DIVERSITY OF WETLAND-BASED LIVELIHOODS IN LIMPOPO RIVER BASIN

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Abstract:

Wetlands in the Limpopo Basin support the livelihoods of many poor people through a wide range of environmental services. In some cases, the development of agriculture might alter the wetland environment with potential negative impacts within but also beyond the wetland. As part of a global project aiming at analysing trade-offs between agricultural production and wetland protection, this paper presents the livelihood analysis conducted in the Intunjambili wetland located in the Tuli river basin in Zimbabwe. The objectives of this analysis are threefold: (i) to understand people's livelihood outcomes and strategies and identify the activities they perform in wetlands and the determinants of their choices in using wetland resources; (ii) to build a typology of households according to these strategies and the contribution of wetland resources to them; and (iii) to collect data to quantify the role and importance of wetlands in livelihoods and prepare the ground for economic valuation of wetland goods and benefits.

Based on the Sustainable Livelihood Approach, the analysis uses a combination of formal survey, participatory techniques and monitoring of households activities. In the case study, the results highlight the diversity of wetland uses, and of their contribution to livelihoods. Such contribution involves not only food security and income generation, but also provides households with some specific goods and services that are not related to crop production (e.g. building material, medicinal plants, grazing areas). In the community, households are strongly differentiated in terms of their use and benefit from wetlands use. Overall, the results emphasize the need for adapted and case-based measures for wetlands conservation, and suggest differentiated approaches according to uses and users.

The results will further feed into economic modeling of the livelihood-farming systems and ultimately into an integrated dynamic model representing the interaction between the socio-economic sub-system and the bio-physical sub-system, used as a decision-support tool for wetland management.

Target sub-theme: Water and land, oral presentation

1. Introduction and rationale

The Limpopo River Basin (LRB) is situated in the east of southern Africa between about 20 and 26 °S and 25 and 35 °E. It covers an area of approximately 412 938 km2 (Food and Agriculture Organisation 1997). The basin straddles four countries: Botswana, Mozambique, South Africa and Zimbabwe. The rainy season is short with the annual number of rain days seldom exceeding 50 which makes the area predominantly semi-arid, dry and hot experiencing very low rainfall (below 500mm per year) (Food and Agriculture Organisation 1997). Consequently the LRB has a highly variable and unreliable water flow which results in unreliable water supply (Görgens and Boroto 1999). Wetlands are characterized by rich soils and all year round soil moisture, which makes them favorable for wet and dry season agricultural production They are complex and ecologically sensitive environments that perform ecological functions as well as providing diverse stock of resources that can be harnessed to support livelihoods of poor people through agricultural and non-agricultural activities for food and income goals (Masiyandima *et al.* 2005). However, these habitats are very fragile and susceptible to environmental damage in the presence of unwise and uncontrolled utilization. Therefore, there is a need to involve interactive and iterative participation of all stakeholders to promulgate the sustainable management of these systems.

Acknowledging the important role of wetlands for local communities but in the same time the necessity to preserve their crucial ecological functions, the research project *"Wetlands-based livelihoods in the Limpopo basin: balancing social welfare and environmental security"* under the Challenge Program Water and Food (CPWF)[1] aims at enhancing food security and improving the livelihoods of wetland-dependent communities by increasing productivity of water and optimising and maintaining wetland ecosystem services. More specifically, the project proposes to analyse the mix of wetland uses and the trade-offs among them, to develop guidelines and tools to assist decision-making at various levels (local community, local governments, policy-makers) and to enhance capacity of wetland users, managers and policy makers. Research is conducted in three sites in the Limpopo river basin: the Intunjambili wetland in the Tuli river catchment in Zimbabwe, the Chibuto wetland in the floodplain of the Changane River, a tributary of the lower Limpopo, in Mozambique; and the Ga-Mampa wetland in South Africa.

Intunjambili village is located in the Matobo area which is found in the Matebeleland South province, South-western part of Zimbabwe. The area is about 50 Km South East of Bulawayo City. It lies in agro-ecological region (IV) and is characterized by low rainfall intensity, periodic seasonal droughts whilst severe dry spells during the rainy season are common. Crop production is therefore risky except in certain very favorable localities, where limited drought resistant crops are grown as a sideline. The Matobo area is a place well known for its plethora in surface rocks, hills or *dwalas.* This implies that the area is very much prone to a lot of surface and ground water run-off that emanates from these rocks which lead to generally higher ground water tables that result in areas around these hills or rocks to be seasonally or perennially inundated with water.

The objectives of this analysis are threefold: (i) to understand people's livelihood outcomes and strategies and identify the activities they perform in wetlands and the determinants of their choices in using wetland resources; (ii) to build a typology of households according to these strategies and the contribution of wetland resources to them; and (iii) to collect data to quantify the role and importance of wetlands in livelihoods and prepare the ground for economic valuation of wetland goods and services.

The paper is organized in a way that it first presents literature on various issues pertaining to communal livelihoods that depend on wetlands including the conceptual framework of the study. The

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[1] This research project associates National Agricultural Research Institutions from Zimbabwe, Mozambique and South Africa (University of Zimbabwe, University Eduardo Mondhlane, Institute of Water and Sanitation Development, University of Pretoria, Witswaterand and Limpopo), French research institutions (Cemagref, IRD, Cirad), and the International Water Management Institute (IWMI).

next section will then outline the research methodology and tools that were used for collecting data. The final section of the paper will present the results conclusions and recommendations.

2. Wetland-based livelihoods in the literature

2.1. Wetland ecosystems: interaction between biophysical system and socio-economic system

An ecosystem is a dynamic complex of plant, animal and micro-organism communities and the non-living environment, interacting as a functional unit (Millenium Ecosystem Assessment 2005). The term wetland refers to a variety of inland, coastal and marine ecosystems, which has led to difficulties in deriving a universally accepted definition for all the different types in existence. A widely accepted definition of wetlands is that they are transitional zones, depressions or valleys between permanent and open access water areas and uplands which act as sinks for nutrients draining off from sloppy areas (Guveya 2000; Kundhlande *et al.* 1995). Wetlands around the world differ tremendously in their biological, chemical and physical characteristics, which in-turn determine the processes (photosynthesis, transpiration, biogeochemical cycling, decomposition, etc) that occur and ultimately the structure and ability of the wetland to be a source of a variety of goods and services (Turner *et al.* 2000).

Wetland ecosystems around the world, provide a variety of goods and services such as land for cultivation, water for productive purposes (crops, livestock and construction) and non-productive purposes (washing, bathing and consumption), grazing pastures, fuel-wood, reeds and building materials and other indirect benefits (recreation, flood attenuation, storm buffering) (Schuyt and Brander 2004). These services can be classified into four types, i.e. provisioning, regulating, cultural and supporting services (Millenium Ecosystem Assessment 2005). Provisioning services are the basic supplies or products that people harvest or utilize from wetlands such as reeds, wild fruits, fish and water. Regulating services are benefits obtained from the regulation of ecosystem processes, which include air quality maintenance, water regulation, erosion control, water purification and waste treatment, regulation of human diseases and storm protection. These benefits derived from regulation services are generally non-tangible and indirect to users of the wetland. Cultural services include non-material benefits in the form of spiritual, recreational and aesthetic values that people derive from the wetland. Supporting services are those services that are necessary for the production processes responsible for activities such as soil formation, nutrient cycling and biodiversity (de Groot *et al.* 2002; Turner *et al.* 2003).

Due to the diversity of goods and services provided by wetland ecosystems as well as the existence of diverging livelihood goals between wetland users that result from disparities in terms of physical access to these resources and access to different forms of assets (social, physical, natural, human and financial), the intensity of use strategies employed by users differ tremendously across households (Chiputwa 2006; Masiyandima *et al.* 2004; McCartney and van Koppen 2004). Humans are an integral part of ecosystems and hence influence, and are influenced by, ecosystems through multiple interacting pathways which can broadly be categorized as direct and indirect drivers of change. The dominant direct drivers that lead to changes in wetland ecosystems around the world emanate from changes in land use and cover as a result of establishment or intensification of agricultural activities through removal and introduction of existing and new species respectively; development of infrastructure for irrigation or industry; over-harvesting of resources like fuel-wood, fish, wild animals, reeds, grazing pastures, thatching grass and freshwater and the pollution of water sources that result from the use of external inputs such as inorganic fertilizers and chemicals (Millenium Ecosystem Assessment 2003, 2005).

On the other hand, indirect drivers are linked to the social, economic and political environment which different users are exposed to, which affect the resource use decisions that are made by households. These factors alter the functioning and ability of wetlands to provide services. Examples of indirect drivers are population growth rate, institutions and policies regulating the use of wetlands and economic factors such as globalization, trade and markets. Indirect drivers of change impact on direct drivers through the households' resource use decisions that they affect. On the whole, changes in factors that indirectly affect ecosystems, such as population, technology, and lifestyle can lead to changes in factors directly affecting ecosystems, such as the catch of fisheries or the application of fertilizers to increase food production. The resulting changes in ecosystem characteristics result in changes in ecosystem services provision thereby affect human well-being and poverty, which are expressed in terms of basic material for good life, health, good social relations and security (see Figure 1 for a summary of the relationships between the ecosystem and the socio-economic system).

2.2. The Sustainable Livelihood Framework

The Sustainable Livelihoods (SL) framework initiated by Chambers in the mid-1980s (further developed by Chambers, Conway and others in the early 1990s) can be used to understand how local communities benefit from wetland goods and services. This framework assumes that people may have access to five categories of assets (human, financial, physical, social, and natural) and combine them to achieve their objectives through livelihood strategies (Carney 1998, 1999). A livelihood comprises the capabilities, assets (including both material and social resources) and activities required for a means of living. The social, institutional, organizational and natural context and the vulnerability context in which they are operating influence these strategies. The livelihood outcomes they can achieve contribute in return to the development of their assets (Figure 2).

The SL framework implies a special focus on sustainability. "*A livelihood is sustainable when it can cope with and recover from stresses and shocks and maintain or enhance its capabilities and assets both now and in the future, while not undermining the natural resource base*." (DFID 1999, adapted from Chambers and Conway 1992). A key feature of this framework is that it recognizes users of natural resources, whether poor or not, as actors with assets and capabilities who act in pursuit of their own livelihood goals (Adato and Meinzen-Dick 2002). The SL approach works with people, supporting them to build upon their own strengths and realizing their potential, while at the same time acknowledging the effects of policies and institutions, external shocks and trends.

This approach constitutes a useful framework to understand the complexity of forces that drive rural community choices about the use of natural resources. Of particular importance in an analysis of relations between people and environment are the characterization of natural assets, how they are combined with other categories of assets and how the environment contributes to shaping the vulnerability context of poor rural people. While, in our research, we are particularly interested in the role and contribution of wetlands resources to the livelihood systems, we need to understand also the whole functioning of the household system, in order to be able to assess it.

2.3. Livelihood and farming system typology

The Sustainable Livelihoods framework, as well as the farming system approach before, acknowledges the huge diversity of livelihood systems within rural communities (Ellis 2000; Coomes *et al.* 2004). Rural households may differ by the combination of assets they have access to, the socio-economic conditions in which they take their decisions and the system of activities they perform, in particular cropping, livestock and resource use activities (Bergeret and Dufumier 2002). Household typology appears to be an appropriate tool to describe this diversity and analyse its determining factors. Historically, farm typologies have been developed in order to better design extension interventions and farm development projects (Landais 1998; Perret 1999). In our project the objective of the household typology is to illustrate the diversity of their wetland resource-use activities and their contribution to their livelihood strategies. It may also be used later to formulate recommendations on wetland uses and practices adapted to each category of users.

A wide range of elements condition the behaviour of households in term of natural resource use, and therefore each farm or household typology is specific to the local context and the objectives of the research or development project into which it fits. Nevertheless, experience shows that the following factors are most likely to influence choice of livelihood activities (Bergeret and Dufumier 2002; Coomes *et al.* 2004):

- The importance and composition of the different categories of assets;

- The household demographics (i.e., age, size and composition of the households)
- Their socio-economic conditions, i.e., their relationships with other categories of actors (other farmers, land owners, traders, credit institutions, industries and small businesses, …);
- The local availability of environmental resources;
- And the vulnerability context (the risks and shocks they are exposed to and their ways of copping with them).

Two main types of methods can be used to build household-farm typology: (i) use of multivariate analysis techniques (such as principal component analysis, correspondence analysis and cluster analysis) applied to a large set of factual data collected through a survey of a sample of households so as to identify the most discriminating combinations of variables and the statistical relationships among them; and (ii) direct search of cause-effect relationships between variables based on key informants interviews (Perret 1999; Bergeret and Dufumier 2002). What ever the method used, it must be emphasised that a typology is always a simplified representation of the reality designed for a particular purpose and relative to a specific point in time. Each farm-household type remains heterogeneous and the limits between types may be blur and overlapping. Finally diversity of livelihood system is a dynamic process: each farm-household type has its own evolution over time and the typology cannot be fixed.

2.4. Household characteristics affecting environmental resource utilization

A lot of studies that have explored resource use behaviour by households have asserted that the extent of resource utilization is largely affected and influenced by household asset endowments in the form of physical assets (land, equipment and tools) and non-physical assets (social, human, natural, and financial capital), demographic factors (age, size, and composition of the household) and geographic factors (location of household relative to natural resource) (Adhikari 2002; Coomes *et al.* 2004; Mulugeta 2004). Most of these studies employ multivariate analyses in the form of discrete choice models (e.g. binomial or multinomial Logit, Tobit and Probit models) to investigate how falling in a particular resource use category is affected by the various socio-economic, demographic and geographic factors. On the other hand, multiple regression analyses have been used to investigate how the extent or level of extraction of resources such as fish, fuel-wood and water have been influenced by various independent factors.

Mulugeta (2004) used logistic regression analysis to determine the extent to which the demographic, social and economic backgrounds of the respondents within Kemise wetlands in Ethiopia discriminate wetland cultivators from non-cultivators category. The results suggest that the neediest members of the community are largely unable to cultivate the wetlands mainly due to the prevailing customary as well as formal restrictions on the access and use of wetland resources. Household size, total holding size and ownership of wetland holdings are the leading factors discriminating between wetland cultivators and non-cultivators. The study also concluded that wetland cultivators were mostly male, generally older, less educated with more married and polygamous members and are characterised by larger household size. Another finding was that wetland cultivators suffered less out-migration of family members in the preceding years in comparison to non-cultivators and that cultivators are closely related to each other because they were born in the same *kebele*[2]. In addition, there were more wetland cultivators that were dependent on agricultural incomes compared to non-cultivators who were predominantly dependent on incomes from formal employment.

Adhikari (2002) modeled household production systems and explored how socio-economic characteristics influence household dependency on forest resources in Nepal. The postulated model

[2] *Kebele* is the lowest administrative unit in Ethiopia. In rural areas the term refers to the area under the control of a single peasant association whereas in urban areas it refers to a neighbourhood unit.

was that forest product collection is determined by socio-economic and demographic variables and labour opportunity costs, which are themselves predominantly influenced by farm and non-farm operations. The results showed that household land and livestock holdings, gender, ethnicity and education of household head exert more influence on household labour allocation decisions for forest extraction and gathering activities than other factors. The study also showed that male farmers were also engaged in firewood collection contrary to the conventional belief that it is mainly the female members of the community that engage in such an activity. Finally, it was concluded that poor households are currently facing restricted access to community forest compared to relatively better-off households.

Coomes *et al.* (2004) applied multiple regression models in analyzing the level of extraction of and degree of dependence to environmental resources among forest people in the Pacaya–Samiria National Reserve (PSNR) in Peru. The study was guided by the assertion that in the absence of strong local institutions that regulate resource use, households draw on different natural resources as common-pool or open access resource and as such, extent of resource use is guided by available assets, demographic conditions, and local environmental endowments. The major finding was that resource use or draw is heavily concentrated among a few households within a few villages. Results also show that the role of household wealth, experience and demographics in explaining draw varies significantly across sectors and products and that resource draw is therefore not readily characterized as a strategy of poor or smaller households. Therefore any efforts that target high-draw villages and households for conservation work could well hinge on the need to examine potential differences in explanatory factors all the way down to a specific product or species level.

All the studies reviewed in this section generally confirmed the existence of linkages between the access and extent of use of natural resources and household socio-economic and demographic characteristics. However, factors that determine the use of natural resources vary with local context and the type of resource. Some regularity can be observed as the role of household characteristics such as the size, the gender of the household head and the fact that users of a particular resource are most likely to be related to one another.

3. Method

Based on the review of previous works on environmental resource utilization, we have based our approach on the Sustainable Livelihood framework.

3.1. Data collection

Data on patterns of wetland uses in the community of Intunjambili was collected using a combination of participatory tools and a formal household survey.

Participatory tools

The first phase of the study, which took place in February and November of 2005, consisted in applying participatory rural appraisal tools in order to obtain qualitative information pertaining to how the community utilizes the wetland resources, and the rules, regulations and access rights to these resources. This information was critical in designing the second step of the study, as well as for other research activities. The main tools used at this stage were:

Key informant interviews were held with members and non-members of the community that are regarded as well versed with issues regarding the utilization of wetland resources in the area. Key informants interviewed included the Agricultural Research and Extension (AREX) officer at the Ward Level, a Natural Resource Manager working in the area, the Village Head, the Village Secretary as well as three other members of the community. Information collected through this method was crucial in developing a broad understanding of the main uses of the wetland in the area and the type of users utilizing these resources.

A total of eight *focus group discussions* were held on several issues pertaining to the utilization of wetland resources. Issues discussed in the groups included ranking the most important wetland resources, rules and regulations that govern the access and extent of wetland resources and wealth ranking of community members. This information was used to develop a well informed and more appropriate questionnaire for the baseline survey, as well as a guide for data analysis.

Resource mapping: A small group of about seven villagers, which included the village chief, the secretary of the Village Development Committee and other members of the community were asked to outline the location of different natural features (wetland area, rivers/tributaries, fields, hills) and physical infrastructures such as dam, roads, Business Centre, electricity and telephone lines. The map was further refined through brainstorming with other villagers that were not in the initial group. Besides setting the boundaries of the system under study and outlining the spatial distribution of different natural and physical resources in the community, the process of participatory mapping also gave an indication of the relative importance of resources mapped (Figure 3).

Individual Household survey

The second phase of the study, carried out in November 2005, corresponded to a more substantive baseline survey of about 131 households out of a total village population of about 180 households.

The stratified sample was based on two criteria: (i) the wealth category (wealthy, moderately wealthy and poor), resulting from the wealth ranking exercise undertaken during the first phase, and (iii) the access to wetland plot for cultivation. With regard to the latter, three categories were considered: wetland plot owner within the system, wetland plot owner outside the system[3] and non wetland plot owners.

The questionnaire was designed on the basis of the Sustainable Livelihoods framework. It comprised questions on household demographics, access to different types of assets (physical and natural), use of wetland resources, description of crop production activities (area under cultivation, yield, production costs including labour for various types of land), sources of food and food security, and sources of income.

3.2. Data analysis

Several techniques of descriptive (means, standard deviation, distribution), bivariate (cross tabulation, ANOVA, t-test) and multivariate analyses (logistic regression, multiple correspondence analysis, hierarchical cluster analysis) were used to analyze the data.

Cross-tabulations were used to show the absolute relationship between the fact that a household cultivates in the wetland or not and other categorical variables such as gender, marital status, place of residency, education level of the household head.

A logistic regression model (an un-ordered binary model, with the dependent variable taking one of two responses: cultivator or non-cultivator) was used to investigate the relationships between wetland cultivation and other household characteristics (sex, age and education of head, total land holding, number of draft animals, number of adults staying permanently as a proxy of the available family labor, index of physical assets, quality of housing, distance from homestead to wetland and access to irrigation plot.

Log (Y=cultivator Vs Non-cultivator) = FN (SEXHHEAD, AGEHHEAD EDUCHHD, LANDHLDNG, DRAFT, ADULTMEM, PHYSASS, HOUSQLTY, DISTANCE, IRRIGTN)

where

SEXHHEAD = gender of household head
AGEHHEAD = age of household head
EDUCHHD = education level of household head
DRAFT =number of draft animals (cattle and donkeys)
LANDHLDNG = total area per household (in ha)

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[3] The wetland system under study is defined as the area limited by the main road on the East, the dam on the West, the Intunjambili river on the North and the community irrigation scheme on the South (see Figure 3).

PHYSASS =aggregated physical assets index
IRRIGTN =ownership of plots in the irrigation scheme
HOUSING = quality of housing (0 =low, 1 = high)
DISTANCE = distance (meters) from homestead to wetland
ADULTMEM = adult members between 16 and 65 years at homestead

The null hypothesis for each explanatory variable is that the explanatory variable has no significant bearing in discriminating wetland cultivators from non-cultivators.

Another logistic regression was used to model the effect of socio-economic variables on the likelihood of a household extracting or utilizing non-agricultural amenities from the wetland, using the same set of explanatory variables.

Multiple Correspondence Analysis and Cluster Analysis

Finally multiple correspondence analysis and cluster analysis were performed to identify the most frequent combinations of wetland activities and assess the relationships with other household characteristics. Households were described by two sets of variables: (i) qualitative variables indicating their use of the wetland (wetland plot ownership, location of the wetland plot, use of wetland for grazing, collection of water for domestic use, fishing, cultural purpose, collection of fuel-wood, edible plants, building materials, medicinal plants, and craft material); (ii) qualitative and quantitative variables describing the assets of the households: human assets (gender, occupation, age, residence and education level of the household head, highest education level in the family, size and composition of the family in terms of age classes and gender, income earning activities), physical assets (agricultural equipments, means of transport and communication, domestic assets, type of housing and sanitation); natural assets (access to dry land, wetland and irrigated land for cropping, number of cattle, sources of water used for drinking and cooking, and sources of water used for watering gardens); financial assets (various sources of income). The complete list of variables and their modalities is provided in Annex 1. Continuous variables have been divided into classes on the basis of their distribution. A Multiple Correspondence Analysis[4] was performed on the first set of variables (131 individuals, 11 variables, 22 modalities). Seven factors were kept for further analysis. Then a cluster analysis (ascending hierarchical classification, Ward method, i.e., minimizing the loss of inter-classes inertia resulting from the aggregation of two elements) was performed on the factorial coordinates of the 131 households. The classes obtained were then described using both the wetland use characteristics and other variables used as supplementary variables[5].

4. Results

4.1. Variety of wetlands goods and services provided to households in Intunjambili

Intunjambili wetland uses are very diverse and greatly contribute to community livelihoods. Such contribution involves not only food security and income generation through farming, but also some specific goods and services that are not related to crop production (e.g. building material, medicinal plants, grazing areas). **Error! Reference source not found.** gives the proportion of households engaged in each of the wetland activities and the community perception of the importance of some of these activities for its livelihoods.

More than 3/4 of households own one or more wetland plots that are mainly used for garden and crop production and occasionally as grazing fields. Wetland plots may be located within or outside the studied system. Gardening is ranked as the most important activity as it is an important source of income and food supply. A wide range of vegetables (leafy vegetables, tomatoes, peas and beans) are

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[4] A description of the principles of this analysis is given in Lebart *et al.* 2000.

[5] All the analyses were processed using ADE-4, a free multivariate analysis software developed by a team of ecologists from University of Lyon I (Thioulouse *et al.* 1997, http://pbil.univ-lyon1.fr/ADE-4/ADE-4.html)

grown in these gardens. Crop production, which is ranked as the second most important activity, provides maize, wheat, groundnuts, bambara nuts and pumpkins. Fruit trees (bananas, peaches and guavas) are also a common feature in the wetland.

In addition to crop cultivation the wetland provides a variety of goods that range from wild fruits like *Matamba, Mpumbulu, Chemaswayoa* and *Xaku-xaku* to medicinal herbs, and edible insects. However these activities are not ranked as important by the community. Different resources are collected at different periods of the year depending on availability. Collection of medicinal herbs is done mainly by traditional healers and elderly people in the village. Brick making, collection of reeds, collection of building materials and fuel-wood are some of the most common activities engaged in by households.

Fishing is a regulated activity and only village members are allowed to engage in this activity at the dam site. The most common fish caught are catfishes (*Mirambas)* and breams. Fishing in the area is done by young boys. This could probably be explained by the high effort or low fish catch rate which renders the activity time consuming hence conflicting with labour requirements for other households' activities.

Water from the wetland is harnessed for a variety of purposes within the households, which include drinking, washing, bathing, irrigation, and building among others. It is one of the main household activities in the wetland throughout the year.

4.2. Differences between wetland cultivators and non wetland cultivators in terms of access to different categories of assets

From bivariate analysis summarised in Table 2, it appears that there are some differences in terms of household demographics between wetland cultivators and non-cultivators. Wetland cultivator household heads tend to be more often full-time farmers, who permanently reside at home (hence less out migration) and more often in the older age class (56 years and over). Other demographics characteristics, in particular gender of household head, are not significantly related to wetland cultivation.

In terms of ownership of physical assets, non-cultivators tend to more frequently own transportation assets (vehicles, motorcycles) than wetland cultivators. In terms of endowment of other physical assets (agricultural, non-agricultural and communication), statistical tests show no significant differences between the two groups in terms of the percentage of households having access to this category of assets. However the relation is statistically significant with the average weighted index of both durable consumer goods and productive assets.

Households engaged in wetland cultivation appear to derive more often and more important income from non-agricultural activities. With regards to household perception of importance of wetland activities, wetland cultivators value more gardening and non cultivators more uses such as fishing, collection of building materials and medicinal plants, which are less frequent.

The results of the logistic regression summarised in Table 3 show that there are only three variables that significantly discriminate wetland cultivators from non-cultivators out of the ten variables that were included in the model: access to an irrigation plot, total land area and total draft power. The positive relation between wetland cultivation and access to irrigation plot and total land area may be linked with social connectedness of these households to the elite families that are responsible for allocating strategic resources such as irrigation and wetland plots. On the contrary, the probability of wetland cultivation is negatively linked to the size of herd own by the household.

4.3. Household characteristics affecting household extraction of wetland goods

The logistic regression, which looks at factors influencing wetland natural resources extraction (Table 4), shows that the probability for a household to collect wild fruits or materials for construction purpose or to engage in cultural practices within the wetland is increased if the household is headed by a male-head[6]. Other demographic characteristics influencing wetland resources extraction are the age of the household head which significantly decreases the likelihood of collecting fuel-wood, and the education level of household head, which impact negatively on craft material collection and on the use of wetland for cultural purpose.

The numbers of draft animals that are owned by the household reduce the likelihood of a household drawing wild fruits and building materials from the wetland. This may be attributed to labour competition that exists between livestock herding and harvesting of wetland amenities.

The quality of housing seems to be related positively to the collection of fuel-wood but negatively to building material collection. The distance from the homestead to the wetland negatively reduces the probability of harvesting fuel-wood and craft material, which can easily be explained by higher time requirements for collection associated with a higher distance. And finally, access to more physical assets enhances the probability of utilizing fuel-wood and materials for construction purposes.

As in Coomes et al. (2004) study, this analysis shows that household characteristics influencing the collection of a particular wetland resource vary from one resource to another.

4.4. Typology of households according to their combination of wetland uses

Results of the multiple correspondence analysis

The first 4 axes explained almost 60% of the variability of the dataset (see table of Eigen values and inertia ratio in Annex 2). The variables that contribute most to the first axis are the absence of collection of wood, edible fruits and building materials. The second axis is better explained by the contribution of the collection of craft materials, the absence of use of wetland water for domestic purposes, and the collection of medicinal plants. On the third axis, the absence of wetland plot and the non-use of water contribute most. The fourth axis distinguishes households with no wetland plots and households who use the wetlands for cultural purposes. Modalities of variables are represented on the factorial plan formed by the two first axes in Annex 2.

Results of the cluster analysis

The dendogram of the cluster analysis suggests a partition in 6 classes (see Annex 3). These 6 classes are interpreted using the variables describing wetland uses. The contributions of modalities to the nodes are assessed through the computation of test-values (Table 5).

- Households in class A (31 households) have generally a small number of wetland uses, among the most common within the community (cropping, fuel-wood and water collection). Their wetland plot is frequently located outside the system.
- Households in class B (25 households) use the wetland for a high number of activities including the least common such as fishing, collection of craft materials and medicinal plants, and cultural use.
- Households in class C (25 households) have also a high number of wetland uses. They differ from class B by the fact that they do not collect craft materials. Their wetland plot is more often located outside the system.
- Households in class D (18 households) have no plot in the wetland but use it for livestock grazing, collection of fuel-wood, building materials, edible fruits, and water.
- Households in classes E and F (9 and 23 households respectively) use the wetland mainly for cropping. They are characterized by the absence or low frequency of the other most common uses (grazing, fuel-wood and building materials collection). Class F households differ from class

[6] It is important to note that there are some households where the husband is not staying permanently at home for employment reason and all decisions are made by the wife but are still considered as male headed households.

E by their use of wetland water. Class E households more frequently own a wetland plot within the system than the average.

Linkages between combination of wetland activities and household characteristics

The analysis of relationships between household characteristics and class of wetland uses shows no clear-cutting association (Table 6). However some tendencies appear: clearly the number and variety of wetland uses is associated with large families (classes B and C). It can be explained by the availability of manpower in these households and possibly by the diversity of needs that arise from the different household members in such large families. These households are also the better-off, as illustrated by their access to productive and / or domestic assets. As expected class D households who do not have wetland plots have more often access to other sources of income and their head is less frequently a full-time farmer, although the absence of wetland plot is compensated for some of them by an irrigation plot. Class F households appear to be more oriented towards farming activities, with no or few other sources of income. In terms of human assets, they are characterized by a lower level of education, a low percentage of women and a high percentage of people staying at home permanently. Their physical assets are limited with more often than the average traditional houses of poles and dagga. Class A households have no striking features and can be considered as the "average" wetland users.

5. Conclusion

This paper is a first step in our attempt to understand people's livelihood outcomes and strategies in Intunjambili village. Activities performed in the wetlands have been identified and relations between these activities and general characteristics of wetland users have been sought. This study shows that the use of wetland by Intunjambili community members varies considerably across households. Household combination of wetland uses can be related to certain characteristics of the household such as the size of the family, level of education, physical assets endowment, and other sources of income. However the relationships is not as straightforward as expected and the analysis should not be limited at one dimension of wetland use at a time (e.g., wetland cultivation, collection of wetland natural resources, etc.) but rather consider combination of wetland uses. The study also demonstrates that a high number of wetland-related activities is not necessarily associated with the poorest households in the community. This broadly confirms results from other authors on natural resource use (Adhikari 2002; Coomes *et al.* 2004; Mulugeta 2004). A typology of wetland users have been built based on their combination of wetland activities. This typology would be further improved by quantifying the contribution of wetland –based activities to household livelihoods.

The combination of participatory approaches with a more formal household survey was useful. While the formal survey allows for statistical analysis, information acquired through more participatory tools is necessary to translate statistical relationships highligthed by the analysis into a real understanding of factors that influence wetland resource use. A complete analysis of the pro and cons of both approaches and of their complementarities still need to be done in order to inform further research in this domain.

It proved to be difficult in this study to collect quantitative data on wetland resource use as wetland users seldom keep records of their activities. A monitoring of their wetland-related activities along the year seem to be more appropriate to gather data needed for this quantification.

Based on present results, it can nevertheless be argued that any initiative seeking to influence wetland use to balance livelihood outcomes with conservation of wetland environmental services should be well targeted and designed to fit wetland user characteristics to ensure effectiveness.

As underlined above, this paper presents preliminary results of the CPWF wetland project. Further analysis of data already collected is necessary to improve our understanding of the factors influencing household decision-making about wetland resources. Additional data collection is also planned to enable quantifying wetland contribution to local livelihoods (draw and reliance as suggested by Coomes *et al.* 2004). It is expected that this will improve the farm-household typology in order to better design development-conservation interventions. Furthermore, comparison of results across different sites in the Limpopo River Basin will be necessary to identify regularities in the relations between wetland resource use and assets endowment. The following steps of the research project also include an assessment of the impact of wetland activities on wetland ecosystem functions. All these results will further feed into economic modeling of the livelihood-farming systems and ultimately into an integrated dynamic model representing the interaction between the socio-economic sub-system and the bio-physical sub-system, used as a decision-support tool for wetland management.

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Figure 1: Flow diagram showing the linkages between the wetland ecosystem, socio-economic system and human well-being. Adapted from the Millenium Ecosystem Assessment (2003)

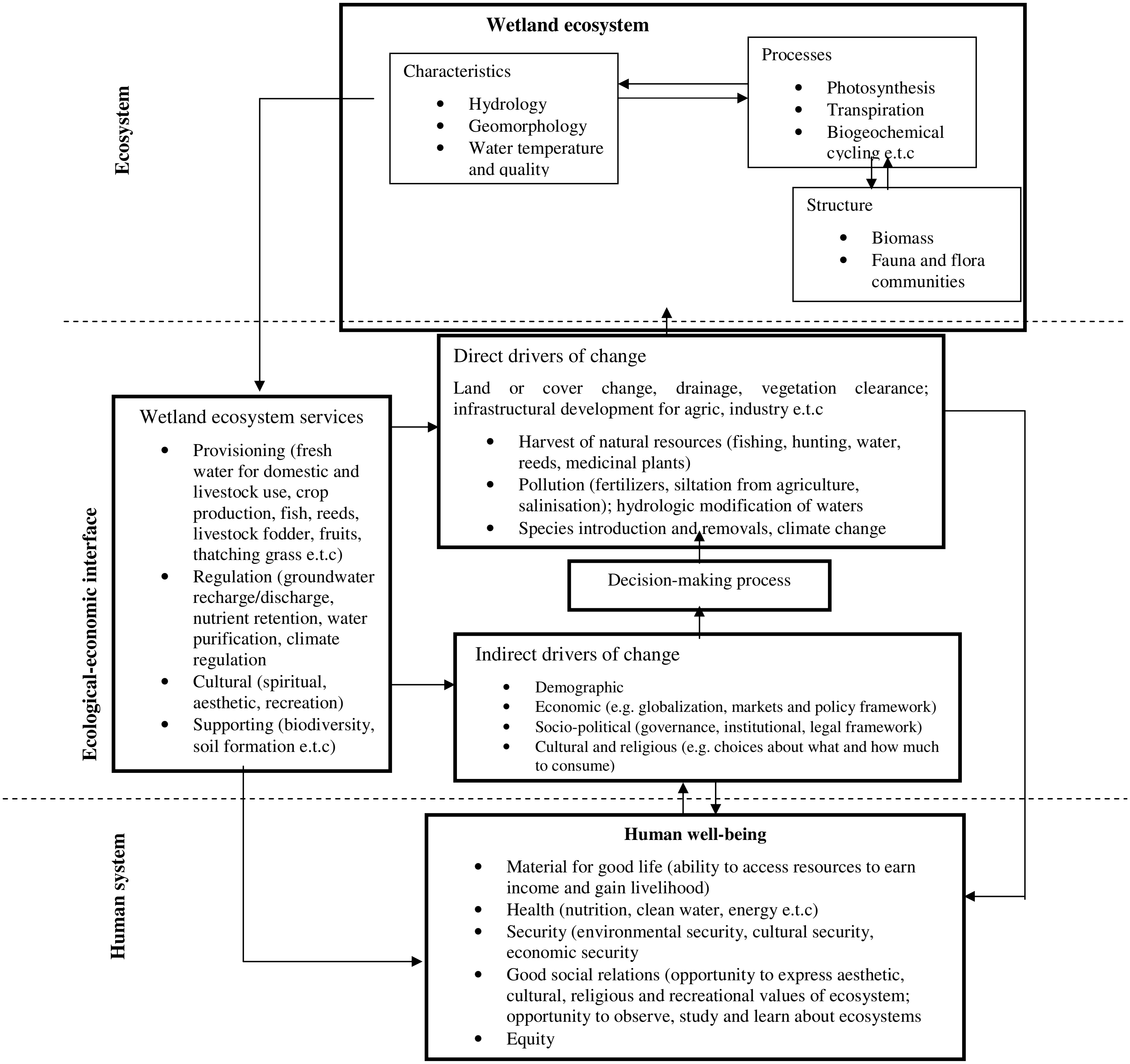


Figure 2: The sustainable livelihood framework (Masiyandima *et al.* 2005)

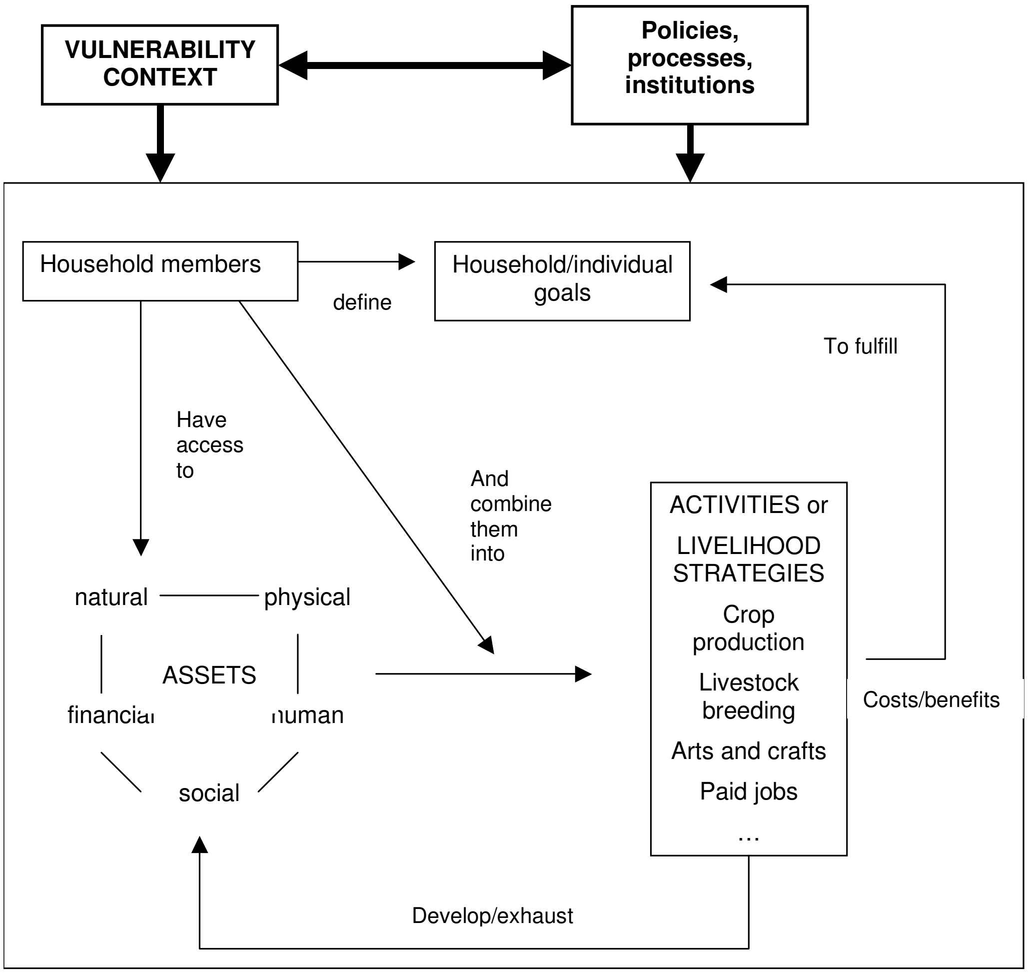


Figure 3: Participatory Resource Map of Intunjambili Village

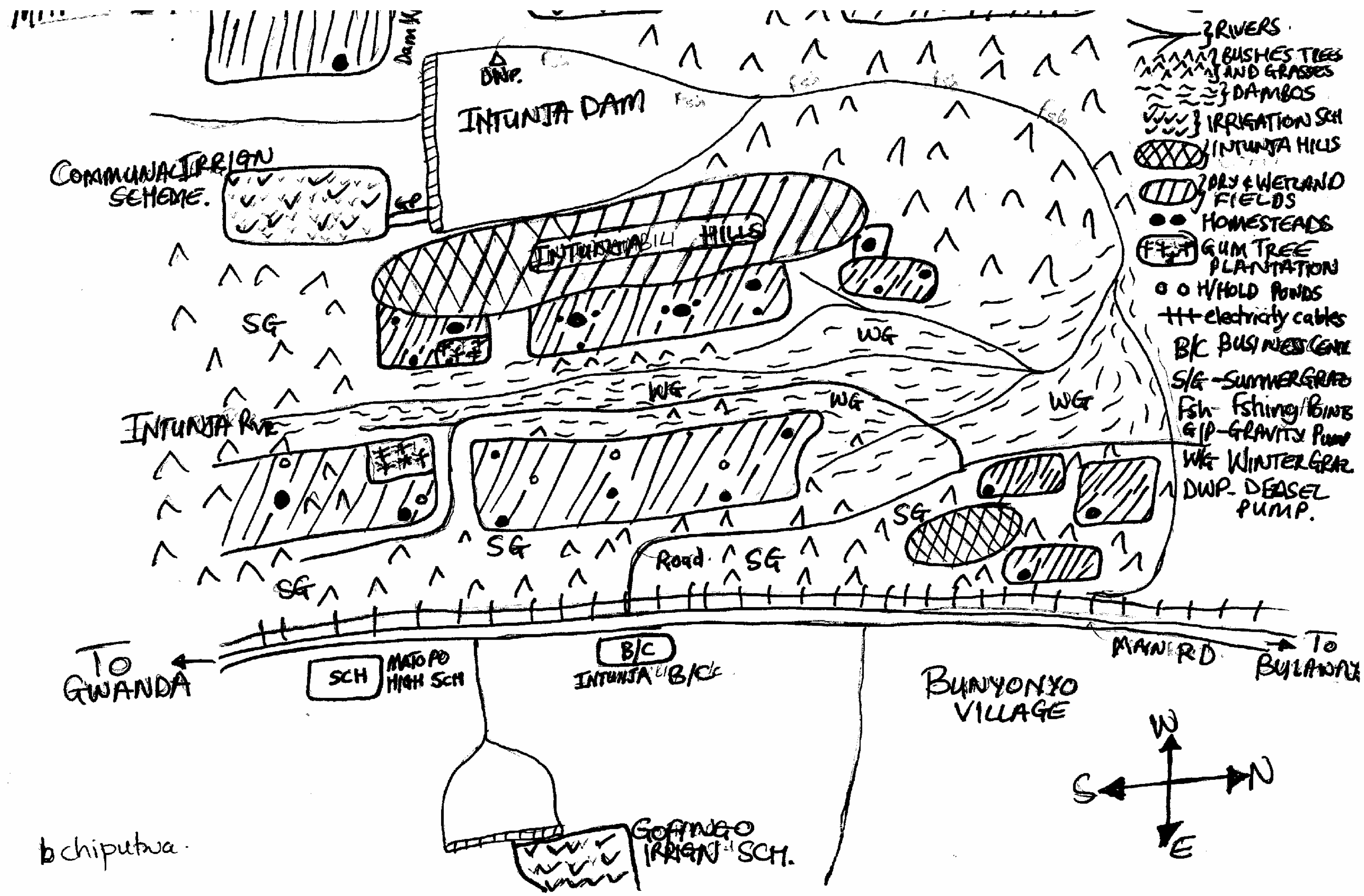


Table 1: Community ranking of wetland activities and occurrence within the household sample

Wetland Activity	Brief description	Rank	Frequency
Gardening	Important crops grown include vegetables such as Rape, *Chomolia,* peas and beans, which are a major source of income as well as food for most families.	6	77%
Crop production	Maize is one of the most common crops cultivated and is usually double cropped in August and November. It is normally intercropped with ground/round nuts	5	
Livestock grazing and watering	Grazing is mainly done in the dry season, May to September, to avoid livestock being trapped in the mud. Watering of animals occurs throughout the year at drinking points along the river and dam	4	71%
Domestic water collection	The wetland is the main source of water for a variety of domestic purposes such as drinking, bathing, watering of small livestock. Availability of water in wetland wells depends on the rainfall intensity and amount of discharge each year.	3	93%
Fruit production	Like crop production, it is a source of food and income. Common fruit trees grown are Bananas, mangoes, guavas and oranges.	2	
Fishing	Important crops grown include vegetables such as Rape, *Chomolia,* peas and beans, which are a major source of income as well as food for most families.	1	24%
Collection of fuel-wood		nr	74%
Collection of edible fruits		nr	62%
Collection of building materials		nr	56%
Collection of medicinal plants		nr	42%
Cultural use		nr	34%
Collection of craft materials		nr	28%

Order of Ranking: 6 most important, 1 least important, nr: not ranked Source: Chiputwa 2006

Table 2: Statistical relationships between wetland cultivation and other characteristics of households

		Total (N=131)	*Non-cultivators (N=30)=23%*	*Cultivators* (N=101)=77%	Test of association
		Characteristics of household head (proportion of households)			
Age class	Young aged (=<35) (%)	11.2	7.7	12.1	2.37*
	Middle aged (36-55) (%)	52	65.4	48.5	
	Mature (>=56) (%)	36.8	26.9	39.4	
Residential status	Stays home (%)	77.9	56.7	84.2	10.14***
	Stays home and away(%)	22.1	43.3	15.8	
Farming	Part time farmer (%)	30.23	48.28	25	5.77**
	Full time farmer (%)	69.77	51.72	75	
		Type of physical assets			
Mobile assets (1)	Proportion of households	44.6	63.3	39	5.53**
	Average weighted index of assets (standard deviation)		13.44 (16.01)	7.47 (11.59)	1.90**
Durable consumer goods (2)	Proportion of households	4.6	3.3	5	0.15
	Average weighted index of assets		3.75 (14.37)	10.13 (26.45)	-1.71**
Productive aggregated assets (3)	Proportion of households	76.2	86.7	73	2.37
	Average weighted index of assets		5 (20.13)	15 (38.6)	-1.88**
Overall access (4)	Average weighted index of assets		47.52 (30.12)	43.92 (29.42)	0.59
		Source of income			
Employment	Proportion of households	43.9	55.6	40	1.98
	Average income/year (ZW$*1000)		4,320 (6,577)	5,847 (12,308)	-1.41
Non-agric activities	Proportion of households	30.5	15.4	35.4	3.72*
	Average income/year (ZW$*1000)		650 (2,265)	10,442 (55,270)	-1.55
Crop production	Proportion of households	32.1	26.9	33.8	0.52
	Average income/year (ZW$*1000)		3,130 (15)	2,297 (7,330)	0.64
Remittances from other sources	Proportion of households	3.8	3.8	3.8	0
	Average income/year (ZW$*1000)		19 (96)	0 (0)	-
Total income	Average income/year (ZW$*1000)	-	15,818 (19,378)	26,452 (66,571)	-0.52
		Importance of wetland activities			
Gardening	% of hholds ranking as important	96.90	90.00	99.0	6.34 ***
	Average ranking	4.78 (0.68)	4.40 (1.22)	4.89 (0.34)	3.62 ***
Fishing	% of hholds ranking as important	6.90	13.30	5.00	2.54 *
	Average ranking	1.32 (0.91)	1.53 (1.25)	1.26 (0.77)	1.47 *
Building materials	% of hholds ranking as important	39.70	56.70	34.70	4.68 ***
	Average ranking	2.78 (1.74)	3.37 1.75)	2.60 (1.70)	2.14 ***
Medicinal plants	% of hholds ranking as important	32.80	56.70	25.70	10.03 ***
	Average ranking	2.40 (1.57)	3.07 (1.60)	2.20 (1.52)	2.72 ***

(1) tractor, vehicle, trailer, motorcycle, bicycle, (2) stove and fridge, (3) agricultural, non agricultural, transport and communication, (4) productive and domestic (durable goods, housing, sanitation)

*, **, *** significance at 90%,95%, 99% **Source:** Chiputwa 2006

Table 3: Results of the logistic regression model with wetland plot cultivation as the dependent variable

Variable	*β*	S.E.	Exp (*β*)/Odds ratio	Wald statistic
SEXHHEAD(1)	0.66	0.67	1.93	0.96
AGEHHEAD	-0.01	0.02	0.99	0.27
EDUCHHD	0.10	0.07	1.10	2.02
LANDHLDNG	0.56	0.26	1.75	4.72**
DRAFT	-0.15	0.07	0.86	4.06**
ADULTMEM	0.10	0.13	1.11	0.60
PHYSASS	0.12	0.53	1.12	0.05
HOUSQLTY(1)	-0.43	0.59	0.65	0.54
DISTANCE	0.0003	0.0004	1.0003	0.42
IRRIGTN(1)	1.80	0.66	6.04	7.43***
Constant	-1.04	1.60	-	0.42
Goodness of fit	116.02**			
Nagelkerke R^2	0.26			
-2 log likelihood	97.659			
% correct	82.91%			

*, **, *** Significance at 90%, 95%, 99% **Source:** Chiputwa 2006

Table 4: Factors affecting household decision to extract wetland goods

Explanatory variable	**Statistics on the following wetland uses**									
	Wild fruits		**Fuel-wood**		**Building materials**		**Craft material**		**Cultural practices**	
	β (Odds Ratio)	z-score	**β** (Odds Ratio)	z-score	**β** (Odds Ratio)	z-score	**β** (Odds Ratio)	z-score	**β** (Odds Ratio)	z-score
Wetland plot	**0.83** (2.30)	0.81	**-1.29** (0.28)	-0.79	**0.43** (0.33)	-1.16	**0.51** (1.67)	0.42	**0.68** (0.40)	-0.87
Sex of head	**2.08** (8.04)	2.36***	**1.09** (2.98)	0.91	**0.36** (11.76)	2.34***	Dropped	Dropped	**0.53** (7.80)	1.54*
Age of head	**-0.01** (0.99)	-0.24	**-0.07** (0.93)	-1.75*	**-0.03** (0.97)	-0.96	**-0.03** (0.97)	-0.64	**0.53** (0.99)	-0.51
Education of head	**-0.05** (0.95)	-0.57	**-0.13** (0.88)	-1.01	**0.31** (0.86)	-1.57	**-0.16** (0.85)	-1.31*	**0.19** (0.82)	-1.89**
Draft animals	**-0.21** (0.81)	-1.81**	**-0.20** (0.81)	-1.09	**0.28** (0.79)	-2.09**	**-0.07** (0.93)	-0.43	**0.67** (0.92)	-0.69
Total income	**3.03E-09** (1.00)	0.35	**6.49E-08** (1.00)	1.32	**0.19** (1.00)	-0.15	**-9.85E-9** **(1.00)**	-0.32	**0.75** (1.00)	-0.31
Number of adults	**-0.13** **(0.88)**	-0.67	**0.06** (1.06)	0.26	**0.80** (1.27)	1.42	**0.12** (1.13)	0.57	**0.57** (0.97)	-0.16
Housing	**1.27** (3.56)	1.28	**1.97** (7.15)	1.56*	**-1.92** (0.22)	-1.65*	**-2.00** (0.14)	-1.39	**0.16** (1.86)	0.46
Distance	**2.18E-04** (1.00)	0.36	**-2.27E-03** (1.00)	-2.4**	**0.02** (1.00)	-1.26	**-2.16E-3** (1.00)	-1.65*	**0.10** (1.00)	0.27
Physical assets	**-0.60** (0.55)	-0.27	**9.07** (8678.38)	1.51*	**0.13** (83.54)	1.85*	**-3.09** (0.05)	-0.47	**0.64** (1.51)	0.13
Constant	-0.44	0.868	5.15	1.39	0.17	0.04	0.97	1.06	0.29	-0.16
Goodness of fit	14.75*		22.20***		15.72*		14.96*		8.53	
R^2	0.203		0.370		0.195		0.230		0.183	
% correct	77.97		81.36		72.88		76.11		86.44	

( ) odds ratio; *, **, *** Significance at 90%, 95%, 99% **Source:** Chiputwa 2006

Table 5: Wetland uses according to the different classes of households determined by cluster analysis

	Class A	Class B	Class C	Class D	Class E	Class F
Collection of water for domestic uses					--	
Cropping	+		+	--		
Collection of fuel-wood	+	+		+	-	--
Grazing		+	+		-	--
Collection of edible fruits		+	+			--
Collection of building materials		+		+	-	--
Collection of medicinal plants	-	++				
Cultural use	-	+	++			-
Collection of craft materials	-	++	-			
Fishing		+				-

Legend: A + and blue color (respectively – and red color) indicates that the frequency of the use (resp. of the non-use) is higher in the class than in the total sample (test-value greater than 2). A double sign (or a more intense color) indicates that the contribution of the variable to the class is highly significant (test-value greater than 5).

Table 6: Household characteristics significantly associated with the various combinations of wetland uses

	Class A	Class B	Class C	Class D	Class E	Class F
Household demographics	more unemployed household heads more family heads aged between 55 and 64 and lower over 65 less family heads with no education more households with no member over 65 more hh with no self-employed member	More large families (7-8 members)	More large families (9 members and over)	More family head temporarily employed, self-employed and unemployed; less full time farmer Less family head aged between 55 and 64 More family head with 6-9 years of education	More family head aged 65 and over more households with members over 65	More family heads farm laborer More family head with no education More households with less than 30% of women More hh with all members staying at home
Physical assets	More households with solar power system	More hh with tractor, bicycle, radio, television, telephone,	More hh with bricked house Less hh with pit latrine	More hh with bicycle		More hh with house in dagga and poles and pit latrines
Natural assets	More hh with wetland plot Less hh using homestead water for drinking	Less hh using wetland water for drinking	More hh with wetland plot	More hh with no wetland plot More hh with irrigation plots		More hh using communal tap water for watering gardens
Financial assets	More hh with non agricultural activities as a source of income Less hh with farming as a source of income	More hh with remittances as a source of income		More hh with an outside job as a source of income Less hh with farming as a source of income	More hh with farming as a source of income	Less hh with an outside job or non-agricultural activity as a source of income More hh with farming as a source of income
Number of activities in the wetland	Less hh with 1-3 activities and 8-10 activities More hh with 4-5 activities	Less hh with 1-7 activities and more with 8-10 activities	Less hh with 1-3 activities More with 6-7 activities	Less hh with 1-3 activities	More hh with 1-3 activities Less hh with 6-7 activities	More hh with 1-3 activities Less hh with more than 6 activities

Hh: households
Note: are indicated in the table the variables for which the test-value is greater than 2

Annexes

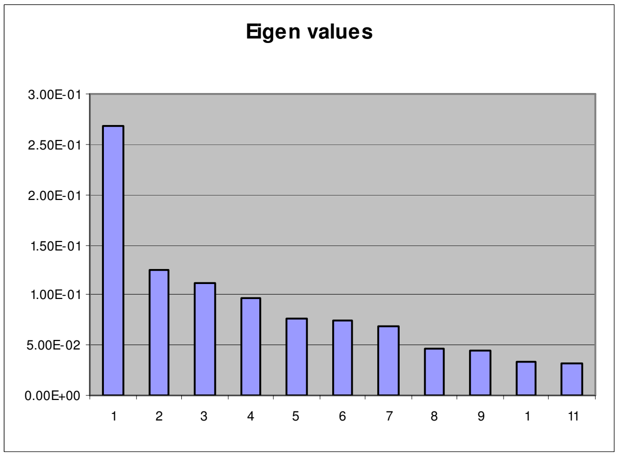
Annex 1: List of variables used for the data analysis of wetland uses

Variable	Modalities	Code	Number of households
Characterization of wetland use			
Wetland plot ownership	No	WETP1	30
	Yes	WETP2	101
Location of wetland plot	Within System	LOCP1	37
	Outside System	LOCP2	64
Grazing in wetland	No	GRAZ1	38
	Yes	GRAZ2	93
Utilization of wetland water for domestic purposes	No	WAT1	9
	Yes	WAT2	122
Fishing in the wetland	No	FISH1	100
	Yes	FISH2	31
Use of wetland for cultural purposes	No	CULT1	87
	Yes	CULT2	44
Collection of fuel-wood in the wetlands	No	WOOD1	34
	Yes	WOOD2	97
Collection of edible fruits in the wetlands	No	FRUI1	50
	Yes	FRUI2	81
Collection of building materials in the wetlands	No	BUIL1	58
	Yes	BUIL2	73
Collection of medicinal plants in the wetlands	No	MED1	76
	Yes	MED2	55
Collection of craft materials in the wetlands	No	CRAF1	95
	Yes	CRAF2	36
Characterization of household assets			
Gender of household head	Male	SEXH1	96
	Female	SEXH2	35
Occupation of household head	Permanently employed	OCCH1	17
	Not permanently employed	OCCH2	4
	Self-employed	OCCH3	15
	Full-time farmer	OCCH4	70
	Farm labourer	OCCH5	1
	Unemployed	OCCH6	19
	Other	OCCH7	2
Residential status of household head	Stays at home permanently	RESH1	102
	Does not stay at home permanently	RESH2	29
Age of household head	Below 42	AGEH1	28
	42 to 54	AGEH2	43
	55 to 64	AGEH3	22
	65 and over	AGEH4	32
Education level of household head	No education	EDUH1	31
	1 to 5 years	EDUH2	20
	6 to 9 years	EDUH3	51
	10 years and over	EDUH4	25
Highest education level in the family	0 to 5 years	EDUF1	9
	6 to 10 years	EDUF2	30
	11 years	EDUF3	69
	12 years and over	EDUF4	23
Size of the family	Less than 5 members	SIZF1	16
	5 to 6 members	SIZF2	42
	7-8 members	SIZF3	35
	9 members and more	SIZF4	38
Percentage of children	Less than 20%	CHLD1	27
	20-34%	CHLD2	36
	35-49%	CHLD3	18
	50% and over	CHLD4	47
Percentage of young adults (16-24 years old)	0%	YADU1	45
	1-20%	YADU2	26
	20-29%	YADU3	24
	30% and over	YADU4	33
Percentage of adults between 25 and 64	Less than 20%	ADUL1	22
	20-34%	ADUL2	47
	35-49%	ADUL3	25
	50% and over	ADUL4	34
Adults aged 65 and older	No	ELDE1	94
	Yes	ELDE2	34
Percentage of women adults	Less than 30%	WOME1	19
	30-49%	WOME2	25
	50-66%	WOME3	49
	67% and over	WOME4	35
Percentage of adults staying at home permanently	Less than 50%	STYH1	27
	50 to 99%	STYH2	47
	100%	STYH3	54

Variable	Modalities	Code	Number of households
Adults with a permanent job	No Yes	PERJ1 PERJ2	90 38
Adults self-employed	No Yes	SLFE1 SLFE2	100 28
Adults with a temporary job	No Yes	TEMJ1 TEMJ2	112 16
Ox-plough ownership	No Yes	OXPL1 OXPL2	55 75
Trailer ownership	No Yes	TRAI1 TRAI2	75 55
Tractor ownership	No Yes	TRAC1 TRAC2	127 3
Irrigation equipment ownership	No Yes	IRRQ1 IRRQ2	126 4
Vehicle ownership	No Yes	VEHI1 VEHI2	119 11
Bicycle ownership	No Yes	BICY1 BICY2	90 40
Sewing machine ownership	No Yes	SEWM1 SEWM2	108 22
Radio ownership	No Yes	RADIO1 RADIO2	83 47
Television ownership	No Yes	TV1 TV2	115 15
Telephone ownership	No Yes	PHON1 PHON2	128 2
Stove ownership	No Yes	STOV1 STOV2	123 7
Solar power ownership	No Yes	SOLA1 SOLA2	114 16
Housing	Improved (bricks and asbestos or iron) Traditional (poles and dagga)	HOUS1 HOUS2	102 28
Sanitation	No toilet Pit latrine Ventilated pit latrine	SANI1 SANI2 SANI3	51 18 61
Access to dryland plot	Yes No	DRYL1 DRYL2	124 7
Access to wetland plot	No Yes	WETL1 WETL2	35 96
Access to irrigation plot	No Yes	IRRIL1 IRRIL2	108 23
Source of drinking water	Homestead Dryland Wetland Downstream	DRNK1 DRNK2 DRNK3 DRNK4	19 34 63 14
Source of water for gardening	Communal tap Borehole Dam Well/pond River/stream	GDER1 GDER2 GDER3 GDER4 GDER5	4 13 4 96 8
Employment as a source of income	Yes No	EMPL1 EMPL2	47 60
Non-agricultural activities as a source of income	Yes No	NOAG1 NOAG2	32 73
Farming as a source of income	Yes No	FARM1 FARM2	34 72
Remittances as a source of income	Yes No	REMT1 REMT2	4 102
Number of cattle owned	Without cattle 1-3 heads 4-6 heads 7 and more	CATL1 CATL2 CATL3 CATL4	50 31 28 22
Number of wetland activities	1-3 activities 4-5 activities 6-7 activities 8-10 activities	ACTW1 ACTW2 ACTW3 ACTW4	25 35 42 29

Annex 2: Results of the Multiple Correspondence Analysis on wetland uses

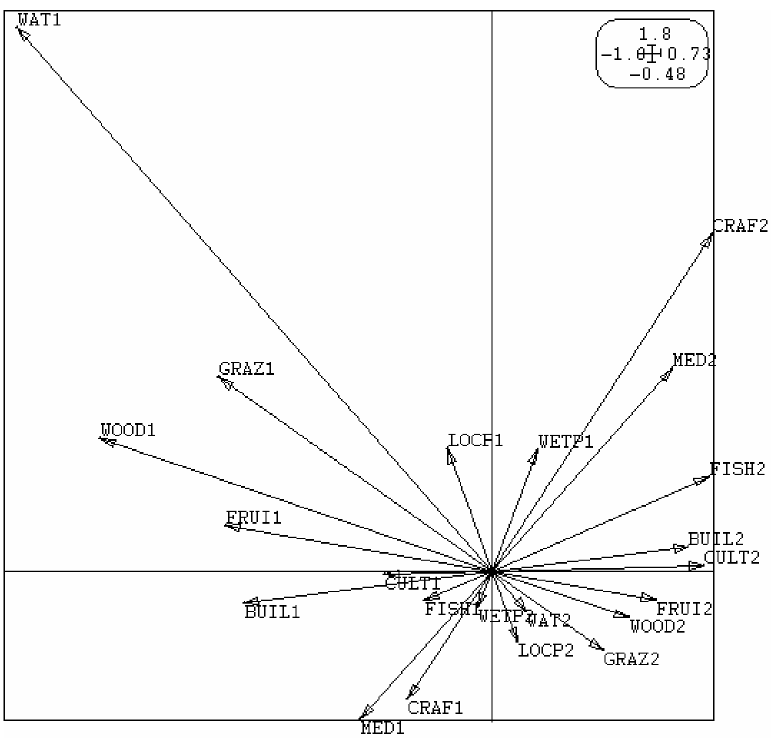
Eigen values graph



Eigen values, inertia ratio of each axis and cumulative inertia

Axis number	Eigen value	Inertia ratio	Cumulative inertia
1	2.68E-01	0.2737	0.2737
2	1.26E-01	0.1283	0.4021
3	1.12E-01	0.1141	0.5162
4	9.77E-02	0.0998	0.6159
5	7.67E-02	0.0783	0.6942
6	7.38E-02	0.0754	0.7696
7	6.93E-02	0.0708	0.8404
8	4.71E-02	0.0481	0.8885
9	4.47E-02	0.0456	0.9341
10	3.35E-02	0.0342	0.9683
11	3.10E-02	0.0317	1

Representation of categorical variables in the factorial plan 1-2



Coordinates, absolute contributions and relative contributions of variables to factors

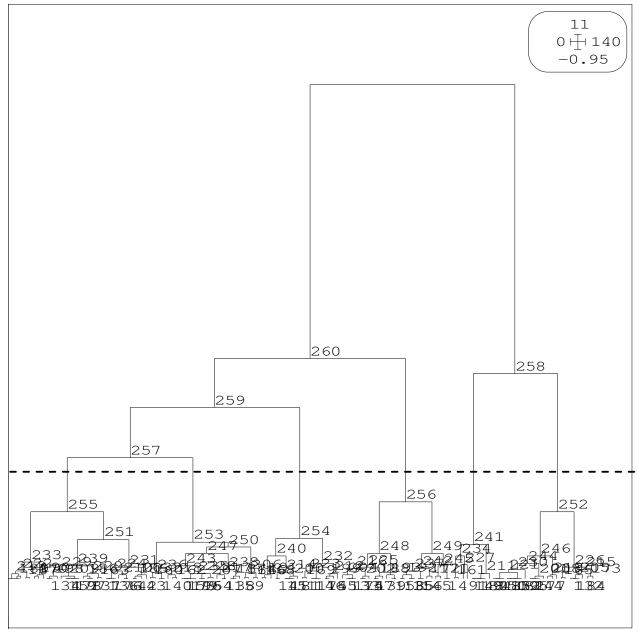
	Coordinates				Absolute contributions				Relative contributions			
	Fac 1	Fac 2	Fac 3	Fac 4	Fac 1	Fac 2	Fac 3	Fac 4	Fac 1	Fac 2	Fac 3	Fac 4
WETP1	0.149	0.391	1.192	0.762	17	252	**2645**	**1237**	65	453	4217	1725
WETP2	-0.044	-0.116	-0.354	-0.226	5	75	785	367	65	453	4217	1725
LOCP1	-0.147	0.393	-0.522	0.468	26	409	813	746	161	1158	2045	1642
LOCP2	0.085	-0.227	0.302	-0.271	15	236	470	431	161	1158	2045	1642
GRAZ1	-0.895	0.621	0.268	-0.31	788	810	169	259	3272	1577	292	392
GRAZ2	0.366	-0.254	-0.109	0.127	321	331	69	106	3272	1577	292	392
WAT1	-1.556	1.745	-1.877	0.878	563	**1513**	**1969**	492	1785	2246	2599	568
WAT2	0.115	-0.129	0.138	-0.065	41	111	145	36	1785	2246	2599	568
FISH1	-0.221	-0.094	0.174	-0.155	125	48	188	171	1569	283	976	777
FISH2	0.711	0.302	-0.561	0.501	406	156	606	552	1569	283	976	777
CULT1	-0.352	-0.01	0.253	0.366	279	0	344	829	2453	1	1262	2654
CULT2	0.697	0.02	-0.5	-0.724	552	0	682	**1640**	2453	1	1262	2654
WOOD1	-1.281	0.425	0.178	-0.504	**1445**	339	66	613	**5755**	634	110	890
WOOD2	0.449	-0.149	-0.062	0.177	506	119	23	215	**5755**	634	110	890
FRUI1	-0.872	0.148	0.16	0.198	**984**	60	79	139	**4696**	135	157	241
FRUI2	0.538	-0.092	-0.099	-0.122	607	37	48	85	**4696**	135	157	241
BUIL1	-0.811	-0.1	-0.164	-0.349	**988**	31	97	501	**5232**	79	214	967
BUIL2	0.645	0.079	0.131	0.277	785	25	77	398	**5232**	79	214	967
MED1	-0.429	-0.471	-0.252	0.296	362	**931**	300	473	2546	3068	879	1211
MED2	0.593	0.651	0.349	-0.409	501	**1287**	415	653	2546	3068	879	1211
CRAF1	-0.274	-0.411	0.006	0.043	184	884	0	12	1979	**4449**	1	48
CRAF2	0.723	1.084	-0.017	-0.114	486	**2334**	0	33	1979	**4449**	1	48

Annex 3: Results of the cluster analysis

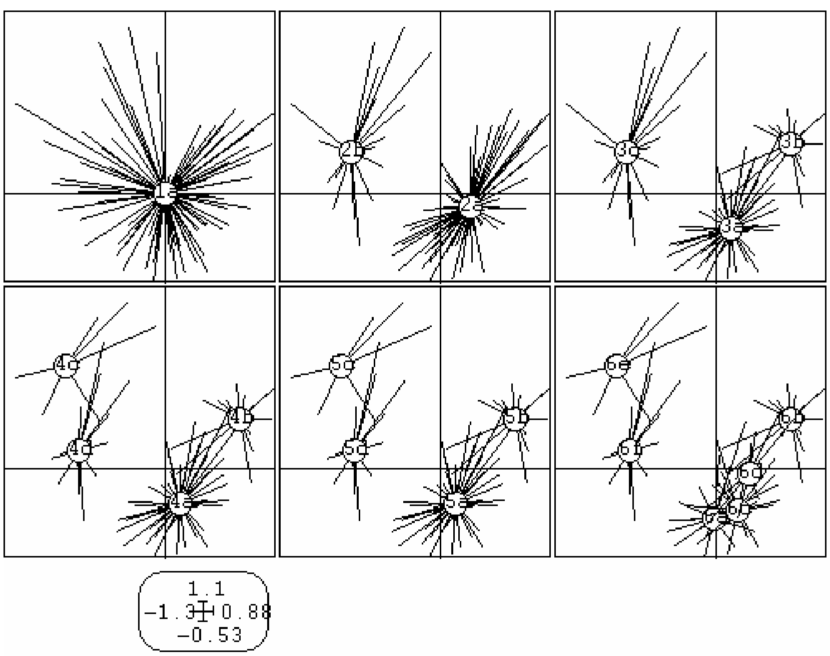
Composition of highest level nodes

Node	elder	younger	Number of elements	Level index
261	260	258	131	9.449
260	259	256	99	4.208
259	257	254	74	3.274
258	241	252	32	3.930
257	255	253	56	2.319
256	248	249	25	1.456
255	233	251	31	1.276
254	240	232	18	0.769
253	236	250	25	0.692
252	246	226	23	1.272
251	239	231	23	0.741
250	247	206	21	0.612
249	242	245	12	0.478
248	225	193	13	0.470
247	243	238	17	0.478
246	244	219	15	0.443
245	171	149	4	0.246
244	230	201	12	0.285
243	218	235	11	0.236
242	237	172	8	0.202
241	234	211	9	0.654

Dendogram of the hierarchy



Representation of the partition in the factorial plan 1-2



Each graph represents the position of elements (the households) and of classes for successive levels of the hierarchy. The first node 1a, which gather all the elements, is divided into nodes 2a and 2b along the first axis. Then 2a is split into 3a and 3b, along the 2nd axis, etc…

Test-values

Classes	Class a	Class b	Class c	Class d	Class e	Class f
WETP1	**-3.460**	-1.436	**-3.018**	**8.350**	-0.869	1.488
WETP2	**3.460**	1.436	**3.018**	**-8.350**	0.869	-1.488
LOCP1	-0.344	0.954	0.462	**-2.855**	**4.172**	-1.268
LOCP2	**3.218**	0.348	**2.121**	**-4.448**	**-3.027**	-0.108
GRAZ1	-0.448	**-2.563**	**-2.563**	-1.795	**3.328**	**5.207**
GRAZ2	0.448	**2.563**	**2.563**	1.795	**-3.328**	**-5.207**
WAT1	-1.724	-1.504	-1.504	-1.236	**11.402**	-1.429
WAT2	1.724	1.504	1.504	1.236	**-11.402**	1.429
FISH1	-0.320	**-3.692**	0.998	0.749	0.105	**2.391**
FISH2	0.320	**3.692**	-0.998	-0.749	-0.105	**-2.391**
CULT1	**4.515**	**-3.097**	**-7.786**	1.630	1.474	**3.742**
CULT2	**-4.515**	**3.097**	**7.786**	-1.630	-1.474	**-3.742**
WOOD1	**-3.291**	**-3.278**	-0.752	**-2.694**	**2.876**	**8.365**
WOOD2	**3.291**	**3.278**	0.752	**2.694**	**-2.876**	**-8.365**
FRUI1	-1.194	**-2.071**	**-2.983**	-1.494	1.817	**6.697**
FRUI2	1.194	**2.071**	**2.983**	1.494	-1.817	**-6.697**
BUIL1	-0.711	**-4.936**	1.753	**-3.547**	**2.782**	**5.442**
BUIL2	0.711	**4.936**	-1.753	**3.547**	**-2.782**	**-5.442**
MED1	**2.911**	**-5.611**	0.671	-0.227	1.937	0.768
MED2	**-2.911**	**5.611**	-0.671	0.227	-1.937	-0.768
CRAF1	**3.908**	**-8.003**	**2.416**	0.536	-0.406	1.189
CRAF2	**-3.908**	**8.003**	**-2.416**	-0.536	0.406	-1.189