the sense that the government passed on the management of the scheme to the farming community, and the transfer was not successful. The risk is that the farmers will first surf on the project opportunity and then give up the governance of the scheme to independently run their farming systems.

Selective and progressive, community based governance system (G2):

This alternative refers to the selective and continuous set up of the institutional framework for irrigation scheme management, by the farming community itself.

The proposal of “selective” governance refers to the set up of institutions (organization and rules) specific to one field of application that is challenging enough for the community to independently craft the required institutions. In the case of Fertilis IS, it means the set up of a governance system that is specific to irrigation water related issues: management of the infrastructure and water distribution. As there is no commercial production yet, there is also no need for commercialization and the governance setting should not focus on organizing it. This contrasts with the above proposal of a holistic institutional setting to deal with both irrigation and agricultural production and commercialization.

However, if the marketing of the production is challenging, the concept of progressive governance leaves room for evolution of the institutions. The people who will be challenged by marketing issues will then organize to form an adapted institutional setting to coordinate the issue.

On this topic currently, the farming community agrees that the irrigation canals must be maintained to guarantee the sustainability of farming systems and water provision to livestock and households. In fact, the announcement of a drip irrigation system triggered an impulse in the former irrigation

committee to restore the infrastructure. This impulse was witnessed at the end of the field work and discussions were organized to evaluate possibilities of actions, using the adequate protocol to guarantee its success. Proposal was made to repair the main breaks in the canals and start practising an irrigation fee managed by a community organisation he irrigation canals. This was first to be validated by the tribal authority and the community assembly.

Nevertheless, the institutional crafting can be supported by external organizations with experience on the topic, by providing legal and technical insights to help the community in the decision making process. The government, and especially the LADC for the Fertilis irrigation scheme, can provide this kind of support.

Selection of possible IS rehabilitation alternatives

For this MO, there are 12 potential combinations of the 7 alternatives (3x2x2). For future research purposes, only 3 alternatives were selected as possibly implemented:

- **A.1 - LADC plan (T3+G1+E1):**

At the end of the field research period in September 2010, the only definite decision LADC had made was the choice of a pressurized abstraction system for drip irrigation. The community voice and results from this research may change the LADC vision of the rehabilitation. Therefore this alternative should not be taken as representative of the final LADC project but as an adaptation of the initial LADC project, for the purpose of research modelling.

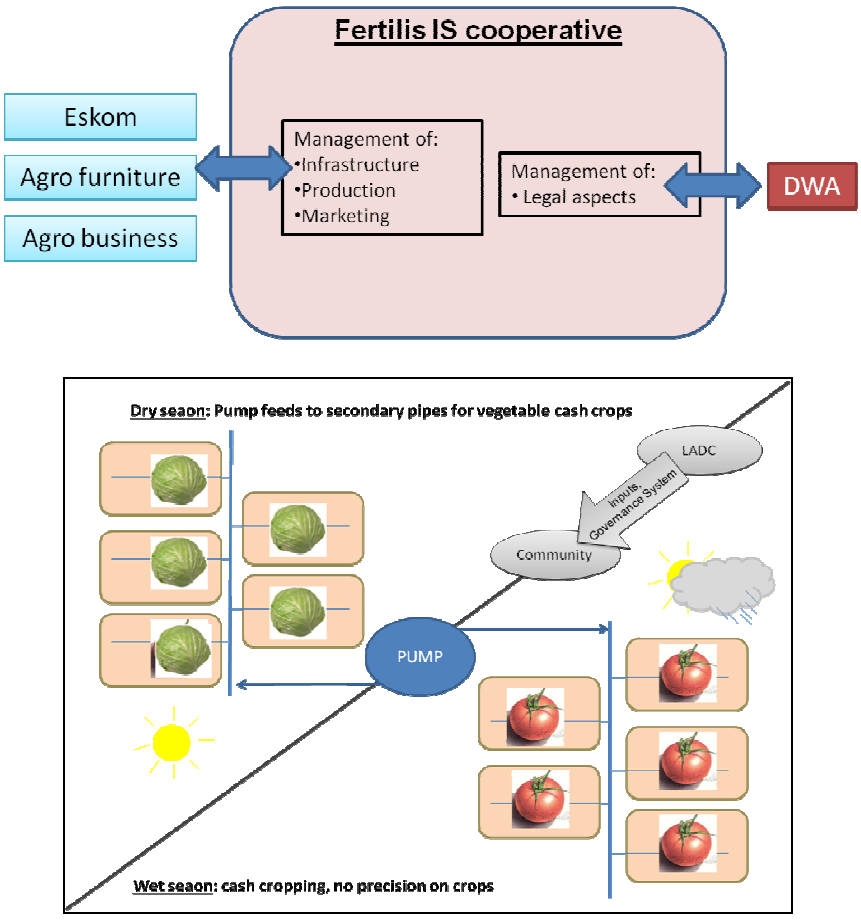


Figure 36: Technical and governance packages to be transferred to the community in the case of A.1 LADC project

As shown in figure 36, this alternative aims at the set up of 100% commercial farming systems, through the introduction of a drip irrigation system with financial support from the state. It implies the destruction and abandonment of the existing gravity systems. The governance of irrigation infrastructure and agricultural production are in the hands of one legal entity as representative of all farmers of the Fertilis IS.

This alternative is risky because:

- It involves a lot of innovation transfer both technical, managerial and market-related, without leaving the possibility for subsistence farming systems, with little irrigation
- It involves uniformity in irrigation techniques, cropping systems and market accessibility.

➢ **A.2 - Community oriented (T1+G2+E2):**

This alternative aims at the continuity of wet season subsistence centred farming systems, through full renovation of the existing gravity irrigation infrastructure with financial support from the state. Such a system leaves opportunities for dry season cultivation of vegetables under the condition of a good management of the irrigation system. The governance is based on the community initiative, without support or incentives from the state. This governance system is thus slightly different from the one presented in G2 in this way. Management of the infrastructure is the responsibility of a community organization whereas agricultural production and marketing stays in the hands of independent production systems.

This alternative matches best the community's demand as it implies a simple renovation of the existing irrigation system in order to return to what it was in the 1990s. It is challenging because experience proved that the community governance of such a system was not sustainable and led to infrastructure breakdown.

It can be considered risky because it involves the most important costs and may lead to an infrastructure breakdown because of poor social organization.

➢ **A.3 - Mixed alternative (T3+G2+E2):**

This alternative is presented as the result of the consultation process, and takes into account the current context of drip irrigation introduction. It is in fact the description of an adaptation process in order to guarantee the success of the rehabilitation project by giving economic development opportunities and enhancing governance capacity building.

As figure 37 shows, this alternative aims at the intensification of farming system for commercial orientation, sustaining wet season maize production. Both irrigation infrastructures (drip and gravity) are coupled to provide flexibility to the system and allow dry season vegetable production. This will allow wet season maize farming without involving technical changes in the system, and dry season water efficient farming for commercial purposes.

Farmers who are interested in drip irrigation can invest in pipes to reach the reservoir and use low cost gravity drip irrigation systems using pressure from the altitude, or small pumps (hand pump, treadle pump, solar pump). It will guarantee that users have stakes in maintaining the drip infrastructure and other management responsibility. Governance of the gravity infrastructure is triggered by full responsibility of the community in canal rehabilitation. The governance of the agricultural production is left to the independent farming systems, and creation of a cooperative for marketing purposes may happen if needed.

The reservoirs in figure 37 are not prerequisites but could however provide flexibility in time. They would allow organizing the drip system in the same institutional setting used for the canals: within groups of farmers using the same gate.

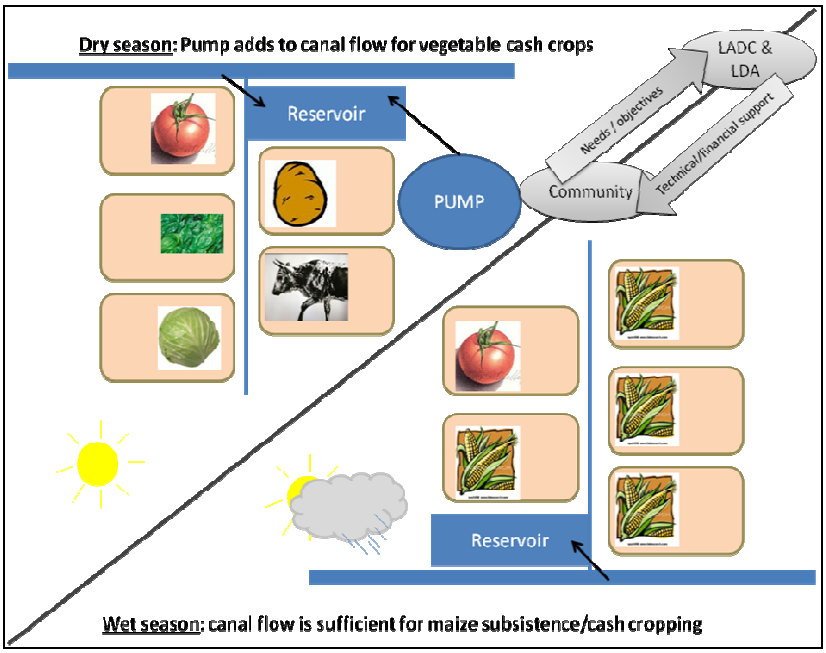


Figure 37: Technical and farming orientations for the infrastructure in the A.1 integrated alternative

Figure 38 presents a possible governance framework in the case of the A.3 mixed alternative. The idea is to separate the irrigation water management from the agricultural production and marketing issues. This way, only the people to whom it is economically interesting will socially and financially invest in the dry season vegetable production. It is an adaptive setting as it can evolve depending on the needs. This, as the LADC fears, might limit the number of people involved in cash crops during the first years but may also guarantee that a sustainable governance system will be set up.

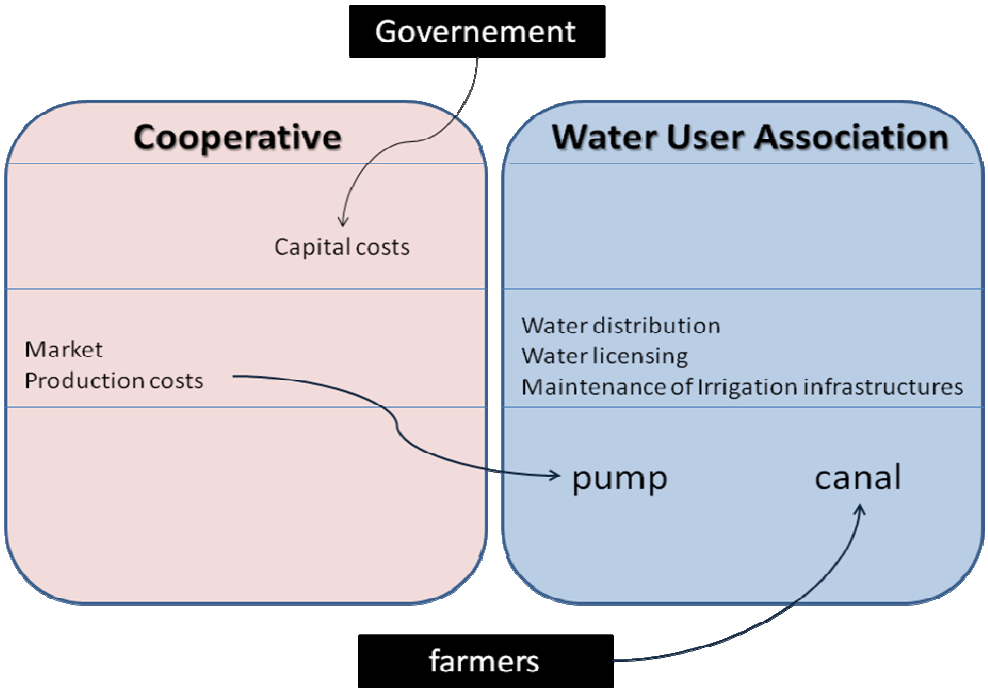


Figure 38: Institutional organisation for the A.3 mixed alternative

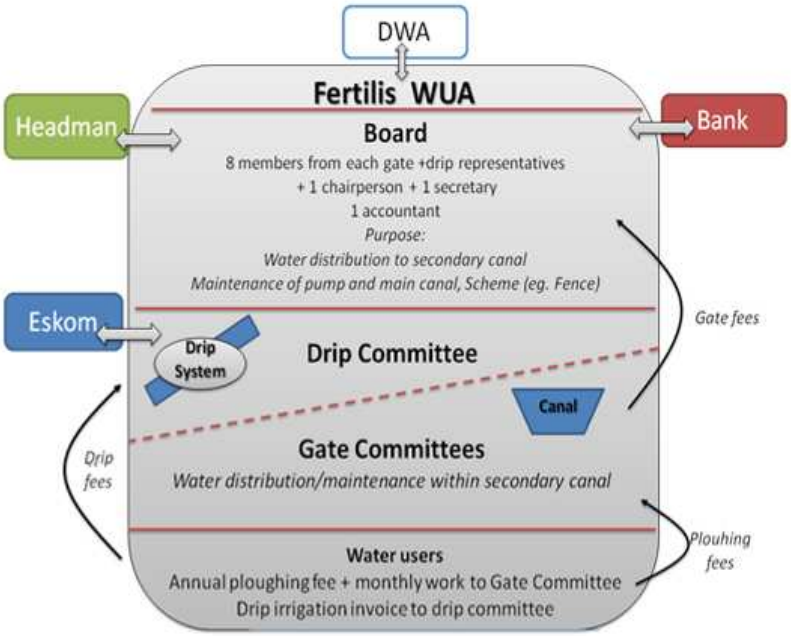


Figure 39: Proposal for the water management organization in Fertilis

Finally, figure 39 gives an overview of the envisaged organization for water management in the case of such an alternative. This diagram was built with the former irrigation committee during a focus group discussion on future management of the irrigation infrastructure.

Ploughing fees are paid yearly by farmers as a tax to plough and use water from the gravity system. They are given to a gate committee which should then pass them on to the Board under the form of gate fees. The gate committee is responsible for water distribution at secondary level and in relation with the Board.

On the other hand, drip fees are paid to the drip committee only if farmers want to use the pressurized infrastructure. The drip committee is in charge of managing the pressurized infrastructure and thus in relation with ESKOM as an energy provider.

Legal and traditional law aspects, as well as financial reports and eventual loans are dealt with by the Board of the water user association.

Conclusion: giving or inducing?

The proposed alternatives for rehabilitation were presented as static alternatives to choose from. In reality, the rehabilitation process is dynamic. It has been ongoing for 5 years now with refusal of technical alternatives during the RESIS period. The current LADC project is an economic and environmental opportunity for the GaMampa community.

The integrated alternative was developed with the farmers as an adaptation to the context. The farmers' aim is in particular to **save the existing canals from destruction** during construction of the drip irrigation system as to guarantee the subsistence farming opportunities. They advanced that they are ready to take this operation under their financial and managerial responsibility for the most urgent works, as a proof of their conviction in front of LADC.

They shall, on the other hand, accept the new **infrastructure as an opportunity for dry season cropping**. The challenge of this alternative lies in the crafting of the institutional framework. The risk is for the government to provide a free infrastructure, because it shall not stimulate economic and social investment for the management of the infrastructure.

This study advances that building the pumping infrastructure and reservoirs to provide each secondary canal shall be sufficient. Only farmers with personal interests will then invest in the distribution system. In the same logic, if the government passes on a marketing and governance package for production and sales, it will not be sustainable because the beneficiaries will not invest time for managing it in the future. On the contrary if they feel the need to craft it and receive adapted cognitive support from the government, there might be sufficient buy in from the locals for the system to last. This study therefore advances that production and market organization under the

form of a cooperative or private enterprise should be a farming community impulse if the need is required. The local and municipal markets are potential absorbers of the production before it is large enough to aim at urban or export markets.

The history of the GaMampa community, particularly the ISs, is that of an oppressed farming community with little or no choices to make and initiative to take. This resulted in very poor farming strategies and capacity for the governance of the irrigation system. The IS rehabilitation process, to be successful, should focus on building this capacity, not by providing technical, governance and marketing packages but by providing incentives for the community to build them itself.

However, the rehabilitation of the ISs is not the only challenge in the GaMampa community, and other MOs are proposed below.

2.1.2 USE SUSTAINABLE WETLAND FARMING PRACTICES

The improvement of wetland agricultural practices was identified as an important step towards sustainable use of the wetland because if it is successful it can directly impact about 30% of the wetland farmers, reducing the extension of farming in the wetland between25 to 50%.

The main concern in the current farming practices is the drainage of the soil for maize cultivation as it affects the geomorphologic and hydrological status of the wetland. Concerns about farming sustainability are mainly the increase of weed invasion in the oldest wetland plots, inducing more work, but no concerns were expressed on yield decreases. Nevertheless, invasion of the wetland has occurred for less than ten years and concerns about soil fertility can possibly occur in the near future.

This MO proposes the adoption of a "package" to address weed control difficulties, potential fertility decrease, and guarantee biodiversity and soil conservation by reducing drainage:

- The use of **wetland adapted crops** (rice, taro plants, and banana trees) to tackle the issue of drainage. These plants should be chosen as most wanted by the farmers for consumption purposes as to replace maize production. They should not be oriented towards commercial cropping to avoid the development of commercial farming opportunities in the wetland.
- The **development of long term fallow periods**, to tackle the issue of biodiversity, weed and pest pressure, as well as fertility. These fallow periods can be used for grazing and wild plant collection and thus should not be considered as unproductive. Local SHs believe that 3 consecutive years of no production should allow constitution of the original vegetation.
- The **use of animal manure and vegetal inputs** (Chiron 2005) to guarantee a constant MO content in the soil. In general, organic practices will help maintain biodiversity in the wetland.
- The management of erosion and soil water content through the use of **crop residues for groundcover mulching**.

These practices are off course challenging because they induce drastic innovations in cropping practices and household consumption habits. The SANBI Working for Wetland program[32] is relevant in providing cognitive information and coordination for extension sessions and training of the local rural extension officers and wetland farmers.

[32] under coordination of Mrs Colleen Silima (provincial level) and Mr John Dini (National level) at the time of the study

The existing wetland committee, in order to implement this kind of initiative in the GaMampa wetland, should communicate with the provincial representative of the program[33]. In addition, the services of the LDA can be used to identify sustainable practices and adapt them to the GaMampa situation. In terms of communication, the need for prerequisite MOs presented below is obvious.
For future research purpose, this MO is considered as only one alternative and can either be implemented or not as follows:

- ***A.2 - Improved wetland agricultural practices***

2.1.3 INTEGRATED LAND USE PLANNING

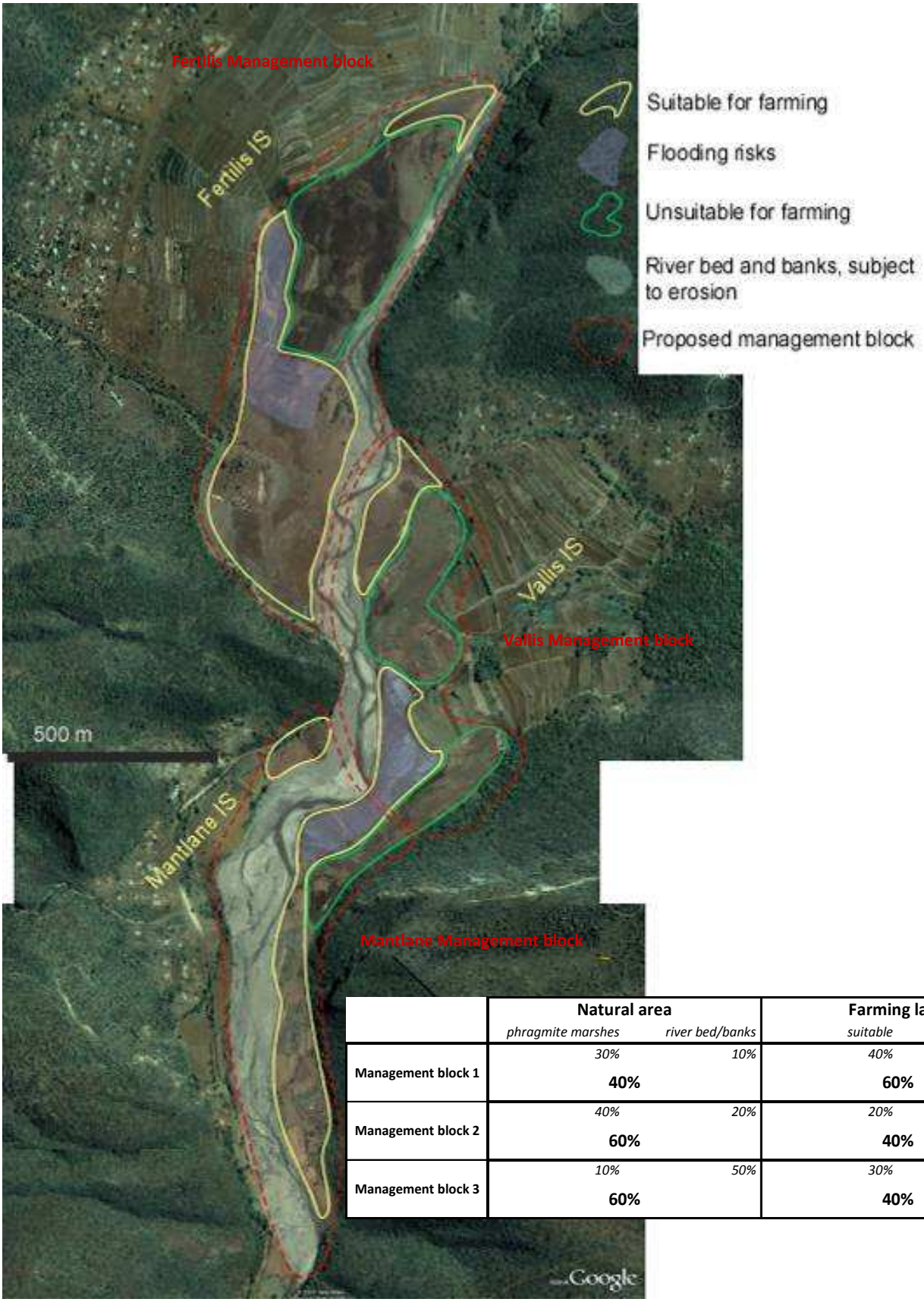
This MO refers to the set up of a land use planning process for wetland resources, involving all SHs at local level and representatives of governmental organizations. It aims at establishing a mid to long term vision on wetland resources use to guarantee their sustainability.
The process must include a governance platform for SHs meeting, and should involve the traditional authorities as owners of the land, but two alternatives, which can be combined, were identified in terms of technical aspects. Only one governance alternative was identified.
The two technological alternatives are the zoning and planning of land and the set up of a rotational use of the farmed land.

- *Zoning of the wetland and definition of possible land uses*
- *Rotation between cultivation / grazing/ natural vegetation*

Zoning of the wetland and definition of possible land uses

Zoning refers to the delineation of areas in the wetland and identification of potential uses for each area. This zoning should allow the midterm planning of human activities, instituted by recognized bylaws. Its main purpose is to ease the conservation of wetland resources and avoid potential conflicts between users.
This zoning should be the consequence of community negotiations and result in operational rules validated and enforced by the TA (see part 2.2.2 on governance of resources). As to provide material for the future implementation of such a MO, mapping workshops with wetland farmers were held to provide information on potential zoning for the wetland and set objectives for land uses.
First, discussions showed that the wetland is used (farming and collection) by different villages according to localization. The participants were also able to provide information on which parts of the wetland are more suitable for maize farming, and which are not farmable and thus should always be left with natural vegetation.
Starting from the current situation (35% natural / 65% farmed), this study proposes the zoning shown in figure 40. It delimitates 3 management blocks according to which village uses most of the wetland in the area (Mapagane, GaMoila and Mantlane management blocks). This is also addressing the discontinuity in current wetland situation and ease governance processes.
Discussions allowed setting objectives for the different zones which were identified. In case pressure on the wetland for farming releases, areas which are at present subject to farming should first return to natural vegetation. River banks are often suitable for farming but risky because of erosion. An objective is thus to free them from farming activity and manage vegetation as to make them more resistant to erosion. Finally, some areas being suitable for farming should stay farmed.

[33] A database of contact persons was established and is available on request from the research team.



	Natural area		Farming land	
	phragmite marshes	*river bed/banks*	*suitable*	*risky*
Management block 1	*30%* **40%**	*10%*	*40%* **60%**	*20%*
Management block 2	*40%* **60%**	*20%*	*20%* **40%**	*20%*
Management block 3	*10%* **60%**	*50%*	*30%* **40%**	*10%*

Figure 40: Proposition of zoning for land use planning in the GaMampa wetland

This zoning shows 3 classes of land, with different potential land use:

1. **The river bed and river banks area** (from 5 to 20 m off the river bed), which are subject to erosion and should not be farmed. The objective for this land class is to preserve the river bed natural areas and leave enough space to the river in case of flooding. Potential land use is
   - Natural vegetation with or without grazing (marshes, grass lands)
   - Tree/grasses plantation (against erosion) with or without grazing.
2. **Areas suitable for maize farming (delimited by yellow lines)**, with extensive and pocket areas subject to flooding in wet season**.** These areas should be cultivated under the rotation system proposed below. Places with higher flooding risks can be left out of the rotation system for natural vegetation regeneration or used for introduction of wetland adapted farming practices (e.g. banana trees).
3. **Areas unsuitable for maize farming (delimited by green lines) correspond to** the currently remaining *phragmite* marshes and should be left as such in order to guarantee a maximum 65% farming area.

In conclusion, this zoning guarantees that a maximum of 65% of the wetland will be farmed and aims at about 50 % farming area after conversion of the river banks and places subject to flooding.

Rotation between cultivation / grazing/ natural vegetation

This proposes the set up of a rotational use of the farmed wetland between cropping, grazing and natural vegetation. It requires that the areas declared farmable should be divided within management blocks, so that alternative uses can occur.

The rotation system proposed here is based on group discussions with local farmers about existing farming practices, wetland vegetation regeneration patterns, grazing opportunities and wetland uses:

- Farming practices: Traditionally in the wetland, the community establishes a cultivation plot using slash and burn practices after reeds harvest. This ensures good yields thanks to the high level of organic matter in the soil.
- Wetland regeneration pattern: the community evaluates that wetland vegetation would need about 3 years without ploughing in order to regenerate, with key growth period during wet season.
- Grazing opportunities: The community explains that grazing of the fields after harvest in dry season largely benefits to the cattle, but not to the soils in terms of organic matter. Livestock grazing of the field could nevertheless benefit to the soils if livestock was brought in at night only, because there would be more droppings. Finally, grazing of wetland natural areas is difficult if vegetation has regenerated already, especially during wet season, but is possible after the first wet season of natural use (one year of fallow).
- Wetland uses: the community stressed the fact that edible plant harvesting is possible and even easier when cropping occurs, and that collection opportunities exist in other natural vegetation types than the wetland, but the demand is quite limited.

This information was then used to propose and the following rotational system, which was validated through a SH workshop:

year	1		2		3		4		5	
Landuse	Agriculture				Livestock		Regeneration			
season	*Wet*	*Dry*	*Wet*	*Dry*	*Wet*	*Dry*	*Wet*	*Dry*	*Wet*	*Dry*
primary use	Cropping	Fodder cropping	Cropping	Grazing	Natural Fodder	Grazing	Natural	Natural	Natural	Reed harvest
secondary use		Grazing			Natural	Natural	Diverse Collection	Diverse Collection		
tertiary use	Morogo Collection		Morogo Collection		Diverse Collection [1]	Diverse Collection				

[1]: refers to an extensive use of the land for plant collection for foos, medical or craft production, or for hunting

Figure 41: Proposal of a rotational system for wetland sustainable use built through consultation and validated by the local community in 2010

In figure 41 above, the rotation system proposes a 5 years cycle with successive use of the wetland for Agriculture (2 years), Livestock breeding (1 year) and natural regeneration (2 years). In addition to the primary uses, secondary and tertiary uses are possible as to maximize the use of the wetland for livelihoods. Cropping refers to maize or other plant species cultivation, grazing refers to livestock use of cropping residues or natural vegetation and natural fodder refers to the harvesting of green fodders later dried for dry season alimentation.

The following graph in figure 42 shows the consequence of such a system in the land use of the dedicated area. This corresponds to a total amount of 40% natural vegetation in a farmed wetland and, in from an agronomic point of view, should guarantee the sustainability of yields in wetland farming as well as reduce pest and weed pressures.

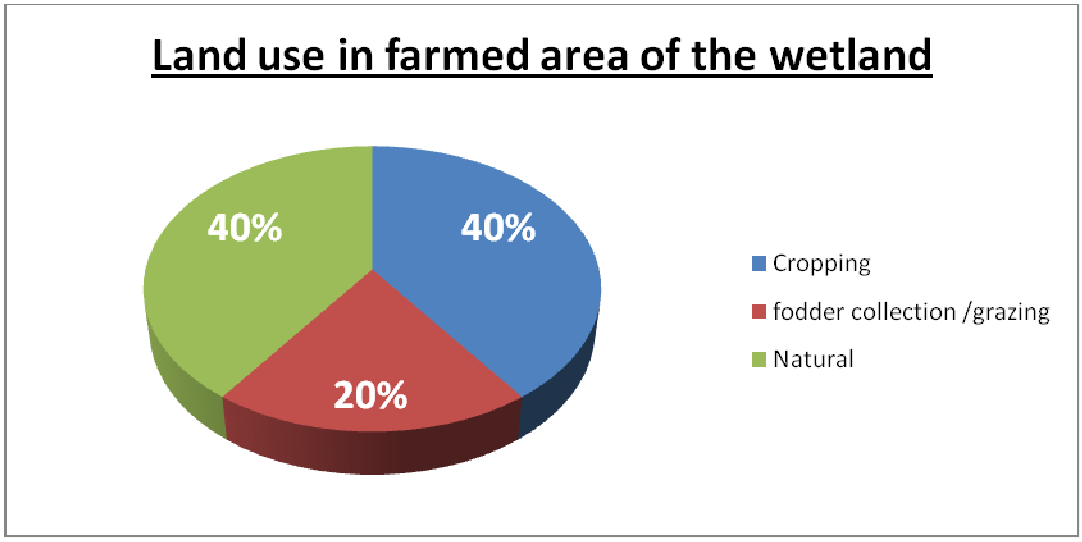


Figure 42: Land use repartition for the proposed 5 years rotational system

About these two alternatives of C.1, few comments should be taken into account:

- The rotational system for wetland farmed areas requires a prior zoning of the wetland to determine which area it should apply to.
- Both alternatives are difficult to set up because of the cognitive challenge behind them and because both require reduction of farmed area. Their implementation requires mediation and technical assistance. As it was done during the field study to identify possible zoning and rotation system, the technical support should make use of existing protocols in the management of resources. This will guarantee the success of C.1
- The main challenge in implementing the integrated zoning of the wetland and land use planning, whether it features the set up of the rotation system or not, is to craft the required institutions for it. There must be very clear and transparent rules which cannot be implemented without a legitimate governance organization. This will be further developed in the part of the report dealing with governance pre requisite MOs.

Conclusion and selection of alternatives for integrated land use planning

In conclusion, C.1 has numerous alternatives depending on the defined cultivated area, and the use or not of rotation practices in the management of resources.

As to simplify the later MSs analysis, 3 levels of cultivated land were chosen corresponding to 35% bad vegetation health, 50% for fair vegetation health, 75% for good vegetation health according to (Kotze 2005). Rotation is possible only if large area of farmed land is available, which in the end gives 5 selected alternatives:

- ***C.1a - 35% wetland natural area, with rotation practices***
- ***C.1b - 35% wetland natural area , without rotation practices***
- ***C.1c - 50% wetland natural area, with rotation practices***
- ***C.1d - 50% wetland natural area , without rotation practices***
- ***C.1e - 75% wetland natural area, without rotation practices***

Table 10 and 11 below give insight on the consequences of each alternative above on land use and wetland ecological health:

total Area of the original wetland (Sarron 2005)	100	Ha

Table 10: Consequences of C.1 alternatives on the land use in GaMampa wetland

C1 alternative	Natural area	Drained/Farmed	Under rotation		
			Regenerating	farmed land	Grazing land
35% wetland natural area, with rotation practices	35	-	26	26	13
35% wetland natural area , without rotation practices	35	65	-	-	-
50% wetland natural area, with rotation practices	50	-	20	20	10
50% wetland natural area , without rotation practices	50	50	-	-	-
75% wetland natural area, without rotation practices	75	25			

	potential cropping area/year (Ha)	natural vegetation area/year (Ha)	Other (Ha)	Wetland Health (Kotze,2005)
35% wetland natural area, with rotation practices	26	61	13	Fair
35% wetland natural area , without rotation practices	65	35	0	Poor
50% wetland natural area, with rotation practices	20	70	10	Good
50% wetland natural area , without rotation practices	50	50	0	Fair
75% wetland natural area, without rotation practices	25	75	0	Good

Table 11: Consequences of C.1 alternatives on the GaMampa wetland ecological status, considering that the original wetland is 100 Ha

Table 11 uses results presented in table 10 and the WEThealth tool developed by AWARD to evaluate management impacts on the vegetation of the wetland. It shows that alternatives using 50% of the wetland area should at least allow a fair ecological health. If later a rotation system is introduced then the ecological health could even be "good". This proves that compromises can be found between agriculture and environmental conservation.

2.1.4 COMMUNITY BASED ECO CULTURAL TOURISM ACTIVITIES

The research on this MO was done by consulting local SH at community and municipality level, as well as actors of the tourism industry in Limpopo and a Prf. Boonzaaeir of the anthropology school of the University of Pretoria, whose concern is mainly the development of community based, eco cultural tourism.

Eco cultural tourism to address wetland degradation

Eco tourism refers to nature oriented outdoor activities which are not challenging for nature conservation. Cultural tourism makes use of specific local traditions to propose tourist activities.

The use of eco-cultural tourism was identified as a relevant MO to address wetland degradation because:

- It may provide **alternative livelihoods** for the community and thus release the pressure on the wetland for farming;
- It may **enhance the traditional use** of the wetland in comparison to modern development of farming, as a source of crafting and cultural material (reeds for crafts, edible plants, medicinal plants etc.);
- It may be an **incentive for conservation** of landscape and cultural assets, as central tourist activities

Challenges in local people's perception

However on the topic of eco cultural tourism, local focus group discussions showed that there is a large discrepancy between potential tourism activities and local perception of tourism. These offsets are described in table 12 below.

Potential activities to benefit the community (Boonzaaeir 2007)	description	Local perception (group discussions with community)
Catering	Tourists are catered for in a safe but traditional environment: - traditional food, local products - traditional housing and bedding - water for bathing from the river	Tourists need modern life: - eat processed food from supermarkets - need Air conditioning and TV sets - Need showers
Guiding	- Cultural routes - Trekking - Landscape sight seeing - Sport activities (biking)	- The mountains are too big to walk on them
Cultural experiences	- Visit of homestead - Participation in cultural activities - Shows of traditional dances	- Our homestead are too dirty to be shown
Small enterprises Crafts/food	souvenirs for tourists (handcrafts) Items to be sold to the tourist camp (food products/linens etc...)	Our handcraft is not nice enough Our food is not good for the tourists

Table 12: Divergence between the potential benefits of eco-cultural tourism and its perception by local stakeholders

Table 12 shows that there is a challenge in the implementation of eco cultural tourism activities in GaMampa because of the local perception of tourist interests. Therefore, there is a need for training and example building for this type of tourism to develop. At provincial level, the AIR initiative[34] already gained experience on this topic in other areas of the province. It is currently rehabilitating a camp in the Mafefe area, about 20km east of the GaMampa valley.

[34] : AIR is a parastatal organization in Limpopo, aiming at development of cultural tourism based on community management.

Community based tourism: challenges in the local context

Community based tourism is the only alternative which can at the same time guarantee the preservation of local cultural, landscape and biological features and benefit the community economically and in terms of managerial empowerment (interview Boonzaaeir, 2010). This vision was validated by the local, municipal and provincial SHs. A feasibility study confirmed that there is potential for the GaMampa valley to develop this kind of tourism activities (Urban-Econ Tourism, 2008).

However, the main challenge in its implementation resides in local and municipal conflicts over the governance and responsibility of the tourism industry. The understanding of these conflicts requires strong knowledge of the local set of minds and of the political rivalries that exist between different locations of the ward. These conflicts are therefore hard to describe but their consequences are simple:

- The main conflict developed around the **introduction of the AIR camp in Mafefe**[35], under the previous ward councillor cooperation. The AIR set up a cooperative to govern the tourism activities linked to this camp. The legitimacy of this cooperative is questioned by the current ward councillor because it doesn't feature people from all locations of the Mafefe ward. There is village rivalry and political stakes in the management of the AIR camp resulting in the non recognition of the existing organisation.
- A **Tourism Centre was built in the GaMampa valley in 2005**, called the Mafefe Traditional Tourism Centre (MTTC). Although it is located in the GaMampa area, it was funded by the municipality for Mafefe ward. Because of difficulties and rivalries in its management and distribution of the potential benefits, it has not been used since its construction. The rivalry prevented use and maintenance of the infrastructure, and the MTTC is not functional anymore.

In conclusion, none of these initiatives was successful, but the AIR initiative proved to have hired people from the Mafefe community and set up a registered cooperative for the management of the camp. On the other hand, the MTTC staid completely unused and now needs restoration.

Conclusion on challenges for the development of eco-cultural tourism in GaMampa

The main challenges in developing eco cultural tourism in GaMampa area are:

- Local perception of tourism
- Village rivalry and political stakes in the governance of tourism activities
- Limited investment capacity for the restoration of the MTTC
- Limited access to communication networks and thus limited possibilities for marketing and management.

The study of the eco cultural tourism MO showed that the existing AIR initiative in Mafefe, although it is questionable in terms of representativeness of the people, is an opportunity for tourism activities in the ward, including the GaMampa area because:

- It has experience in community based management of tourist camps and can address the capacity building issues
- It has potential investment capacity for restoration of the MTTC

[35] Further referred to as AIR camp and Mafefe Tourism Centre (MTC)

- It has remarkable marketing capacity

Proposal of alternative for the development of eco cultural, community based tourism

The study of this MO showed that the alternatives for tourism are not to be developed according to the type of activities but in terms of organizational set up. Only one of these two alternatives is selected for the following MSs analysis. In fact, the socio political context of GaMampa prevents the emergence of tourism activities fully managed by the community. For this MO, there is one selected alternative:

- ***L.1 - Partnership with AIR for development of eco cultural tourism***

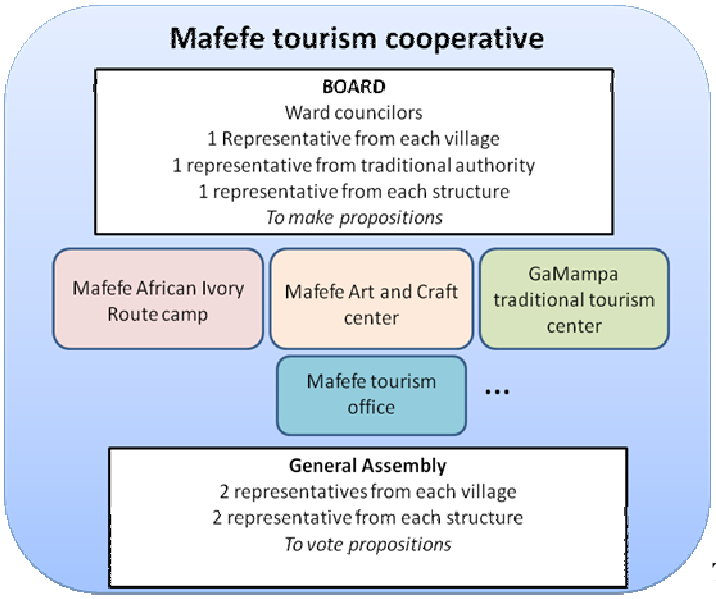
The partnership with the AIR should allow the renovation and future utilization of the MTTC. The idea is to use the AIR investment capacity and experience in community management of a camp, but to leave the management of the MTTC and other tourism assets in Mafefe to the community.

Adaptive governance

Accommodation of tourist groups in the MTTC would require hiring a staff for maintenance of the camp and services to hosts. Members of the staff should not only come from GaMampa valley villages but also from other villages in Mafefe. Guides and porters would be hired to accompany the groups during visits. The activities would include hikes and overnight stays in the mountain reserves, as well as cultural experiences in the GaMampa villages.

In addition, existing municipal buildings located in a central area of Mafefe and accessible by a tarred road and under cell phone network coverage would be used to set up a management office (Mafefe Tourism Office) and an art and craft centre.

Figure 43 and 44 present two diagrams drawn during a focus group discussion. They give a picture of the governance system for the tourism activities in GaMampa, and its integration into the Mafefe tourism cooperative.



A tourism cooperative, already under construction thanks to the AIR initiative, would enable coordination of the tourism activities in Mafefe. All tourism organizations should be part of this cooperative. The AIR camp should be at the same level as other organizations set by the community. A Mafefe Tourism Office (MTO) could ensure a booking and marketing service, as well as be a contact for the municipality or other tourism organization in the country.

Figure 43: Schema of the proposed Mafefe Tourism Cooperative (MTC)

Each of the organizations would be represented in the Board, and work in collaboration with the ward councillor and the traditional authorities to govern tourism activities. A general assembly would also feature people from villages to ensure that there is an equal representation of villages' interests in the decisions proposed by the board. The cooperative would thus be an arena for discussions and a mean to avoid hidden decisions, as well as a possible coordinator and governmental funds manager.

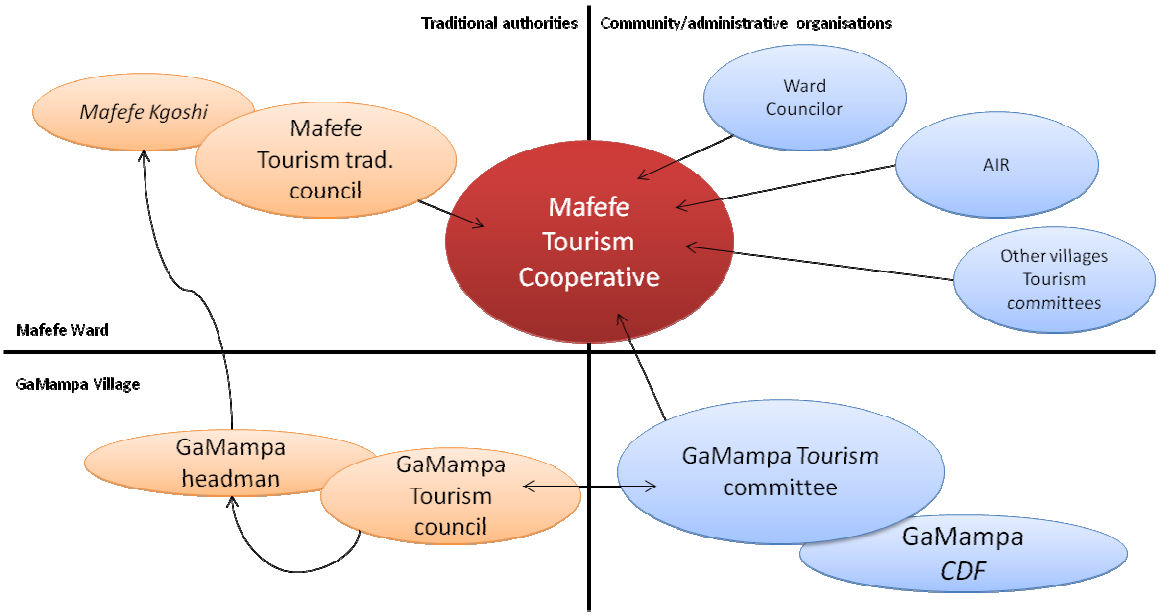


Figure 44: Diagram of the imagined governance entities to be involved in the Mafefe tourism cooperative at local and municipal scales, and decision making protocols

Figure 44 shows that the communication protocol and integration of the Mafefe tourism cooperative is different for the community municipal organizations and the traditional authorities' spheres.

A local tourism committee should be constituted in GaMampa, under the existing CDF. This committee would directly represent the GaMampa community in the MTC, just like other villages' tourism committees and other tourism infrastructures. On the other hand, the TA should be locally involved in the decision process but the information should flow through the Mafefe Kgoshi and his tourism council before being represented in the MTC.

Economic benefits of the proposed alternative

"It is a difficult subject because it raises expectations much higher than what it actually brings"

Prof. Bonzaaeir about tourism in poor rural communities

One of the reasons why the MTC and AIR projects have not been successful overall is because tourism generally raises expectation of direct economic profits higher than they can be in community based tourism. Mr Boonzaaeir explains that one main challenge is that people then tend to create conflicts over the governance of the activity because they want to enrich from tourism.

Table 13 presents an evaluation of the potential monthly income from a community based management of tourism with the support of the AIR. The reference costs are based on AIR and an interview with Prof. Boonzaaeir on his experiences with community based tourism.

Activity	Rands/month	nb of people and employment regime	
To manager in Mafefe office	3600	1	employed full time for management (Salary 1)
To camp workers	7300	4	employed full time for camp maintenance/services (Salary 2 and 3)
To guide	960	1	employed during group presence (4 days out of 7)
To porters	1543	2	2 days of hike during stay + donkey (2 days out of 4)
To homestead	771	2	2 homestead visits in 4 days
For food catering	13714	3	employed during group presence
Total income to the community	**27889 rands per month**		
Total people directly benefitting from tourism activities:		**13**	

Table 13: Estimated direct income from a group of 8 tourists during 4 days every week

Table 13 makes use of a program of 4 days every week with a group of 8 people. The idea is to propose a 2 days hike with porters and donkeys, with overnight stay in the mountains. There would be two homestead visits with cultural experience and a visit of a craft centre before leaving Mafefe. The guide must always be with the group during the stay for security and translation purposes. Eventually, it would be possible to build a partnership with the AIR camp and propose hikes to link the two camps

The estimated direct income is **about R28 000** every month, which does not take the charges into account. However charges should be quite small as the food would be from local production and camp maintenance would be at the charge of the municipality.

The number of people directly benefiting from the tourism industry is very limited in comparison to the number of households in the valley. Nevertheless this income should be subject to redistribution effect and should therefore benefit the community more largely.

In addition, the tourists are expected to spend money on local businesses, especially crafts and local traditional natural products. The economic return is difficult to evaluate but could be considered easily as R50/pers./stay, which for an average group of 8 people 4 days every seven days is **R1600/week, i.e. R6400/month**.

2.2 SELECTED PREREQUISITE MOS

A group of 4 MOs are considered as prerequisites to the above selected MOs. This means that in order to implement A.2, C.1 and L.1 alternatives, one or more of the following MOs must be implemented to guarantee their success. They mainly tackle governance issues, and one brings up the lack of communication infrastructures.

2.2.1 COMMUNICATION INFRASTRUCTURES

Two alternatives relative to communication infrastructures, that can be combined, were identified:

- *Government investment in road construction to Mapagane*
- *Public-private investment in phone network*

The telecommunication network was identified as the most important infrastructure for future economic development. It is indeed listed in the IDP document of the municipality for several years. The following selected prerequisite MO includes both infrastructure improvements into one "package":

- ***L.3 - Road access and network coverage***

This MO implies that the government of South Africa should invest in network coverage to create incentive for fill cell phone companies to invest in a network even if the current market opportunities are low.

Cell phone communication can potentially ease the implementation of the above selected MOs, including the rehabilitation of the ISs, by providing communicating tools for market organizations, and better coordination of tourism activities, by allowing for example direct bookings or direct communication between the MTC and the AIR camp.

In addition, the set up of a cell phone network can generally ameliorate the governance of resources in GaMampa by facilitating the set up of meetings and allowing more spontaneity and responsiveness.

As we saw in Part II of this study, banking opportunities are a limiting factor for the economic development of the GaMampa community and the intensification of the farming systems. Remarkably, cell phones access can also allow access to banking services, which is already developed widely in the South African banking context.

A tarred road access to the GaMampa valley could also ease the set up of tourism activities and the access to markets in the case of commercial agriculture development. For the cited but not selected MO: "investment in agro processing", the set up of a road and cell phone network is absolute prerequisite investors to set up processing industries.

2.2.2 RESOURCE MANAGEMENT INSTITUTIONS

As seen in part II of this study, the empowerment of the community is a stake to sustainably govern the natural resources, specifically the wetland. During field work, through consultation of local SHs, three sets of institutions were identified as relevant for future management of resources in the valley, which are of three different kinds: semi private, community, and traditional:

- *Traditional Council for Natural Resources (TCNR)*
- *Committee for Wetland Resources Management (WRMC)*
- *Committee for Livestock Control (LCC) and rules*

Traditional Council for Natural Resources (TCNR)

The aim of setting up such an organization is to allow the coordination of grazing, collecting and farming activities in the GaMampa valley.

This council would be appointed by the local chief and approved by the Mafefe Kgoši. Being appointed by TAs, is relevant in officialising rules and enforcing them at local level.

It should not be responsible for setting up operational rules but instead should consult the following two organizations and the rest of the existing or future GaMampa CDF committees. Its responsibility is thus to guarantee the enforcement of community based decisions. Figure 45 presents a schematic view of the insertion of a TCNR in the local governance framework.

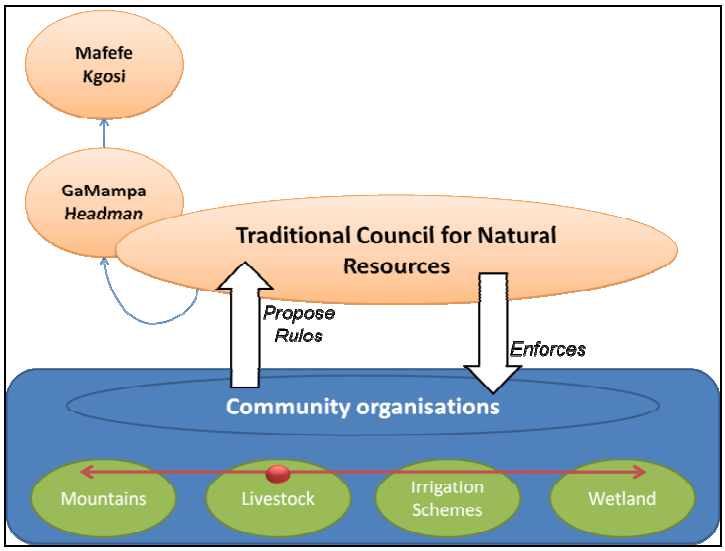


Figure 45: Institutional insertion of the TCNR in the management of natural resources of the valley

In the figure, one can see that the TCNR is in charge of reporting to the local TA and to enforce the rules. Interviews with the headman showed that he is aware that he does not have full knowledge in all domains that he is responsible for. Traditionally, the headman could and did have councillor within and outside his family to help him take decisions. Enforcement was defined by the participants as the payment of a fine to the GaMampa headman. The group discussion with local SHs brought out that rules on natural resources management should focus on the integration of livestock grazing to the ISs, the mountains and the wetland resources. The main purpose of the council would thus be to limit animal straying and this would, as a side effect, help integrate grazing to all rural activities in GaMampa.

Committee for Wetland Resources Management (WRMC) and rules

The role of WRMC would be to propose wetland management rules, specifically the set up of land use planning and possible rotational use of the resource.

The following alternative was developed through group discussions with the local SHs. The participants stressed the importance of the following:

- In order to be legitimate, since this MO deals with the use of land, the traditional authorities must be at the source of the committee's creation and closely related to its decisions. The headman can assign a person of his advising committee to represent him to the committee. This person would have to report any decision and ask for the headman's validation.
- The organization should include all types of users of the wetland (croppers, livestock owners, collectors, reed harvesters) and not only farmers. The existing wetland committee being made of wetland farmers, this committee should have one or more representatives reporting the wetland farmer's concerns. Other wetland users should have the same number of representatives.
- A person responsible for technical support should be involved to provide technical and methodological support in land use planning, for example for map creation.

The following figure provides a protocol for the set up of a WRMC and rules in integrated land use planning. It was also developed through consultation and consideration of socio cultural aspects in the community:

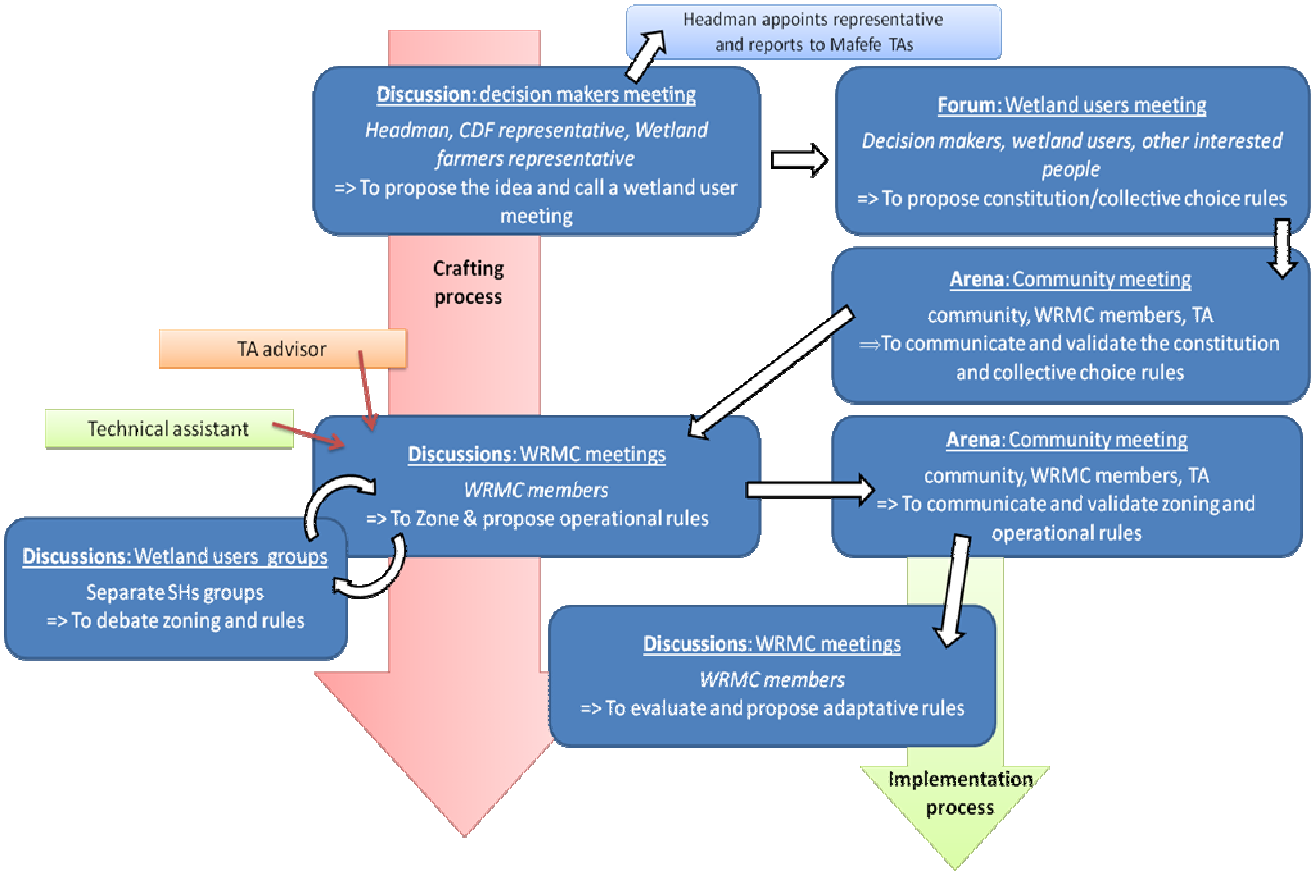


Figure 46: Illustration of the protocol for land use planning governance

The process of institutional crafting must start with a meeting of the decision makers of the valley, in other words influential people. This is a social requisite to guarantee buy in.

Forums of discussion should feature any community member who is interested in the topic of wetland resources (around 10 to 20 people). They should look at what collective choices rules are relevant, in other words propose a reason of being for the institution. These rules include how the WRMC members are nominated and dismissed, and the definition of their rights and responsibilities. The difficulty of this step is to ensure that all types of users are represented in the forum and can voice their concerns equally.

Arenas of discussion will involve all community members and happen during CDF meetings. They should enable communication of the results of forums and validation of the decisions

Group discussions within the WRMC should start the implementation process for land use planning by zoning the wetland and developing operational rules. The conclusions of these discussions must be reported and argued within groups of wetland users and with the headman, in order to be validated or not. If there is a disagreement then the WRMC can debate and refine the proposal. This process should go on until the WRMC members all agree.

Committee for livestock control (LCC) and rules

A Livestock Control Committee is relevant for livestock related issues, specifically to avoid animal straying and improve the breeding systems. The idea of this committee was developed in response to the observation that fences are not sufficient in preventing livestock intrusion in the wetland and ISs plots.

It was proposed to build a partnership between the community youth and private owners of livestock. In practice, this means that livestock owners commit themselves not to let their animals without shepherd, or in strongly fenced areas (kraals or plots). Rules on the topic must be written so that the TCNR can enforce them. In return, the community provides the livestock owners with alternatives for improvement of livestock management, through the creation of a youth enterprise called GaMampa livestock youth association (LYA).

The livestock owners are left with the choice to:

- Privately manage their livestock by hiring people, which means they will look for economically interesting breeding systems
- Invest all or part of their livestock in the LYA as a living capital, with insurance to secure the capital.

The economic return of this capital would be partly redistributed to the youth in kind with new born animals or in cash with animal production sales. Figure 47 gives a schematic view of the institutional framework required for implementation of a livestock control committee. It was built according to the findings of group discussions on the topic.

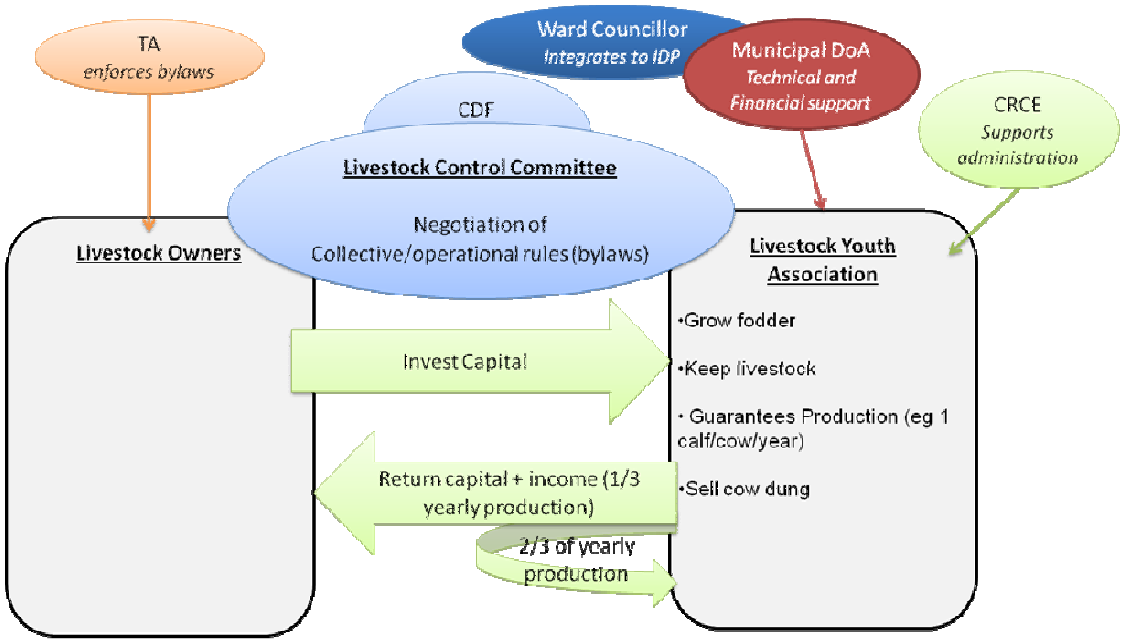


Figure 47: Institutional framework for implementation of a livestock control committee

The LYA should be managed by the youth itself in order to address inactivity, and can be supported by the CRCE for administrative issues and the DoA for technical training and support. The community CDF and the TA, through TCNR, will support this association by providing plots in the ISs to grow fodder crops, kraals in the valley to keep cattle at night (e.g. empty reservoir), and grazing camps in the mountains. For example, if farmers leave their plots in wetland, they can be kept and left to the use of the association for dry season grazing and fodder production. In figure 47, one can see that the Livestock committee is a negotiation platform for livestock owners and the youth association to come to a point of agreement in the definition of operational rules.

This alternative builds on the local traditional view that livestock is a capital but makes it contemporary by introducing the notion of capital investment for economic profit. It provides advantages to the community and to the livestock owners.

- Animal straying would be limited and investment in cropping system is possible.
- The youth can find an economic advantage by building up a capital from this activity. Income from this activity includes benefits from the capital (in cow or goat per year) as well as commercial activities like forage and cow dung sales.
- Breeding system can be intensified thanks to better control: illnesses control, balanced feed. The municipal DoA will find an opportunity to monitor cattle and goat production, and implementation of projects will be easier (selection of animals, forage)
- Integration of livestock to the management of all natural resources is easier because livestock is better controlled. It is easier to set up the rotation system for farming in the wetland and fertility transfers are better controlled.

Selection of an MO alternative for the governance of resources

The governance issues in resource management were identified as a main stake for wetland sustainability. The three alternatives which were proposed above are complex to set up and require further involvement of the research team for facilitation of dialogue between potential SHs. It was decided to group them as a prerequisite MO, in order to simplify the MSs Analysis.

- ***G.1 – Functioning local resources management institutions***

2.2.3 IDP AND LEGISLATION

Integration of local management plans to the IDP

The implementation of any MO described above requires that a management plan is included in the municipal IDP. This is for the simple reason that it is necessary in order to receive government financial support in implementation of the MOs alternatives, through the municipality. The following MO was selected:

- ***G.2 Integrate local resources management plans to IDP***

However, the implementation of such a MO requires the redaction and validation of the document to fit in the municipal standards. This is to be supported by the ward councillor and the GaMampa community development forum. This report can be used as a support for writing a resource management document.

G.3 Present / Implement legislation at local level

This MO refers to the introduction and enforcement of the South African legal framework at the local level, in order to enforce decisions and bylaws induced by the implementation of MO alternatives. MOs alternatives should be in accordance with the national laws. Conversely enforcement of national legislation could ease the implementation of MOs. One of the main local challenges on this topic is the identification of a DWA office to manage the Mohlapitsi river catchment. The following MO was selected for further analysis of the MSs:

- ***G.3 Present / Implement legislation at local level***

2.3 OTHER UN-SELECTED MOS

This lists the MOs and alternatives which were not selected for the modelling purposes of the project, either by lack of time, or because they were considered of lesser interest by stakeholders.

C.2 - Use fencing to ease resources management

- *Living fencing*
- *Artificial fencing*

The use of living or artificial fencing was envisaged to ease management of resources in GaMampa. However, it is not sufficient in itself to prevent livestock intrusion in cropped fields. Rather it should be seen as a result of the technical alternatives proposed in C.1 (land use planning) and set up thanks to G.1 (local resources management institutions). The failure of previous fencing projects proved that it does not achieve the protection of enclosed area but is only a representation of property limits.

C.3 Use anti erosion structures

- *Gabions*
- *Re-vegetation of river banks*

The topic of erosion is controversial and the need for infrastructure has not been scientifically proved or significantly advanced in SHs consultation processes. It was thus evicted from the MSs analysis.

L.2 - Stimulate investment in agro processing

- *Public private investment in packaging/storing of cash crops produce*
- *Public private investment in transformation of cash crops produce*

This MO clearly cannot be implemented in the socio economic context of the case study, although local farmers expressed a strong wish to see such investments. There is in fact a lack in infrastructure (road and telecommunication accesses), lack in farmers investment capacity, and most importantly a lack in agricultural or natural product production. Nevertheless, this MO is not to be left aside in the future development of the GaMampa community, but is cannot be well assessed in the MSs analysis through modelling, and is also not a priority for the management of resources in GaMampa.

After analysis of implementation possibilities of C.2 and C.3, it appears that their impact cannot be assessed through the WETSYS model (developed under the Stella platform). They are seen as *curing MOs*, less relevant than *prevention MOs*, specifically the ones focusing on the governance of resources. L.2 is relevant and desired by all interrogated stakeholders, but requires much prerequisite achievements that are not likely to be set up in the midterm.

Thus C.2, C.3 and L.2 are not selected for the following analysis of MSs.

Box 5: List of MOs and alternatives, after selection for MS analysis:

Agricultural development

A.1 - Rehabilitate the irrigation schemes

- *A.1 - LADC plan*
- *A.1 - Community oriented*
- *A.1 - Integrated alternative*

A.2 - Improved wetland agricultural practices

Nature Conservation

C.1 Integrated and concerted land use planning

- *C.1a - 35% wetland natural area, with rotation practices*
- *C.1b - 35% wetland natural area , without rotation practices*
- *C.1c - 50% wetland natural area, with rotation practices*
- *C.1d - 50% wetland natural area , without rotation practices*
- *C.1e - 75% wetland natural area, without rotation practices*

Alternative livelihoods for economic development

L.1 - Partnership with AIR for development of Eco cultural tourism

L.3 - Road access and network coverage (*prerequisite*)

Governance

G.1 - Functioning Local resources management institutions (*prerequisite*)

G.2 - Integrate wetland management plan to IDP (*prerequisite*)

G.3 - Present / Implement legislation at local level (*prerequisite*)

3 ANALYSIS OF THE MSS

Theoretically, the list of selected MOs (see box 5 above) can lead to 480 (3x2x5x2x2x2x2) possible combinations and thus as many MSs. The next part proposes a subjective selection process of a more limited set of MSs, to be used in the trade off analysis framework of the WETwin project.

3.1 ANALYSIS OF POSSIBLE MSS

The following analysis is based on the sustainable development framework, with the objective of finding a sustainable balance between economic, social and environmental development.

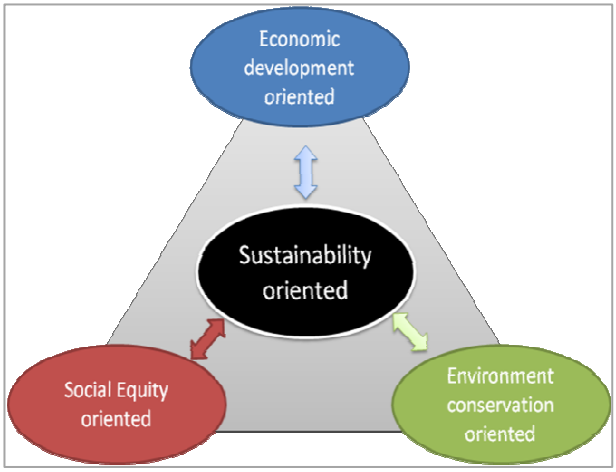


Figure 48: Framework for MS analysis

As shown in figure 48, it proposes three extreme MS oriented towards economic development, social equity or environment conservation, in order to propose a more balanced alternative called Integrated Management Solution.

The following table gives a summary of the proposed MSs

Management Options	Alternatives	Management Solutions			
		3 fundamental principles of sustainable development			**integrated solution**
		Conservation oriented	**Economic oriented**	**Social oriented**	
A.1 Rehabilitation of irrigation schemes	LADC plan		X		
	community ISs			X	
	Mixed ISs	X			X
A2. Improved wetland agricultural practices	technical package	X			X
C1. Land use planning	35% natural area + rotation				
	35% natural area , no rotation		X		
	50% natural area + rotation				X
	50% natural area , no rotation			X	
	75% natural area	X			
L1. Eco-tourism	partnership with AIR	X	X	X	X
Pre-requisites					
G1- Local resources management institutions	TNR, LCC, WRMC	X		X	X
G2 - Integration of WMP into IDP		X	X	X	X
G3 - Implementation of legislation		X			X
L3 - Road access and network coverage			X	X	X

Table 14: Description of the MSs for the GaMampa study case

3.2 PRESENTATION OF THE SELECTED MSS

This part gives a qualitative description of the 4 selected management solutions. It intends to explain how the alternatives articulate and orientate the MS towards conservation, social, economic or integrated management of the GaMampa resources.

3.2.1 CONSERVATION ORIENTED MS

This Management Solution was built by combining MO alternatives which are the most relevant in addressing environmental issues.

A.1 Rehabilitation of irrigation schemes - Mixed ISs

The choice of a mixed IS will allow flexibility between the gravity system for wet season use and the drip irrigation system for dry season uses.

On one hand, keeping a gravity system working is crucial for the existence of wet areas around the canals. It also allows diversion of water to the wetland through the ISs during wet seasons, when water is abundant and should be distributed around the valley to limit erosion of the river bed and allow a slow release of the resource through ground water. On the other hand, in times of high water scarcity, the drip irrigation system can minimize the amount of abstracted water.

It is however an economic challenge because it requires investment of the farmers for renovation of the gravity infrastructure, as well as in operation and maintenance of the pumping system. It is also a social challenge to organize the rules for water distribution and management of the two systems in parallel.

A2. Improved wetland agricultural practices

This option should be set up to guarantee wetland sustainability as it is most probable that there will always be wetland farming. It should diminish drainage of the wetland and guarantee wetland soils fertility.

C1. Land use planning – 75% of natural wetland vegetation

This defines 75% of the original wetland area as natural, including the river banks within 5 to 20m of the river bed, leaving only the most suitable areas for maize farming. However, the set up of a rotation system would be difficult because of the limited amount of land available.

This, as shown in table 11, should guarantee a good ecological health, and limit human activities to mainly plant collection in most areas of the wetland. It represents a governance challenge because it requires that many wetland farmers leave the wetland.

L1. Eco-tourism partnership with AIR

The eco cultural tourism activities in GaMampa can impact on the wetland ecological status in two ways:

- By enhancing the importance of the natural landscape and vegetation of the wetland to serve economic benefits (sightseeing, crafts production, and cultural aspects).
- By providing alternative livelihood opportunities (direct benefits, market opportunities for craft or agricultural products from the wetland) which can release the pressure on the wetland for farming.

G1- Local management institutions

The need for local resources management institutions is a prerequisite management alternative for the success of environmental oriented MOs. All organizations described in 2.2.2 are necessary to guarantee a good coordination of resources management rules and their enforcement.

G2 - Integration of WMP into IDP and G3 - Implementation of legislation

These alternatives are also prerequisite for conservation of the wetland as they will enable financial, technical and managerial support from the government, NGOs and parastatal organizations to the local community.

3.2.2 ECONOMIC ORIENTED MS

A.1 Rehabilitation of irrigation schemes - LADC plan

The use of drip irrigation should allow intensive dry season vegetable production. Nonetheless, drip irrigation system aims is not the only asset of the project, which also relies on the set up of long term contracts and a managing entity for production of large quantities.

It represents mainly a governance challenge because it requires that farmers manage the ISs infrastructure and production as a whole, whereas there are currently no local institutions dealing with this. The economic challenge lies in the fact that profits from agricultural production must not only allow the economic development of households but also be used for sustainability of the irrigation system. In the current context, families are so attracted by economic profit that provision for maintenance and operation of the system will require a strong, working institutional framework.

C1. Land use planning - 35% natural area, no rotation

This alternative gives importance to the most economically productive wetland activity: farming. Subsistence maize farming would extend on about 65% of the wetland area, which is more or less the current situation. No rotation system is possible.

This alternative, together with the installation of a drip irrigation infrastructure for vegetable production, makes way for a two face agrarian system in GaMampa, where the IS is used for commercial farming , and the wetland for subsistence farming, at the expense of the natural environment.

The main challenge here is both environmental and ecological, since the wetland services are endangered in the long term. However, the governance challenge is not so important since the 35% remaining natural area is not suitable for cropping activities.

L1. Eco cultural tourism partnership with AIR

The eco cultural tourism activities in GaMampa can impact on the wetland economic development in two ways by providing livelihood opportunities.

Nonetheless, two limitations must be taken into account:

- GaMampa's attractiveness for eco cultural tourism activities depends partly on its wetland ecological status. The previously selected alternatives for economic development may limit this.
- As shown in table 6, the potential direct benefits to the community are limited in amount (R30 000) and in the number of households benefiting from it (13).

G2 - Integration of WMP into IDP, L3 - Road access and network coverage

Integration of management plans into IDP is a prerequisite for economic development in GaMampa as a condition for governmental investment in economic activities.

Road access and network coverage favour investment in economic activities and stimulate employment of the local community in neighbouring economic centres.

3.2.3 SOCIAL ORIENTED MS

The social oriented MS refers to management of the wetland and resources following the community's demand. It requires a strong support from the government (mainly provincial and municipal) to guarantee social equity, which means that the government is involved in activities which benefit all social classes and SHs.

A.1 Rehabilitation of irrigation schemes - community ISs

The choice of a renovation and improvement of the existing infrastructure is made, even though it is the most costly alternative, because it matches best the community's demand.

The governance of the system is supported by the government, both for infrastructure maintenance and operation, as well as agricultural production management.

The challenge is that the government nowadays does not have the mandate and sufficient budget to implement this alternative fully, which might lead to inappropriate management. This questions the sustainability of such a system.

C1. Land use planning - 50% natural area , no rotation

The community wishes to release farming pressure on the wetland but requires part of the land for farming. Social inequities in the valley of GaMampa exist on the topic of land distribution. Even though the wetland is not intensively farmed in this sistuation, community members do not all have access to farming land. It is thus important for equity that all members who do not have access to land in the ISs have access to land elsewhere, thus in the wetland.

The rotation system is not a demand from the community and requires social organization that challenges equity. In fact, users of plots in the wetland would be disadvantaged by the rotation system compared to users in the IS since they would have to set their land to fallow or leave for grazing 3 years out of five.

L1. Eco cultural eco tourism - partnership with AIR

Eco cultural tourism activities might enhance the social equity in the valley by providing livelihood opportunities to those who have limited access to land or investment capacity. In fact, it provides potential salaries and allows the set up of low investment enterprise like crafting.

On the other hand, we saw that the potential number of households directly benefiting from eco cultural tourism is quite limited in comparison to the total number of households in the valley.

G1- Local management institutions

Local management institutions are a prerequisite to guarantee social equity in the community. They would include organization to build a system of bylaws, coordinate activities and allow equal enforcement of the rules.

G2 - Integration of WMP into IDP, L3 - Road access and network coverage

These alternatives are relevant in addressing social equity between the people of the valley and other communities in the region and in the province.

3.2.4 INTEGRATED MS

The integrated management solution intends to balance the 3 previous objectives of economic development, social equity and environment conservation, by selecting a set of MOs which, if implemented, should allow sustainability of the wetland ecosystem and wetland related human activities.

A.1 Rehabilitation of irrigation schemes - Mixed ISs

The use of a mixed IS is:

- Environmentally sustainable because it is adapted to both water abundance and water scarcity. It guarantees the continuity of IS integration into the hydraulic system of the valley;
- Socially equitable because it guarantees access to water in relation to the work invested in rehabilitation of the gravity infrastructure and its management;
- Economically promising with the possible intensification of cropping systems for commercial purpose during dry season, and the sustaining of existing subsistence systems.

The economic and social challenges related to the introduction of a pressurized irrigation infrastructure are limited because keeping the old infrastructure will allow the community to take time in creating an adapted social organization and rules in the use of the new infrastructure. Finally, the farming systems will not have to drastically change in just one cropping season, farmers will be able to adapt according to their investment capacity.

A2. Improved wetland agricultural practices

The use of adapted cropping practices in the wetland should allow more sustainability of the wetland ecosystem, most notably soil and hydrological features. At the same time, it is economically and socially interesting as it guarantees continuity in wetland farming.

C1. Land use planning – 50 % natural area and rotation system

The land use planning management alternative is a central activity to guarantee the implementation of an integrated MS. It allows the coordination of economic and conservation objectives while providing the possibility of social equity.

The proposed rotation system allows integration of the wetland into the valley resources system through livestock related activities. It allows fertility transfers with other resources of the valley. Farming and nature conservation are integrated, which guarantees a good ecological health of the wetland. It still provides about 20 Ha of farming land every year and leaves a lot of room for intensification of breeding systems.

The governance challenge for implementation of this alternative is high and conditions its success.

L1. Eco cultural tourism activities

As we saw in the above MSs, eco cultural tourism may have economic, social and environmental benefits in the valley.

G1- Local management institutions

Especially for this MS, since it intends to balance all aspects of the local development, a working institutional framework is a prerequisite to guarantee the implementation of the above alternatives.

To tackle the governance challenge, the integrated solution is interesting because it is supposedly economically interesting for all SHs of the valley. Therefore the farming community will have an interest to socially invest in the governance system.

G2 - G3 - L3

The integrated solution requires all three of these options to fully address other alternatives cited above.

3.3 Evaluation of the Management Solutions, linking the research to the end of WP8

This research was not meant to go further than evaluation criteria definition[36]. Nevertheless, as to provide insight for future steps of WP8 of the WETwin project (*Stakeholder Elicitation* and *Multi criteria Analysis* for decision support), it was decided to produce an expert judgement of the proposed Management Solutions.

3.3.1 Expert valuation of the Management solutions

An expert judgement based on qualitative evaluation of the management solutions was carried out according to selected criteria, each broken down into several indicators with different weights. The outcome of this is the Evaluation Matrix, which is a major input for the multi criteria analysis. The following figure illustrates the evaluation matrix based on expert valuation, which is presented in Annex IX.

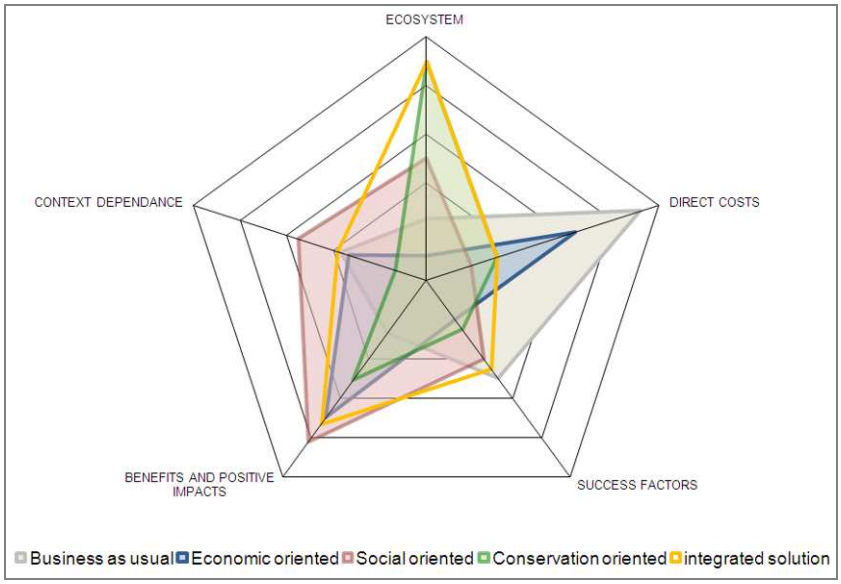


Figure 49: Spider diagram to illustrate the evaluation matrix based on expert judgment.

The spider diagram shows the performance of each management solution on the 5 chosen criteria. For each criteria, the closer the line is to the centre of the diagram, the more negative the effect of the management solution on the criteria will be. On the opposite, the more towards the outside, the more positive the effect of the management solution on the criteria will be. In figure 49, the integrated solution appears to overall outbound or perform as good as other solutions, with the best success factor of all. The social oriented management solution seems to be most relevant to content the local community, but more costly and challenging for the environment.

[36] Refer to Part I, figure 1 and 2

3.3.2 THE MULTI CRITERIA ANALYSIS

For GaMampa, the evaluation of the management solutions should be further worked on in the future. First, to refine the expert evaluation of the management solutions by making use of computer models (WETsys dynamic system model and farming system models) and other evaluation tools. Second, during multi SH workshops, to confront different point of views and come up with weights and judgements representative of the SHs. In other words, while expert valuation can provide objective judgment on the MSs performances, the SHs will give an evaluation matrix according to their preferences. The purpose of multi-criteria analysis is to rank the MSs according to their performances against several criteria and also according to the preferences of the stakeholders and decision makers.

The Evaluation Matrix is an essential input for this analysis. The other essential input are the weights expressing the preferences of the stakeholders and decision makers towards the evaluation criteria. The ultimate aim of this ranking is to help the decision makers in identifying the best compromise solution that will be recommended for implementation.

Conclusion

The overall objective of this research was to provide material for decision makers looking at resource management in the GaMampa valley that aims at wetland sustainability. This material was provided under the form of:

- A diagnosis of stakes and challenges in wetland management;
- A list of management options, with a selection of alternatives and details on their implementation;
- A list of Management Solutions which can be used in future modelling processes in the WETwin project;
- A proposition of an integrated management solution which includes, according to the results of the research, the most relevant set of management measures in the actual context of the GaMampa valley.

Another objective of the research was to provide a functional Wetland Management Plan document for the use of the local community or any organization willing to be involved in the management of resources in GaMampa. This was not included in the report for diverse reasons, mainly lack of time and thus may be tackled in later IWMI or Cemagref related activities.
Also, as we saw in the description of management options, a management plan document is crucial for future implementation of measures taken concerning GaMampa wetland. Therefore, writing such a document should be under the responsibility of the stakeholders themselves.
In addition to the formal objectives described above, the time spent in the GaMampa valley with the local community allowed adding to the knowledge of the research team on many aspects of the GaMampa case study. This study provided advances in the understanding of social, economic and ecological aspects of the GaMampa valley. It introduced and gave greater details by providing:

- A wetland typology and mapping of the resource according to the biophysical and uses, which can be used in practical decision making processes;
- A description of the dynamics and motivations in wetland invasion, specifically the ongoing privatization of the wetland resource to the detriment of communal uses;
- A formalization of the tradeoffs previous analysis into the choices between a mono use of the wetland resource to the benefit of private interests with a short term vision and little governance challenges, and multiple uses to the benefit of the community on the long term and governance challenges;
- An analysis of the links between the expansion of maize cultivation in the wetland and changes in grazing opportunities and wild plant collection;
- An overall description of the conflict of interests at local and regional scales, and most importantly an understanding on how they can impact on future wetland management proposition and thus should be taken into account.

These results were surely achieved thanks to the methodological approach used in consulting the local and external stakeholders. This process can be qualified as continuous, because **it stressed the importance of time and reiteration in building trust with people** when dealing with livelihood provisioning issues and conflictual topics. Attention was also put on using **simple participatory**

methods as to guarantee understanding and interest from all participants and flexibility from the researchers' side.
In conclusion on the objective of this research, this report is thought to be relevant in supporting decision making process concerning wetland management, and especially the writing of a management plan to be included in the local municipality Integrated Development Plan. CRCE, as a support for rural communities, may be the most relevant entity to use the information of this report and valorise it locally. The WETwin project will use the information for research purposes, in the implementation of the ToA framework.
Finally, **the results which were presented in this report intend to be objective**, aiming at the best compromising solution to reduce potential conflictual situations. However it would be a mistake to take the results from this study as the correct affirmation and future blueprints for wetland management, because they were not yet reviewed and validated by all stakeholders. Instead, results presented in this report should be used as orientations and material for further discussions.

The GaMampa wetland, just like many wetlands of the world, is a buffer for socio economic issues and natural variations. As a conclusion, **this report wishes to emphasize that the wetland currently suffers from dysfunctions outside of the ecosystem itself**, and that therefore managing the wetland for environmental sustainability is a matter of managing socio economic issues in the community, and finding solutions to cope with climate variability. In other words, it means integrating the wetland to the GaMampa resources system.
The author's personal opinion is that the GaMampa wetland is capable of providing environmental services while benefitting to the local community through provisioning services. **Solutions like payments for environmental services are not adapted** to the case of GaMampa. First because the regional stakes in wetland sustainability are too low and that no stakeholder has interest in paying for the wetland integrity. Second, because local stakes are high as the wetland supports local community livelihoods through provisioning. In the South African context, extra cash entries would be assimilated to welfare programs and would not stimulate social organization for sustainable management of the resource but reinforce private interests instead. The proposed integrated management solution hopes to provide alternative ways which would benefit the population as a whole because it will allow using the wetland for provisioning services and at the same time trigger collective action to guarantee its sustainability. **It especially focuses on allowing private use for cropping and communal use for grazing as well as natural vegetation collection.** It makes use of alternating dry and wet seasons and land use planning, coordinated by local institutions. In addition, it proposes a rehabilitation of the irrigation schemes in a way that it allows intensification of irrigated agriculture but is not challenging in terms of collective action for operation and maintenance.

The recent change in the use of the wetland is a benchmark in the history of the GaMampa community. It can be seen as a move from communal, multiple uses of the resource towards privatization and reduction of the services for enhancement of food production. In the local context, it is not exactly privatization since the land is still owned by the local traditional chief, but the enclosure phenomenon proves that wetland farmers would like to limit communal access to the land they farm.
Has the apartheid regime erased all possibilities of collective organization? Have the withdrawal of the state and development of liberalism triggered privatization of the communal land? Whatever the answers to these questions are**, this study advances that the current situation is challenging but not**

desperate for environmental sustainability. The interest that users have in the wetland, even if it is for farming, might trigger the necessary stakes for collective action to take place, and could actually induce a better integration of the wetland to the GaMampa resources.
This, in the personal opinion of the author, is especially possible through the challenge of livestock control. The consequences of enclosure and wetland farming on livestock are high both because of the fertility management and because it limits the possibilities of livestock straying for grazing. The community will have to find solutions to integrate wetland farming to livestock breeding for fertility and livestock feed, especially during dry season.

Apart from the rehabilitation of the irrigation scheme which tackles difficulties in the socio economic context, the proposition of a land use planning might be the most wetland focused solution which can induce collective action and trigger technical solutions to address tradeoffs.
In any case, **this study wishes to emphasize that infrastructure solutions, especially the fencing of wetland, will not be sufficient**. It has, until now, only intensified the phenomenon of uncoordinated use and search for private benefits instead of cooperation. On the other hand, **institutional empowerment is very much necessary in all aspects of the GaMampa valley socio economic and environmental difficulties**. The state, through the work of municipal and provincial department representatives, should look at possibilities to assist local stakeholders in the decision making process, and more specifically should not provide any infrastructure without long term accompaniment of its users.

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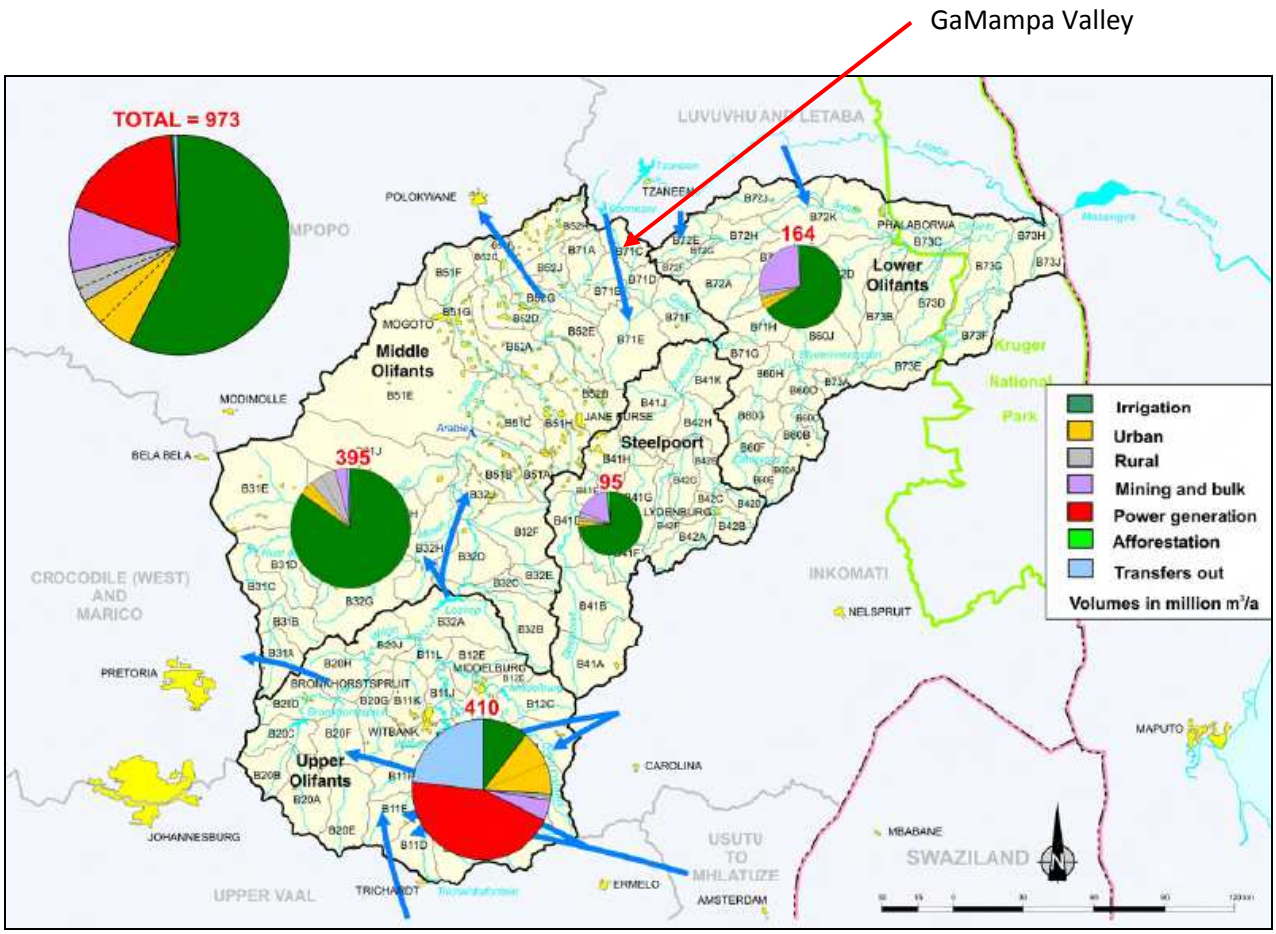
Annexes

ANNEX I - LAND USE MAP OF THE OLIFANTS



Overview of water resources availability and utilization per sector in the Olifants Water Management Area.

This map is taken from the Department of water affairs and forestry in 2003, Olifants water management Area (Basson Rossouw 2003, Overview of Water resources and availability in the Olifants river basin, DWA)

ANNEX II WATER BALANCES IN THE FERTILIS IS (ALLOWANCE 2010)

		Sept	Oct	Nov	Dec	jan	feb	march	abril	may	jun	july	aug	total rain
	efficient rainfall (mm)	13	50	96	97	102	79	81	28	12	6	9	7	580
Maize	*water requirements*	*27*	*117*	*158*	*143*	*86*								
actual farmed	irrigation requirements mm	14	67	62	46	-16	0	0	0	0	0	0	0	
area	Irr. Requi m3/Ha	140	670	620	460	-160	0	0	0	0	0	0	0	
83%	Irr. Requi L/Ha	140000	670000	620000	460000	-160000	0	0	0	0	0	0	0	
72,9 Ha	Irr. Requi Fert. m3	10206	48843	45198	33534	-11664	0	0	0	0	0	0	0	
IS eficiency	Irr. Requi Fert. M3/sec	0,004	0,019	0,017	0,013	-0,005	0	0	0	0	0	0	0	
18%	Irr. Requi Fert. L/sec	4	19	17	13	-5	0	0	0	0	0	0	0	
	head canal Requi Fert. (L/sec)	**22**	**107**	**99**	**73**	**-26**	0	0	0	0	0	0	0	
	River intake requirements (L/sec)	**107**												
Groundnut	*water requirements*			*59*	*91*	*146*	144	96						
actual farmed	irrigation requirements mm	0	0	-37	-6	44	65	15	0	0	0	0	0	
area	Irr. Requi m3/Ha	0	0	-370	-60	440	650	150	0	0	0	0	0	
6%	Irr. Requi L/Ha	0	0	-370000	-60000	440000	650000	150000	0	0	0	0	0	
5,2 Ha	Irr. Requi Fert. m3	0	0	-1924	-312	2288	3380	780	0	0	0	0	0	
IS eficiency	Irr. Requi Fert. m3/sec	0,000	0,000	-0,001	0,000	0,001	0,0013	0,0003	0,0000	0,0000	0,0000	0,0000	0,0000	
18%	Irr. Requi Fert. L/sec	0	0	-1	0	1	1	0	0	0	0	0	0	
	head canal Requi Fert. (L/sec)	0	0	**-4**	**-1**	**5**	**7**	**2**	0	0	0	0	0	
	River Intake requirements (L/sec)	**7**												
SwtPotato	*water requirements*								47	53	78	66	45	
actual farmed	irrigation requirements mm	0	0	0	0	0	0	0	19	41	72	57	38	
area	Irr. Requi m3/Ha	0	0	0	0	0	0	0	190	410	720	570	380	
6%	Irr. Requi L/Ha	0	0	0	0	0	0	0	190000	410000	720000	570000	380000	
5,28 Ha	Irr. Requi Fert. m3	0	0	0	0	0	0	0	1003,2	2164,8	3801,6	3009,6	2006,4	
IS eficiency	Irr. Requi Fert. m3/sec	0,000	0,000	0,000	0,000	0,000	0,0000	0,0000	0,0004	0,0008	0,0015	0,0011	0,0008	
18%	Irr. Requi Fert. L/sec	0	0	0	0	0	0	0	0	1	1	1	1	
	head canal Requi Fert. (L/sec)	0	0	**0**	**0**	**0**	**0**	**0**	2	5	8	6	4	

Tomato	*water requirements*							71	77	77	74	81		
actual farmed	irrigation requirements mm	0	0	0	0	0	0	-10	49	65	68	72	0	
area	Irr. Requi m3/Ha	0	0	0	0	0	0	-100	490	650	680	720	0	
0,3%	Irr. Requi L/Ha	0	0	0	0	0	0	-100000	490000	650000	680000	720000	0	
0,3 Ha	Irr. Requi Fert. m3	0	0	0	0	0	0	-30	147	195	204	216	0	
IS eficiency	Irr. Requi Fert. m3/sec	0,000	0,000	0,000	0,000	0,000	0,0000	0,0000	0,0001	0,0001	0,0001	0,0001	0,0000	
18%	Irr. Requi Fert. L/sec	0	0	0	0	0	0	-0,01	0,06	0,07	0,08	0,08	0,00	
	head canal Requi Fert. (L/sec)	0	0	0	0	0	0	**-0,06**	**0,32**	**0,41**	**0,45**	**0,46**	0,00	
	River Intake requirements (L/sec)	**0**												
Cabbage	*water requirements*									53	61	74	80	
actual farmed	irrigation requirements mm	0	0	0	0	0	0	0	0	41	55	65	73	
area	Irr. Requi m3/Ha	0	0	0	0	0	0	0	0	410	550	650	730	
0,3%	Irr. Requi L/Ha	0	0	0	0	0	0	0	0	410000	550000	650000	730000	
0,264 Ha	Irr. Requi Fert. m3	0	0	0	0	0	0	0	0	108,24	145,2	171,6	192,72	
IS eficiency	Irr. Requi Fert. M3/sec	0,000	0,000	0,000	0,000	0,000	0,0000	0,0000	0,0000	0,0000	0,0001	0,0001	0,0001	
18%	Irr. Requi Fert. L/sec	0	0	0	0	0	0	0,00	0,00	0,04	0,06	0,06	0,07	
	head canal Requi Fert. (L/sec)	0	0	0	0	0	0	0,00	0,00	**0,23**	**0,32**	**0,36**	**0,42**	
	River intake requirements (L/sec)	**0**												
Onions	*water requirements*									47	41	53	75	
actual farmed	irrigation requirements mm	0	0	0	0	0	0	0	0	35	35	44	68	
area	Irr. Requi m3/Ha	0	0	0	0	0	0	0	0	350	350	440	680	
0,7%	Irr. Requi L/Ha	0	0	0	0	0	0	0	0	350000	350000	440000	680000	
0,6 Ha	Irr. Requi Fert. m3	0	0	0	0	0	0	0	0	210	210	264	408	
IS eficiency	Irr. Requi Fert. m3/sec	0,000	0,000	0,000	0,000	0,000	0,0000	0,0000	0,0000	0,0001	0,0001	0,0001	0,0002	
18%	Irr. Requi Fert. L/sec	0	0	0	0	0	0	0	0,00	0,08	0,08	0,10	0,16	
	head canal Requi Fert. (L/sec)	0	0	0	0	0	0	0	0,00	**0,44**	**0,46**	**0,56**	**0,89**	
	River Intake requirements (L/sec)	**1**												

	Irrigation requirements (agriculture use)	3,9	18,8	16,7	12,8	-3,6	1,3	0,3	0,4	1,0	1,7	1,4	1,0	
	head canal Requi Fert.	22,3	106,8	94,6	72,7	-20,7	7,4	1,6	2,5	5,7	9,5	7,7	5,7	
	river intake requirement	**107**												
	leakages in head canal	43												
water balance	total leakages in main canal	19												
(L/sec)	leakages in secondary canal	13												
	infiltration at plot level	13												
	left for irrigation purposes	19												
	surface runoff ("extra water")	15	0	2	6	22	18	19	18	18	17	17	18	
	total water diverted to wetlands	*103*	*88*	*90*	*94*	*110*	*106*	*107*	*106*	*106*	*105*	*105*	*106*	

ANNEX III: WETLAND GROUNDWATER LEVEL MAPPING IN 2007

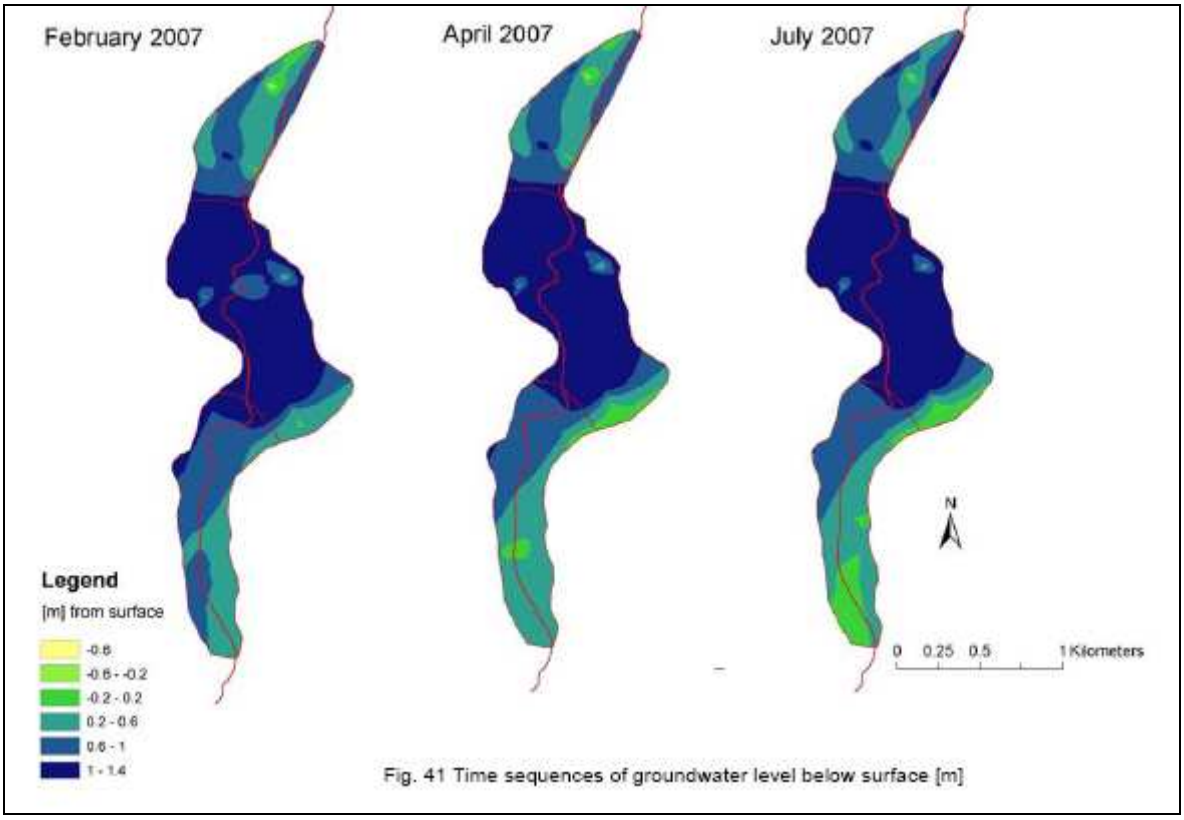
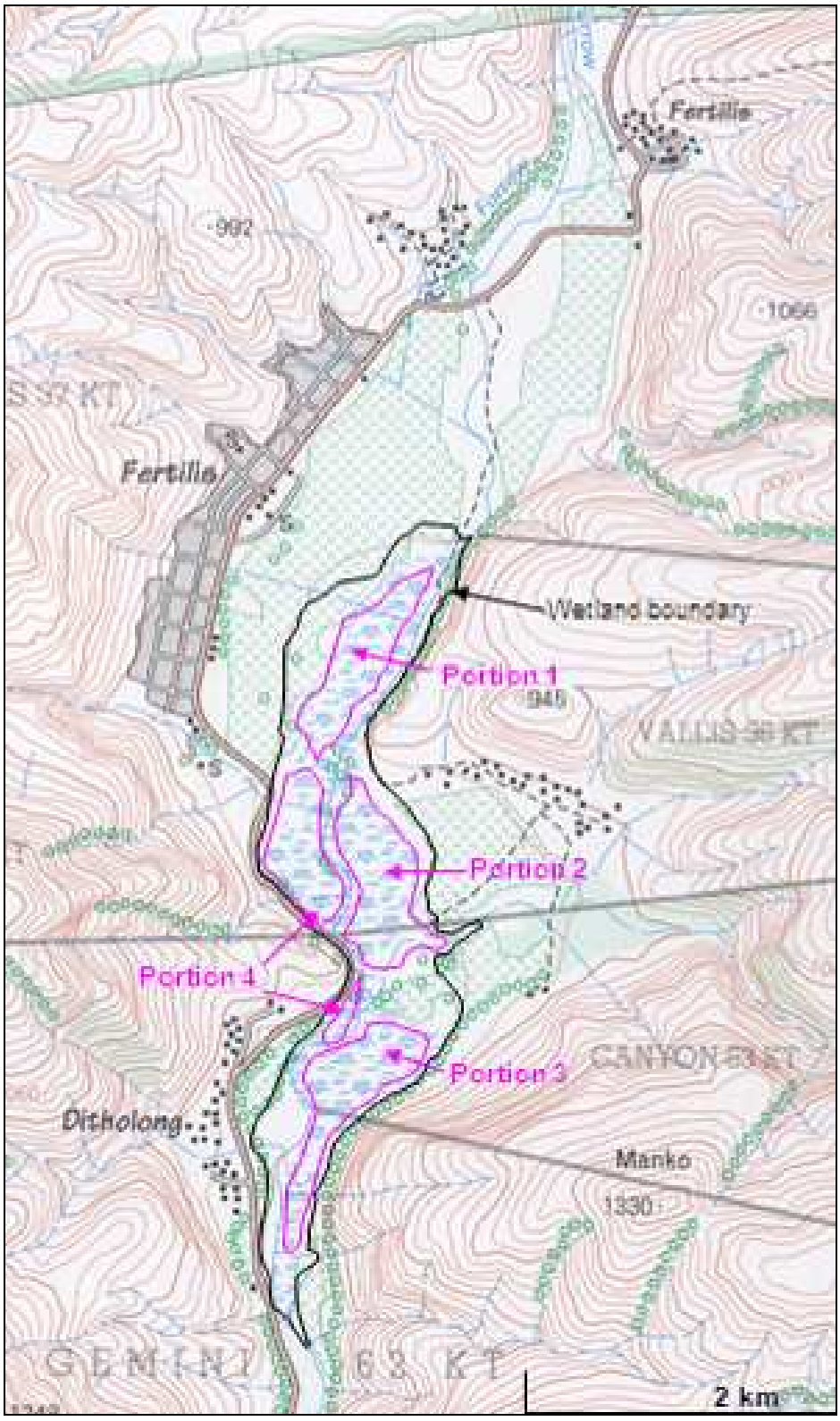


Fig. 41 Time sequences of groundwater level below surface [m]

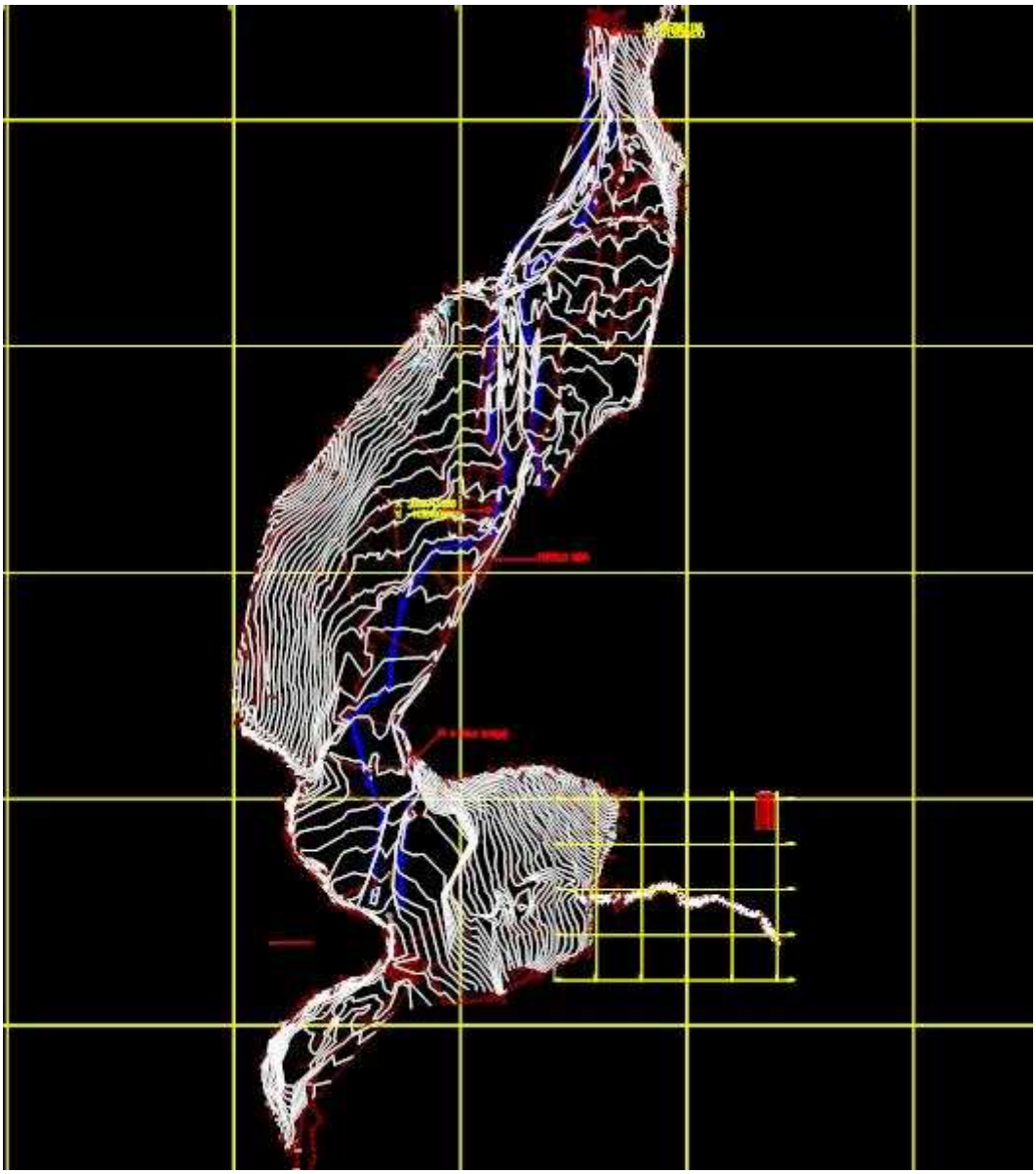
This map was taken in Kogelbauer 2009, p. 82

ANNEX IV: ZONING OF THE ORIGINAL MOHLAPITSI WETLAND

It shows the location of the 4 valley floor portions of the wetland determined by Kotze 2005. Portion 1, 2 and 3 are partly remaining today.



ANNEX V: FLOODLINES OF THE MOHLAPITSI RIVER.



This map was taken from the VELA VLK hydrological studies, 2009. Its original softcopy has a good format. It was added to the WETwin data base

ANNEX VI: IMPACT OF LAND USE CHANGES ON ECOSYSTEM SERVICES

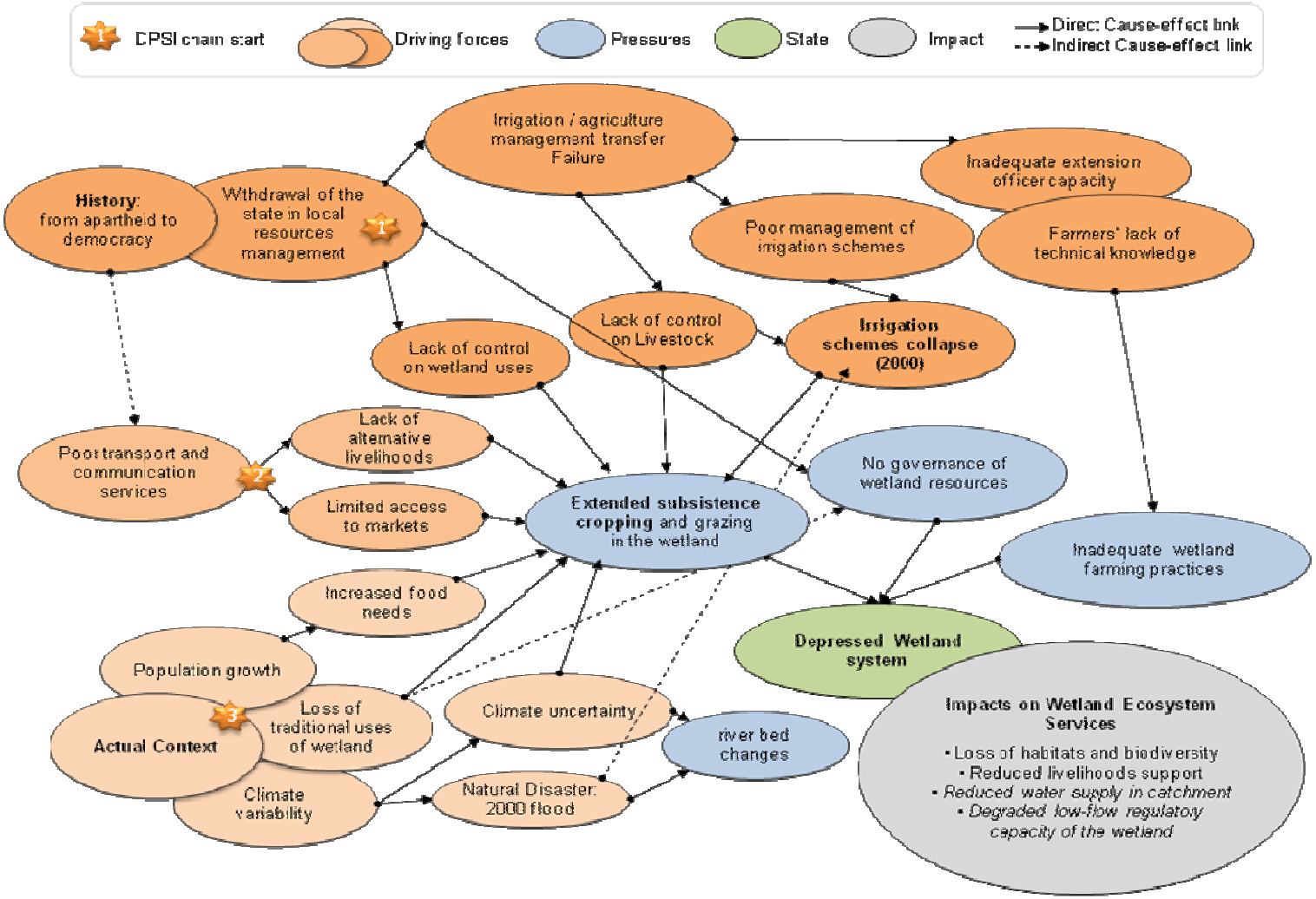
Change in the delivery of ecosystem services for future land-use scenario relative to the current state of the wetland, Kotze 2005:

Ecosystem services	Current situation – existing 65% extent of cultivation	Extent to which the current delivery of ecosystem services has been modified	Comments
Flood attenuation	2.3	↓	Moderate reduction in surface roughness of the wetland owing to the removal of reeds and replacement with crops which are shorter & less robust
Streamflow regulation	2.7	↓	Reduced detention capacity of the wetland as a result of the extensive drainage network. Water loss through transpiration unlikely to be greater from crops than from natural vegetation which remains actively growing through the year because of the warm climate with mild winters
Sediment trapping	2.0	-	
Phosphate trapping	1.9	-	
Nitrate removal	2.7	↓	Reduced level of wetness and vegetation growth resulting from cropping would diminish the assimilative capacity of the wetland
Toxicant removal	2.6	↓	As above. Also, the diminished SOM level would further reduce the assimilative capacity
Erosion control	2.2	↓↓	
Carbon storage	3.0	↓↓	(see Section 3.2)
Maintenance of biodiversity	2.3	↓↓↓	(see Section 3.3)
Water supply for human use	3.3	-	
Natural resources	3.5	↓↓	The extent of natural grazing for livestock has been considerably reduced. Owing to the low level of harvesting of natural wetland plants for crafts and construction, their reduced extent because of cropping has probably not greatly affected the harvestors.
Cultivated foods	3.8	Short term: +++ Long term: ↓↓	
Cultural significance?	2.0	-	
Tourism and recreation	2.3	-	
Education and research	2.3	-	

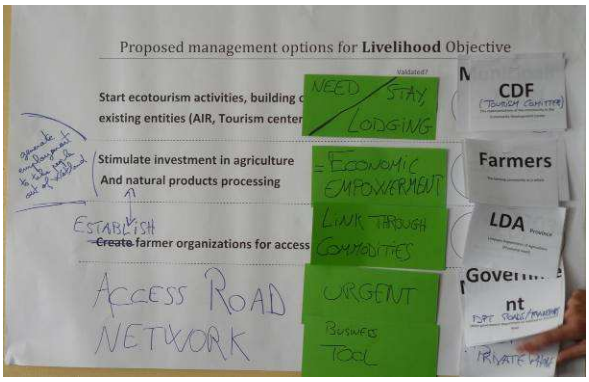
Extent to which the current delivery of the ecosystem service has been altered from that of the system in its natural state:

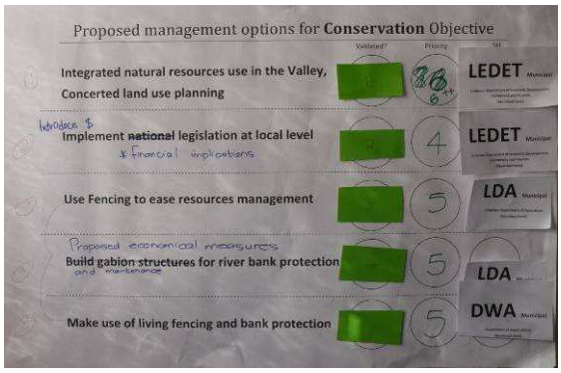
High increase in the delivery of the ecosystem service +++
Moderate increase in of the ecosystem service ++
Slight increase in the delivery of the ecosystem service +

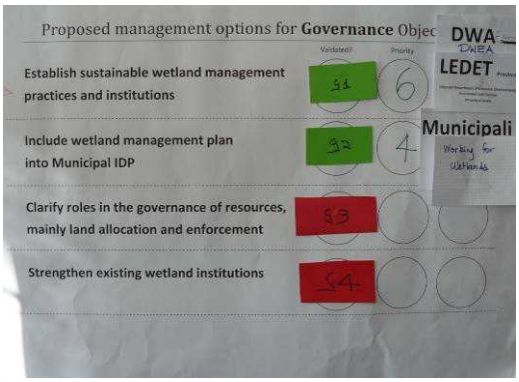
ANNEX VII: PERSONAL VERSION OF THE DPSI DIAGRAM

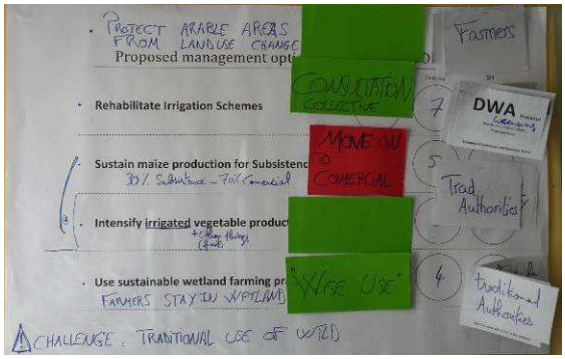


ANNEX VIII - PICTURES OF THE WORKING POSTERS ON THE 07-07-2010

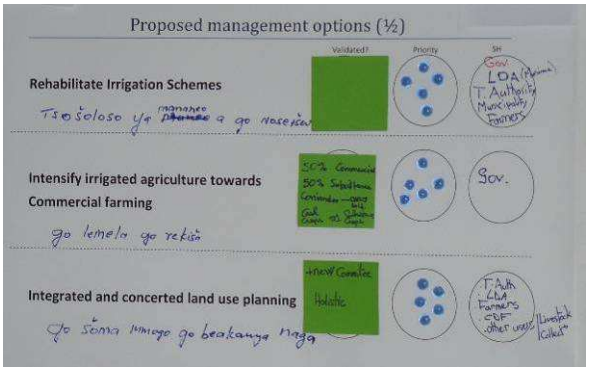


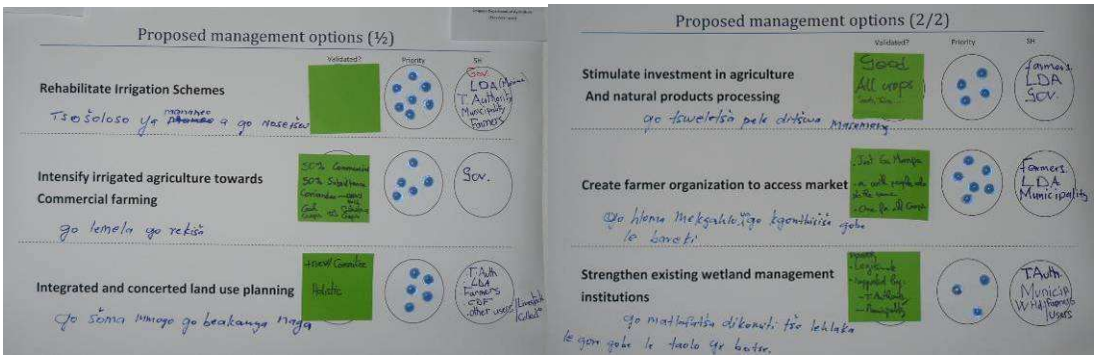






Pictures of the working posters on the 08-07-2010





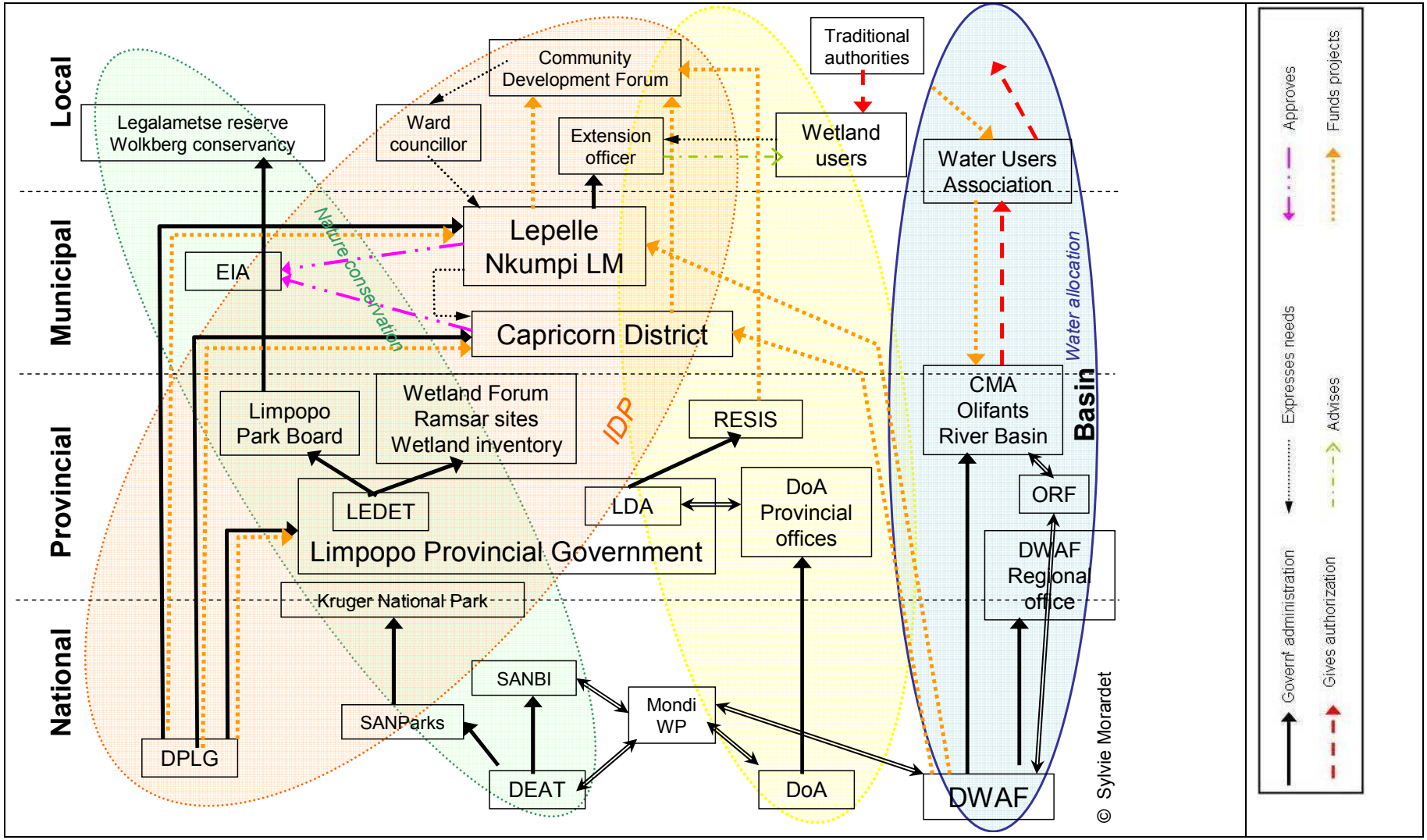
ANNEX IX: EVALUATION CRITERIA MATRIX

qualitative judgment	--	-	0	+	++
scoring	0	0.25	0.5	0.75	1

	Weights	Business as usual	Qltve judgment	Score	Conservation oriented			Economic oriented			Social oriented			integrated solution		
ECOSYSTEM	**25**		**-**	**0,25**		**++**	**0,9**		**--**	**0,1**		**+**	**0,5**		**++**	**0,9**
Drinking water supply eco-service	**0**	depletion of organic matter and deterioration with time			the most environmental oriented MS: natural area and water abstraction flexibility			risk of pollution, complete disappearance of natural wetland			more natural wetland than today			Same flexibility in water abstraction; less natural area than in Conservation but moe sustainable (rotation)		
Water Quality regulation eco-service	**3**															
Hydrological health	**9**															
Geomorphological health	**5**															
Vegetation health	**8**															
DIRECT COSTS	**25**		**++**	**0,92**		**-/--**	**0,30**		**-**	**0,64**		**-**	**0,19**		**--**	**0,30**
Costs of implementation of management option	**17**		++	1,00	mixed IS is the most expensive option of rehabilitation	-	0,35		-	0,75		--	0		-	0,35
Costs of maintenance and operation	**8**		+	0,75		-	0,2		--	0,4		0	0,6		-	0,2
BENEFITS AND POSITIVE IMPACTS	**25**			**0,27**			**0,51**			**0,70**			**0,82**			**0,73**
Number of beneficiaries	**8**		-	0,25	resources collectors increase, wetland farmers decrease	0	0,5	no more resources collectors, wetland farmers as present, irrigation farmers more active	0/+	0,5	maximum number of beneficiaries	++	1	less wetland farmers	+	0,75
Increase of income from economic activities	**8**		-	0,25	increase of cash income from IS	+	0,75		++	1		0	0,5		+	0,75
Labour requirement	**2**		0	0,50	labour requirement of irrigation farming increases but those of wetland farming decrease	0	0,5		++	1		+	0,75		0	0,5
Food security	**7**		-	0,25	increase of food production in IS does not compensate decrease in wetland	-	0,25	production in wetland as present	0	0,5		++	1		+	0,75
SUCCESS FACTORS	**10**			**0,50**			**0,25**			**0,20**			**0,40**			**0,45**
Need of capacity building program	**4**		0	0,50	high capacity building requirements	-	0,25	high capacity building requirements	--	0		0	0,5		-	0,25
Energy requirements for M&O	**2**		0	0,50	moderate	-	0,25	high	--	1		0	0,5		-	0,25
Risk of technical and economic failure	**4**		0	0,50	moderate	-	0,25	risk of technical and market failure	--	0		-	0,25		+	0,75
CONTEXT DEPENDANCE	**15**			**0,37**			**0,13**			**0,33**			**0,55**			**0,38**
Economical wealth	**3**		0	0,50	high	--	0	high	--	0		+	0,75		-	0,25
Policy preferences	**4**		-	0,25	low	-	0,25	high	++	1		--	0		-	0,25
Need institutionnal capacity	**4**		0	0,50	high	-	0,25	high	--	0	same needs than today	0	0,5		-	0,25
Community acceptance	**4**		-	0,25	low	--	0	low	-	0,25		++	1		+	0,75
ECOSYSTEM	**25**			0,25			0,90			0,10			0,50			0,90
DIRECT COSTS	**25**			0,92			0,30			0,64			0,19			0,30
SUCCESS FACTORS	**10**			0,50			0,25			0,20			0,40			0,45
BENEFITS AND POSITIVE IMPACTS	**25**			0,27			0,51			0,70			0,82			0,73
CONTEXT DEPENDANCE	**15**			0,37			0,13			0,33			0,55			0,38
Overall score				**0,47**			**0,47**			**0,43**			**0,50**			**0,59**

ANNEX X - STAKEHOLDER ANALYSIS

Cross scales wetland management in South Africa



ANNEX XI: HISTORY OF THE GA-MAMPA VALLEY AND WETLAND (SOURCE: CHIRON 2005; FERRAND 2004)

Five main periods can be distinguished in the history of the Ga Mampa valley.

1. At the beginning of the 20th century, agriculture in the valley was rainfed. There were three large white-owned farms: Mashushu, Fertilis and Vallis (indicated in Error! Reference source not found.). Crops grown were cotton, probably sugarcane and avocados.The wetland was uncultivated.
2. In 1959, the Native Government of Lebwagomo bought the 3 farms equipped with earth canals. The Government built cemented canals for the Fertilis farm, which became the Fertilis irrigation scheme with 78 plots of around 1ha each for 78 farmers. Mashushu (around 30 farmers for 35 ha) and Vallis (around 35 farmers for 32 ha) were fenced. During the 30 years that followed, civil servants (2 water rangers, 2 rangers, 3 tractors drivers, 1 clerk and 1 extension officer) were responsible for water management and agricultural organization. Farmers produced wheat and maize and some vegetables. GaMampa was also well known for its sugarcane production. During the 1960s, the natural wetland covered the land downstream of Fertilis and Vallis on more than 90 ha. Irrigated agriculture dominated and rainfed agriculture in wetland was rare. Grazing lands separated Mashushu from Fertilis and the forest surrounded the irrigation schemes. At the end of the 1980s, the three irrigated schemes had grown (40 farmers in Mashushu equipped with an additional earth canal, irrigating 6 more ha; 10 more farmers for a final area of 92 ha in Fertilis). Farmers started to occupy the natural wetland downstream Fertilis and Vallis.
3. At the beginning of the 1990s, the winter cropping system changed with the arrival of a new extension officer and the end of apartheid. A high value crop (relative to maize), coriander, was introduced. Many farmers produced this aromatic crop; it was marketed through the extension officer. Wheat production decreased because of increased competition and lower prices. In 1991, the fences of Fertilis and of Vallis irrigation schemes were rehabilitated.
4. In 1994, the management of irrigation schemes was transferred, too quickly, to the inexperienced and insolvent black community. This resulted in a rapid deterioration of the hydraulic equipments and a decline of the schemes, despite the creation of water committees under the Headman control. Because of decreasing water supply, animal straying, difficulties of farmers' self-organization and the 1995 flood, some farmers abandoned the winter crop production whereas others started to farm in the wetland. This corresponds to the first significant conquest of the natural wetland. At the end of the 1990s, the natural wetland had decreased by 25%. About 70ha of the natural wetland remained.
5. In 1999, a weir was built for Fertilis and Mashushu irrigation schemes. However it was destroyed by the floods in 2000 flood. The 2001 and 2002 crop seasons were bad for most of the farmers. Thus, around 5 to 10 farmers of Fertilis, Mashushu and Vallis asked the wetland committee to get some plots in the wetland. This can be regarded as the second conquest of the natural wetland (In 2004, less than 8 farmers cultivate winter crops in Fertilis, 3 in Mashushu and around 7 in Vallis. In September 2004, the Fertilis irrigation scheme was earmarked for rehabilitation under the RESIS program, which includes rehabilitation of the infrastructures and training of farmers. It has started with the provision of fences that should soon be followed by the rehabilitation of the canals. To this day the rehabilitation is still incomplete. Most of the wetland has been converted to cropland.

ANNEX XII: LIST OF PARTICIPANTS OF THE MANAGEMENT OPTION WS

Name	Position	Address	Country	email
Ms Sylvie Morardet (+ husband)		UMR G-EAU Cemagref, 361 rue Jean-Francois Breton, BP5095, 34196 Montpellier Cedex 05 France	**France**	sylvie.morardet@cemagref.fr
Francois Milhau		UMR G-EAU Cemagref, 361 rue Jean-Francois Breton, BP5095, 34196 Montpellier Cedex 05 France	**France**	
Clement Murgue		UMR G-EAU Cemagref, 361 rue Jean-Francois Breton, BP5095, 34196 Montpellier Cedex 05 France	**France**	
Dr Robyn Johnston		International Water Management Institute, 127 Sunil Mawatha, Pelawatte, Battaramulla, Colombo, Sri Lanka	**Sri Lanka**	r.johnston@cgiar.org
Ilse Kogelbauer			**Austria**	ilse.kogelbauer@gmail.com
Patience Mukuyu	Consultant - IWMI & IHE	IWMI, 141 Cresswell Street, Weavind Park, Pretoria, South Africa	**Safrica**	pmukuyu@gmail.com
Lisa-Maria Rebelo		IWMI Addis Office (IWMI, P O Box 5689, Addis Ababa, Ethiopia)	**Ethiopia**	l.rebelo@cgiar.org
Mbali Dlamini		Department of Water Affairs, Cnr Brown & Paul Kruger Street, Prorom Building, Private Bag X11259, Nelspruit, 1200	**South Africa**	dlaminim2@dwaf.gov.za
Ms Nonkanyiso Zungu		Resource Directed Measures Section, Department of Water Affairs, 125 Schoeman Street, Emanzini 02, Private Bag X313, Pretoria	**South Africa**	ZunguN@dwa.gov.za
Nokuthula Cebekulu	Principal Water Pollution Control Officer	Department of Water Affairs, Mpumalanga Region - Water Quality Management, No 22 Rooth Street, Bronkhorstspruit, 1020	**South Africa**	CebekuluN@dwa.gov.za
Eiman Karar	Director, Water Resources Management	Water Research Commission	**South Africa**	eimank@wrc.org.za
Chris Moseki	Director, water Resources	Water Research Commission	**South Africa**	chrism@wrc.org.za
Duncan Hay		Water Research Commission	**South Africa**	Hay@ukzn.ac.za
Eustatia Bofilatos	Director: WMIG	Department of Water Affairs HQ	**South Africa**	BofilatosE@dwa.gov.za

Ms. N. Zungu		DWAF Resource Directed Measures	**South Africa**	ZunguN@dwa.gov.za
Chris Dickens			**South Africa**	
Collin Nemadodzi		SANBI	**South Africa**	nemadodzi@sanbi.org
Thomas G-Abiobabi		Kruger National Park	**South Africa**	ThomasGa@sanparks.org
Stanford Macavele	Water Quality	Department of Water Affairs-Mpumalanga Region	**South Africa**	MaceveleS@dwaf.gov.za
Mbali Dlamini	Water Quality	Department of Water Affairs-Mpumalanga Region	**South Africa**	dlaminim2@dwaf.gov.za
Mishack Masindi		Limpopo Dept of Evnironment	**South Africa**	masindimm@ledet.gov.za

ANNEXE XIII - EVOLUTION OF RESOURCES MANAGEMENT ACCORDING TO FERRAND 2004

Gestion des ressources naturelles (selon FERRAND, 2004)						
	Système d'« origine »	Système colonial 1800-1900 avant l'arrivée des blancs sur l'Olifants river	Début du 20ième siècle et arrivée des blancs sur l'Olifants river	Aire du renforcement de l'apartheid (des années 50 aux années 80)	De 80 à 1994: dégradation de l'agriculture	De 1994 à nos jours
Autorité politique	Autorité tribale représenté par le chef	Autorité tribale : chefs et headmen	Autorité tribale représenté par le chef et les headmen dans chaque communauté mais remis en cause de plus en plus par le gouvernement d'Afrique du Sud	Autorité tribale représenté par le chef et les headmen dans chaque communauté . Ils deviennent l'interface entre les communautés et le régime d'apartheid	Autorité tribale représenté par le chef et les headmen dans chaque communauté contrôlé par l'autorité du gouvernement central: interface entre les communautés et le régime d'apartheid	Autorité tribale représenté par le chef et les headmen dans chaque communauté Représentants élus des municipalités Formation d'associations de propriété commune
Changements politiques et sociaux			Native Lands Act en 1913 Native Trust Act en 1936 Les officiers agricoles et les magistrats deviennent des représentants locaux du gouvernement.	Expropriation des blancs sur les territoires des réserves Publication du rapport de la commission Tomlinson et institutions de planification des «'améliorations » dans les années 50 Construction de périmètres irrigués dont l'usage reste sous la supervision des officiers agricole	1972: création du territoire d'auto-gestion de Lebowa Retrait de l'état et diminution des subventions	Première élection multi-raciales en 1994 Abolition des mesures raciales de répartition des terres en 1991
Système foncier	Terre possédée et gérée par le Chef Droits d'utilisation des parcelles de mère en belle-fille	Terres possédées par le chef ou ses représentants (headmen) Paiement de 3 rand pour obtenir un accès à la terre Transmission de l'usage des terres de femme à belle-fille	La terre appartient au gouvernement sud-africain représenté par diverses institutions mais elle est gérée par le chef et ses représentants (headmen) L'occupation est basée sur le permis d'occupé (PTO) Les autorités traditionnelles contrôle les PTO qui sont suivi et enregistré par les magistrats locaux du département de l'agriculture Chaque année les occupants doivent payé 13 rands pour chaque parcelle Les PTO sont délivrés aux fermiers hommes. Le droit est exclusif et à vie.	Renforcement du système des PTO et du pouvoir de South African Native Trust dont le rôle d'acheter et d'administrer de territoire des réserves. Système de regroupement en village avec détermination de trois types d'usage des terres: résidentiel, pâture et terres arables Impact importants du rapport Tomlinson Paiement de 13 rands par an pour la parcelle et 5 rand pour chaque tête de bétail (vache ou âne) 10c pour les chèvres et les moutons.	Même chose	Suppression des 13 rands à payer pour l'accès à la terre Superposition du système des PTO et du système traditionnel d'allocation des terres par le chef Disparition des règles communes pour la gestion des ressources communes basiques Plus de planification d'amélioration respectée Dégradation des infrastructures

				Pas de possibilité de vente, d'hypothèque, de location ou de partage et donc terres en conséquence non reconnue par les institutions financières.			
Système agraire	Agriculture	Système d'abatti-brûli (rotation de 10-15ans) Sorgo et mille + plantes comestibles et médicinales collectées	Aires cultivées autour de la maison Rotation des parcelles et des friches de 3 à 5 ans: Friche/ patate douce/mille/sorgo Utilisation des arbres pour la fertilisation Sorgo,patate,patate douce,courge, arachide...	Deux types de systèmes: En montagne même chose qu'auparavant avec introduction du maïs Sur le périmètre irriguée, limitation de la taille des parcelles (1morgen) pas de rotation et pas de jachère:maïs seulement. Fertilisation arborée et fumier	1 morgen par famille. Pas de rotation ni de jachère abandon du fumier et usage de fertilisants chimique.	1 morgen par famille. Pas de rotation ni de jachère Arrêt des cultures de rente et uniquement culture de subsistence: maïs, arachide, courge, système associé Uniquement fertilisation chimique Introduction de l'avocat, mangues, pêches, oignons, carottes et épinard	Même chose
	Élevage	Bétail à l'étable le soir	Bétail, âne, chèvre en étable la nuit	Même chose qu'auparavant mais le nombre de têtes diminue	Pas plus de 5 têtes de bétails par famille. Le bétail en étable la nuit et à la montagne le jour	Bétail seulement sur les aires de pâture Pas plus de 5 têtes de bétails par famille. Le bétail en étable la nuit et à la montagne le jour	Plus de restriction sur le nombre de têtes de bétails Augmentation du cheptel sans contrôle. Dommage aux cultures et sur-pâturage
Mode de formation/supervision		Pas de supervision apparente. Mais contrôle par le chef de l'allocation des terres et de leur usage	Pas de supervision apparente. Mais contrôle par le chef de l'allocation des terres et de leur usage	En montagne: aucune supervision Sur les périmètres irrigués: supervision par les blancs	Activités agricole contrôlé de très près par de département de l'agriculture Beaucoup d'appui technique aux fermiers à travers la méchanisation et l'approvisionnement en intrants Fermiers noires deviennent des ouvriers agricoles plus que des fermiers Introduction de la canne à sucre, du blé (1959) de la tomate, banane (1962) haricots 5années 70) par les officiers agricoles	Aires contrôlées par le gouvernement central à travers des rangers responsable de la gestion de réserves naturelles à proximité	Officier agricole deviennent des conseillers agricoles

ANNEX XIV: LIST OF INTERVIEWS, MEETINGS AND DISCUSSIONS

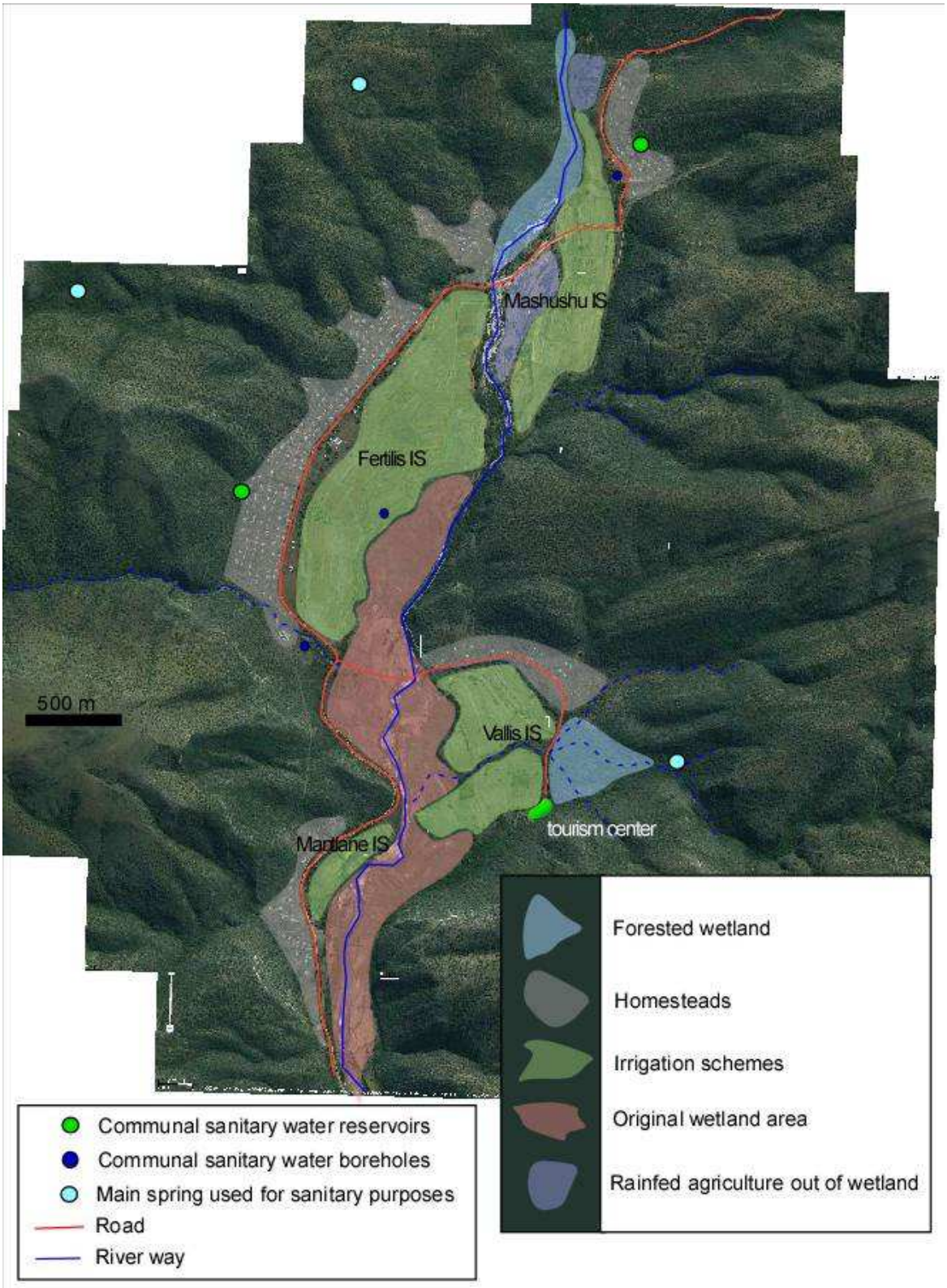
	Aims/Topic	SH	Time	Material	Main Outputs
Interviews	Tourism opportunities in GaMampa	Mr Lovengo (AIR); S. Mbakane (tourism cooperative); Ward councillor; C. Boonzaaier (Univ. Of Pretoria); GaMampa Youth	June-August	interview guide, semi open, notes	Information on tourism center rehabilitation opportunities, conflicts over control of tourism, between villages
	Historical insight	Old people	May-June	id.	information on recent history and lifestyle changes
	Fertilis IS rehabilitation: what objectives	Vela VLK, Consulting engineer for LADC	July	id.	Information on most probable technical orientations, costs
	Fertilis IS rehabilitation: what technical possibilities	C. Stimie in ARC	July - August	id.	Information on possible technical orientations, costs, conflict of interest at national/provincial scale
	Fertilis IS rehabilitation: what objectives	P. Ngoasheng LADC	July	id.	Information on most probable technical/economic/organizational orientations
	MWP : what objectives, implementation process, dificulties	Muncipal engineers LDA (H. Mpapholo)	June	id.	Detail Information on who has power over wetland resources governance.
	Details on farming/water distribution practices for land cover and water needs evaluation	IS farmers, Wetland Farmers	May-July	id.	Information for future agricultural information in IS/wetland. Input data for WETsys
	Mountain Springs water management	informal managers, users (community members)	June	id.	Information on traditional/informal management of water.
	Communal borehole/taps water management	informal managers, users (community members)	June	id.	Information
	WC functioning/objectives/difficulties	WC representative (Z. Mampa); WC members	May	id.	Information on CDF functioning, power balances and conflicts in
	Future irrigation management In Fertilis and rehabilitation of current infrastructure for next cropping season	ex Water Committee leaders, Canal I, II, V, VIII	August	id.	Information / propositions for future rehabilitation of IS (governance and water distribution)
	LDA engineering section: what involvement in IS rehabilitation	Municipal engineers LDA (H. Mpapholo)	June	id.	Information on stakes/conflict of interests in IS rehabilitation at regional level

	Aims/Topic	SH	Time	Material	Main Outputs
Group discussions / workshops	Tourism opportunities in GaMampa	Ward Councilor, AIR, GaMampa decision makers, tourism cooperative	August	proposals from interviews/bibliography	SH reconcialiation, evaluation of opprtunities, planning for future meetings, involvment of AIR in GaMampa tourism projects
				schematization of	
	Future irrigation management In Fertilis and rehabilitation of current infrastructure for next cropping season	ex Water Committee, CDF leader (F.Mampa)	August	id.	Proposals for WUA organisation and management rules. Decision for current infrastructure rehabilitation to be submitted to community. Dynamisation of the water management
	Evaluation of cropping opportunities for future rehabilitation of Fertilis IS	Fertilis IS farmers (10)	July	validation of bibliography,observations and information from interviews	crop list, calendars, production possibilities, farmer's concerns and objectives.
					Submitted for development to LADC for business plan
	Evaluation of business plan opportunities following the Rehabilitation of ISs in Mafefe	Sheryl Makobala from DoA Value Chain office in Lepelle Nkumpi municipality	August	material from workshop with farming community	Communication of Farming community's concerns and socio economic risks in developping a unique production unit
	Livestock grazing management	GaMampa livestock owners	June	notes	information on grazing locations and needs,
	What opportunities for a youth livestock association	GaMampa youth, CRCE	August	notes	dynamics for youth involvment in livestock management: use of wetland for grazing, limitation of roaming.
					Proposal for organisation and rules on livestock management
	SANBI, meeting for future involvement of Working for Wetland in GaMampa	Working for wetland national coordinator (J. Dini), IWMI	July	notes	dynamics for futur involvment of working for wetland in GaMampa and collaboration with IWMI
	WRC, meeting for future involvement	WRC and DWA representatives, IWMI	July	notes	dynamics for futur involvment of WRC in
C					

	Aims/Topic	SH	Time	Material	Main Outputs
Multi SH workshops	DPSIR/Management Options	External: research (WR, Kzn Univ., IWMI, DWA,	April	Existing data from IWMI/Cemagref	Responses, Mos, conceptual framowork for
	Climate change Workshop: what climate scenarios for GaMampa	"external": community representatives, LDA representatives	May		data on climate change scenarios
	validation of management options / evaluation criteria	local: community representatives and members	July	prepared material from interviews/bibliography/discussion	MOs proposal and selection/validation, evaluation criteria
	validation of management options / evaluation criteria	External: decision makers, gvt. Offices, working for wetland	July	prepared material from interviews/bibliography/discussion	Conceptual framework for MOs development, MOs proposal and selection
	Mapping Workshops: wetland zoning for cultivation potential and invasion dynamics	Wetland farmers	June	Satellite pictures, observation from highpoints	Information on invasion logics/dynamics, wetland cultivation potential, soil typology, conflicts between villages for wetland use Maps
Meetings attendance	Presentation of LADC project to farming community	LADC, farming community	August		Observations of the LADC participatory process, evaluation of the offset between community
	MWP first phase assessment	Municipal LDA, LEDET, DWA, Wetland Committee	June		Understanding of MWP objectives, acheivements, strength and weaknesses
	Pumping station for Fertilis rehabilitation, field visit	engineers from Vela VLK and ARC rural engineering	August		Understanding of the rehabilitation process in technical terms

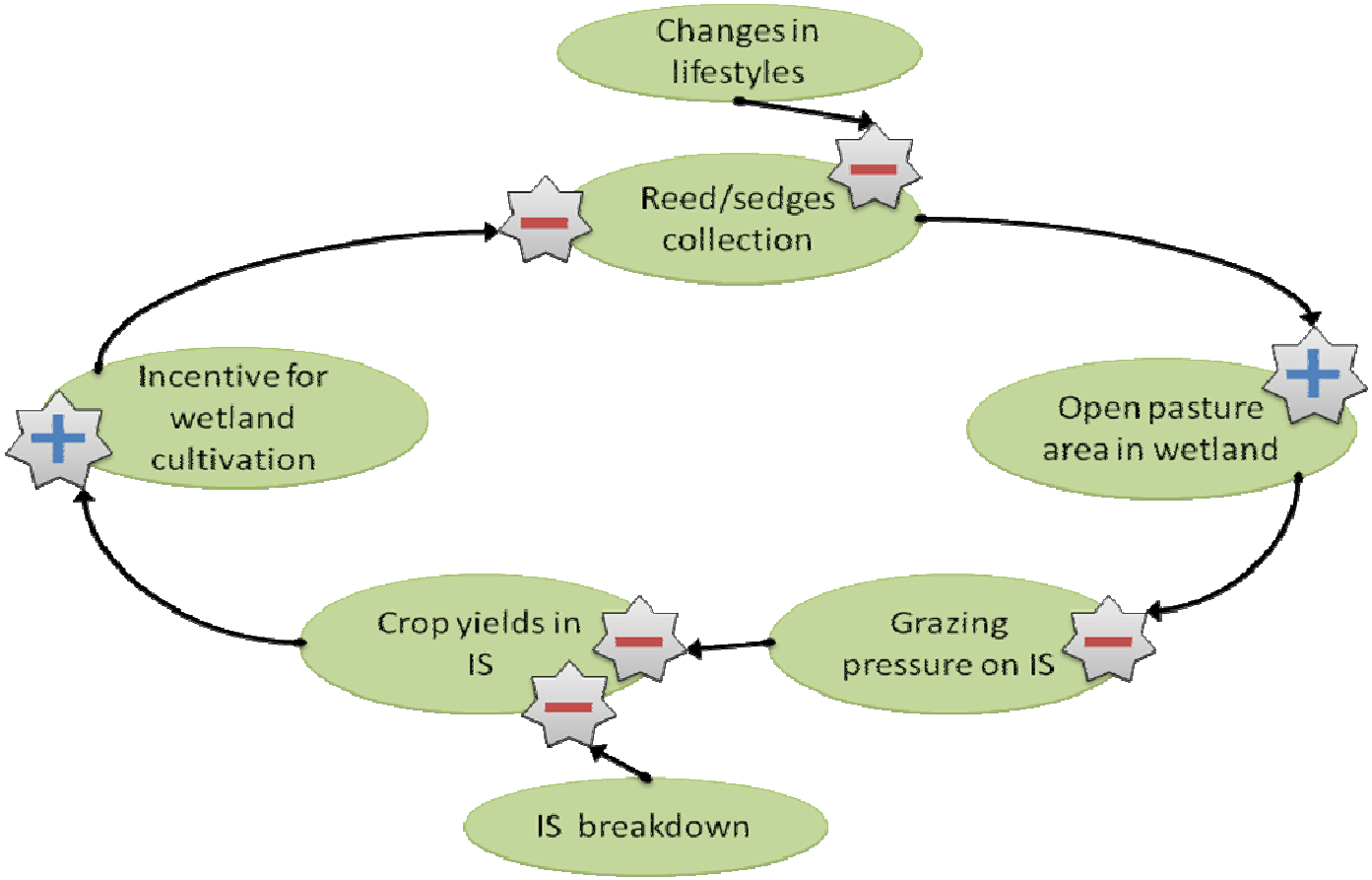
* Interviews and discussions were done in a continuous process to limit

ANNEX XV : MAP OF THE GAMAMPA VALLEY AND LAND USES, AS WITNESSED IN 2010



Source: google earth (background), observations (2010), Kotze 2005

ANNEX XVI : SCHEMATIC REPRESENTATION OF THE "WETLAND INVASION LOOP"



ANNEX XVII : DIFFUSION LIST

Organization	Level	Program	Involvement	Contact person
WRC	National	?	Potential implementation agent (financial, technical, institutional support)	Bonani
				Duncan Hay
SANBI	National	Working for Wetland	Potential implementation agent (financial, technical, institutional support)	J. Dini
	Limpopo			Colleen Silima
Rural integrated engineering company	National	Formerly involved in RESIS	Consultant (Rehabilitation of ISs)	Chris Stimie
University of Pretoria	National	Consultant - tourism	Consultant (tourim)	Chris Boonzaaeir
AWARD	National	Consultant	Potential implementation agent (techncial, institutional support)	Derick Dutoit
LEDET	LEDET polokwane	Limpopo		P. Leshabane
	LEDET Nelspruit	Mpumalanga	Potential implementation agent (financial, technical, institutional, legal support)	Mishak Masindi
	LEDET Lepelle Nkumpi	Leplle Nkumpi	Potential implementation agent technical, institutional, legal support)	Mr Mamorakane
LDA	Limpopo	RESIS – engineering section	implementtion of IS rehabilitation	Peter de Witt
			research	Brilliant Petjam
	Limpopo	Landcare program		Escort Netshikovhela
	Lepelle Nkumpi	Engineering section	Technical and managerial support for rehabilitation of irrigation schemes and development of comercial agriculture	N.A. Mpahlele
		Agribusiness section	implementation, coordination for IS rehabilitation and farmer organisation	Shirley Makobala
DWA	CMA			???
	Limpopo	Limpopo wetland forum	Implementation: legislation, technical spport	Mpho Makhavu
LADC	Rehabilitation of Irrigatio schemes and Mafefe cooperative		Implementation: rehabilitation of the IS and comercial agriculture development Financial, technical and organisational support	Peter Ngoasheng
Lepelle Nkumpi Municipality	Ward	IDP	Ward Councillor - Implementation: coordination, facilitation, especially Wetland Management Plan for IDP	Zebulon Mpophela
	Leplle Nkumpi	Local economic development		Matome Mokoena
AIR	Limpopo		Implementation Tourism	Nelson Lovengo
CRCE	regional		Implementation: coordination, facilitation and technical/organizational support for all Mos, especially land use planning	Ernest Letsoalo Koketso
Community	CDF		Imlpementation	Frank Mampa
				Zaccharia Mampa
				Bernard Mashavela