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Summary

The Magoye River is located in the Southern Province of Zambia. This is the most drought prone region in Zambia and a lot of water bodies dry up during the dry seasons, including the Magoye River. Small scale livestock farming is widespread in the area and low water availability during dry seasons forces local farmers to push their cattle long distances for drinking water and grazing during dry seasons. Having cattle spending long periods far away from their farm poses health risks and agricultural management difficulties. In an attempt to increase water availability during dry seasons a local stakeholder forum has proposed a weir construction on the Magoye River. This study assesses the socio-economical impacts and feasibility of this proposal. This study finds that although a new weir on the Magoye River would increase the dry season water availability it would not affect grazing availability, which is already low during dry seasons, much. As such, cattle would still have to leave their farms during the dry season when grazing is depleted. Therefore, a proposed weir would have to be accompanied by expanded irrigation and water withdrawal in the area to increase grazing availability for it to be feasible. On the other hand, as water resources are already under stress in the catchment area increased water withdrawals might come in conflict with downstream water users.

Keywords: drought, dry season, weir, Mazabuka District, livestock farming, cattle health, grazing availability

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1. Introduction

The Magoye River is located in Mazabuka District in the Southern Province of Zambia.

Figure 1 – Mazabuka district in the Southern Province, Zambia

This province is the most drought prone in Zambia and a lot of water bodies dry up during the dry seasons (Baumle et al. 2007:5). Excessive rains in concentrated periods may result in floods, and the lack of rain in other periods can result in a water shortage for vital activities and livelihoods such as domestic- and livestock consumption and agriculture. This is the case in southern Zambia where the rain season occurs from November to April followed by a dry season. With water storing constructions water that would otherwise flow pass an area can be stored for usage during dry season. In 2010 a local stakeholder forum was created for the river's catchment area. This forum is a pilot project within a program on integrated water resource management run by the government of Zambia and the Danish Development Agency (DANIDA). Farmers from the area participating in this forum have proposed a site on the Magoye River where they think a weir could be built to increase water availability, which at this point is very low during the dry season. This low water availability forces farmers to push their cattle long distances for drinking water during dry seasons.

1.1. Purpose

The purpose of this study is to assess the socio-economical impacts and feasibility of a proposed weir construction on the site on the Magoye River proposed by the local farmers in the stakeholder forum. Its findings and results can and should be taken into account for further decision making concerning weir and dam constructions in the area. The two research questions posed for the process are:

- How will a weir in the proposed area affect water availability?
- How will this altered water availability affect local livelihoods in the area?

2. Methodology

Field studies were conducted during 1 month in the area in July 2010 to assess the socio-economical impacts that a new weir on the Magoye River would have on the area. To be able to answer the research question the following data was collected: number of inhabitants and farmers in the area, water availability, water sources used, water demand, animal health related to water availability, and expansion possibilities for farmers who might benefit from increased water availability.

Before arrival in the field general background research for the area and topic was done. On site field documents were collected and interviews conducted with representatives from: Mazabuka municipality's office, Department of Water Affairs (DWA), Department of Agriculture and Co-operatives (DACO), Ministry of Energy and Water Development (MEWD), District Veterinary Office, Cotton Development Trust Mazabuka, local milk co-operative Magoye Smallholder Dairy Farmers Cooperative (MSDFC), engineering consulting firms COWI and ZMCK Consulting Engineers, local chiefs, and local farmers. For clarity it can be added that Ministries work on national level while Departments work on provincial level.

The majority of the local information was received through interviews and documents from the DACO representatives in Mazabuka district. DACO has agricultural extension officers for each agricultural camp which the studied area is divided into. Qualitative interviews with these extension officers provided the most reliable and local information this study has to present. Interviews with local farmers and chiefs were only taken into account as a very general guiding, as this information generally seemed to be biased in favor of the interviewee.

Local field information was difficult to acquire as settlements are disperse and difficult to access as there are only few roads. Not many thorough studies have been conducted in the area. This study's

limited time span and budget together with these factors resulted in that few interviews, seen to the area's size and population, were conducted. Questions for each interview therefore concerned large areas, which makes it harder for the interviewee to give accurate and precise information. Although more precise and accurate local information would be preferred, this study's current general characteristics still manages to result in relevant and interesting findings.

To answer the research questions information had to be gathered on:

- hydrology and flow regime of the river
- agricultural activities in the region such as: crop activities, type and amount of cattle, number of farmers
- water demand
- food demand for cattle
- linkages between agricultural activities and water availability
- altered flow regime and water availability due to a weir

3. Area description

3.1. Mazabuka District

Magoye River flows in the Mazabuka district, located in the Southern Province in Zambia (see figure 1). The district has approximately 240,000 inhabitants with 80,000 of them residing in urban areas (Mazabuka Municipal Council 2008:18). In the whole Southern Province 83% of the 1.4 million inhabitants live in rural areas (Baumle et al. 2007:11). Mazabuka District is known as a farming district and holds a lot of commercial farming, among others large sugar cane estates which attracts a high number of jobseekers from the region (Mazabuka municipal Council 2008 :11). The average household consists of 8 people and most of them are headed by men (ibid. :15). Mazabuka town, the largest urban settlement in the district, is experiencing strong economic growth, mainly because of: existence of established markets structures, a larger crop diversification than before, presence of established finance and banking institutions and a large self-employed sector of around 34% of the inhabitants (ibid.). Current constraints for further economic growth and improved livelihoods are identified as: inadequate support systems for agriculture and livestock activities, a large agricultural

dependence which during droughts and floods cause problems, high rates of unemployment and over-reliance on the sugar estates (ibid.).

The southern province is the most drought prone region in Zambia (Baumle et al. 2007:5). Crops grown in the district are: maize, vegetables, citrus trees, rice, bananas and sugarcane (ibid.:35). The climate is humid sub-tropical and it can generally be divided into three seasons: a warm rainy season from November to April, a mild to cool dry season from April to August, and a hot and dry season from September to November (ibid. :17). Mean annual rainfall ranges from 650 to 800 mm, which is the lowest in the country (ibid.). The distribution of rainfall is very unpredictable even during rain season which makes rain fed agriculture unreliable (ibid.). Because of major tributaries drying up during dry seasons, distances between water sources and elevation differences it is not deemed economically feasible to distribute the surface water for household consumption, and therefore groundwater is the most reliable source of water for households (ibid.). Groundwater volumes are sufficient to assure long-term water supply for rural areas and smaller settlements, but is insufficient for development of irrigation schemes (ibid.). There are over 889 weirs and dams in the province and the majority of them are earth embankment dams (Baumle 2007:35).

3.2. Magoye area

Magoye area is a rural area located on the border between Mazabuka and Monze district. The part of Magoye area that is studied in this report is located in Mazabuka district, see figure 2.

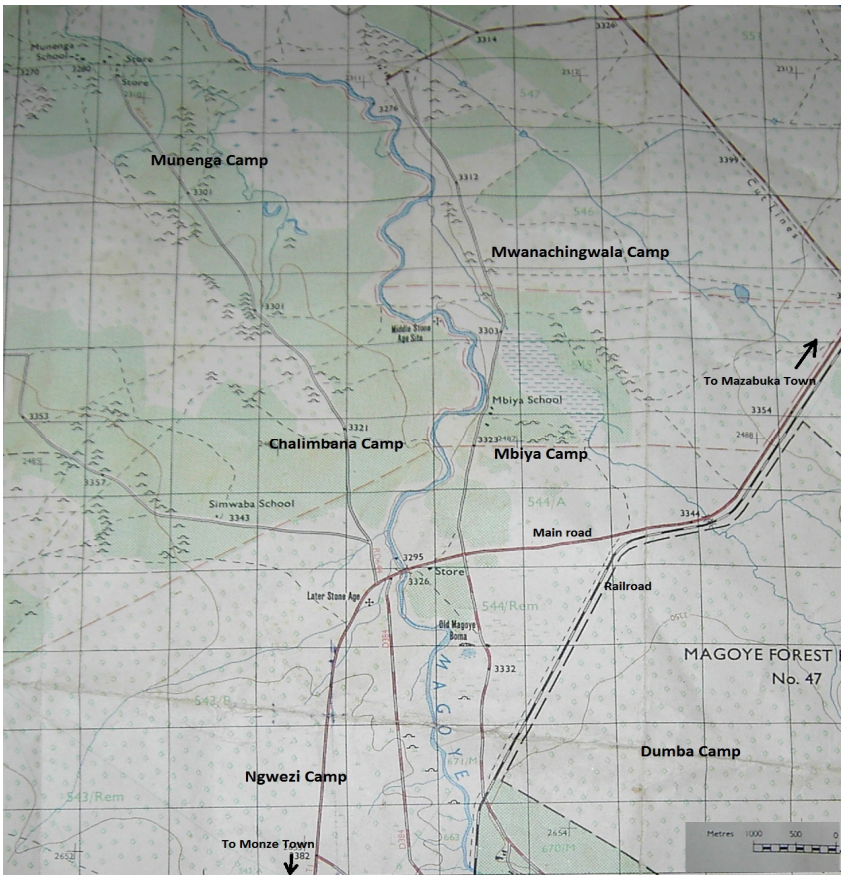

Figure 2 - Map of Magoye area in Mazabuka district with Magoye River and agricultural camps (Published by Surveyor-General, Lusaka, Zambia Government 1972). Camp locations added. Scale 1:50 000.

In figure 2 the Magoye River, which flows northbound, is clearly visible in the center. The main road between Mazabuka and Monze, and the 6 local agricultural camps (Munenga, Mwanachingwala, Chalimbana, Mbiya, Ngwezi and Dumba Camp) are also indicated. The main road from Mazabuka to Monze town goes through Magoye area, which spreads out from each side of the main road. Other roads in Magoye are small gravel roads, which generally require a 4x4 or motorcycle to access. The area is very sparsely populated with few larger settlements. According to DACO there are around 3700 farmers in the Magoye area that are using the Magoye River as a water source. The absolute majority of the farmers are small-scale. There are only two farmers with irrigation schemes and both are commercial. Irrigation methods for small scale farmers include buckets and water cans. A couple of years ago a local milk co-operative, Magoye Smallholder Dairy Farmers Co-operative (MSDFC), was created in the area to buy milk from local farmers and sell it to the markets in the nearby towns.

3.3. Magoye River

The Magoye River has a catchment area of 2281km2 (Baumle 2007:23). With a mean annual rainfall in the region of 650 to 800 mm**,** the average annual flow amounts 47-58 m^3/s. Its main tributaries are the Ngwezi and Nalube rivers (ibid.:15). Kabomba stream is a smaller tributary flowing into the Magoye River from the Dumba Camp in the south east. The Magoye River flows northbound to the Kafue Flats before reaching the Kafue River with its catchment area of 156,000 km2 which in turn is a tributary to the major Zambezi River (COWI & SWECO 2009a:12).

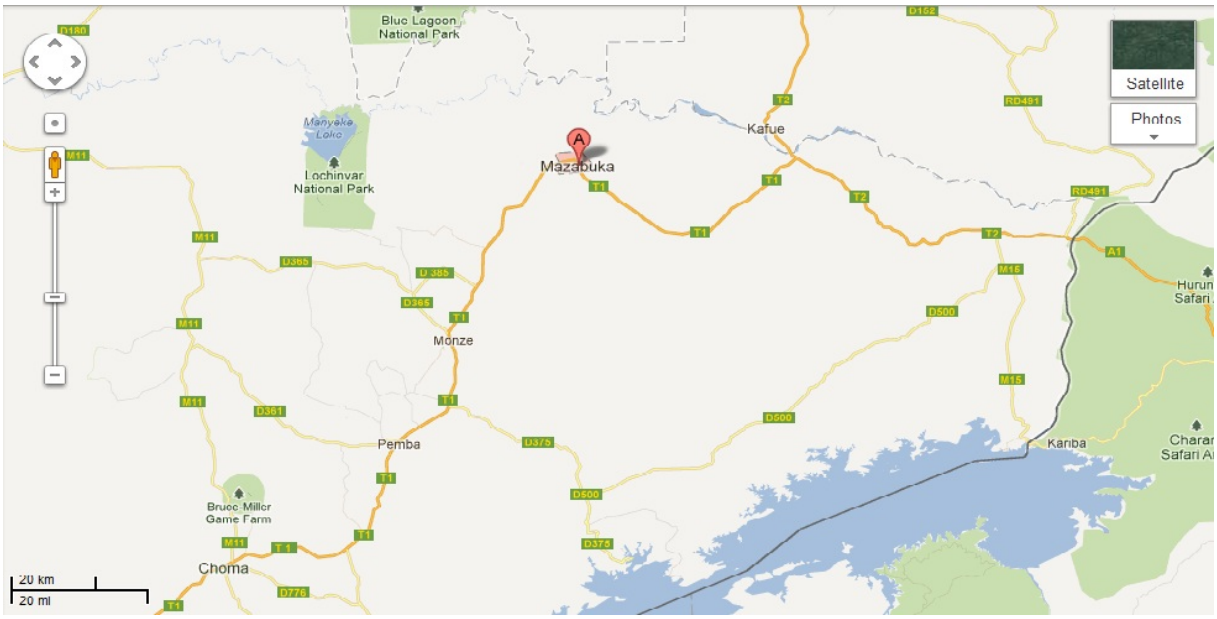

Figure 3 – Mazabuka town, Kafue river and Zambezi river (Google 2012)

In figure 3 Magoye River is not visible but it flows just west of Mazabuka town and joins the Kafue River to the north. The Zambezi River is seen in the bottom of figure 3 where it forms a large reservoir behind the Kariba Dam. The confluence between Kafue River and Zambezi River is around 100 km north of this dam. The Kafue River is claimed to be the most important river for Zambia's economy as most of the country's mining, industrial and agricultural activities are found within its catchment area (ibid. :12). Two large dams, Itezhi-Tezhi and Kariba Dam, are located on the Kafue River which is used to produce electricity under the parastatal company ZESCO. Hydropower generation is stated to be one of the priority developments for the country (ibid. :25). The main reason for constructing the two dams was to supply electricity for the country's copper industry (Godet & Pfister 2007:15). The construction of these two dams has had significant impacts on the flow regime in the Kafue Flats. Some areas are now permanently flooded, and others receive less floods than before as the part of the wet season flooding is now held by the Itezhi-Tezhi dam (ibid. :6). Decreased flooding in some areas of the flats have resulted in lost feeding and breeding grounds, affecting both biodiversity and socio-economic aspects in the region due to reduced possibilities for fisheries and agriculture (COWI & SWECO 2009a:44).

The Kafue and Zambezi Rivers are the only perennial watercourses in the province, as all other rivers and stream dry up in the dry season (ibid.). The Kafue Flats by the river with its wide wetlands and alluvial plains are used for grazing grounds for cattle and is a source of livelihood for villagers, small scale farmers and commercial irrigation farms (ibid.). The Kafue Flats floods each year and attenuates flood flows, resulting in extensive evaporation (COWI & SWECO 2009a:12). Although competing demands from commercial and small scale agriculture, fisheries, households, mining and hydropower, the water withdrawal from the Kafue catchment area can be increased somewhat without adverse effects on other users (ibid.:28). Up until 2008 the Kafue River had been used for irrigation without any adverse effects on the power production, but it is now assumed that further expansions could have significant negative economic effects (ibid.:17). With ZESCO's projected power production expansions for Kafue River and major irrigator's increased technical pumping capacity it is likely that there will be upcoming conflicts between stakeholders (ibid. :40). ZESCO also argues that any water use in the area should only be allowed to the extent that it does not affect the company's capacity to meet the power demands (ibid. :40). This means that the potential for increased withdrawal of water in the catchment area is limited. Conflicting water withdrawal rights is further complicated by the fact that ZESCO and major irrigators in the area have invested heavily in infrastructure to be able to withdraw the amount of water they have been entitled to (ibid. :40). As such they are not likely to accept reduced future water withdrawals.

Several dams and weirs already exist along the Magoye River and its tributaries:

- One weir on Magoye River opposite the Cotton Development Trust (CDT) in Dumba Camp
- One old weir on Magoye River a couple of hundred meters north of the main road as indicated in figure 2, which functions badly
- Two weirs on the Ngwezi River which is used by the Riverdale farm.
- Two weirs on the Kabomba Stream which is used by the Riverdale farm
- The Dumba Community Dam on the Kabomba Stream

The Magoye River thus already has several constructions regulating and altering its flow regime. These existing structures also show that there are several stakeholders in the area with investments in the river that will be concerned and affected by future interventions on the river.

4. Institutional structures

For agricultural coordination purposes the concerned area is divided into the following agricultural camps: Ngwezi, Dumba, Chalimbana, Munenga, Mwanachingwala, and Mbiya. For a map of the different camps and their locations, see figure 2. The DACO has assigned agricultural camp officers for each of the camps to coordinate activities within and between the camps. The districts veterinary office also divides the area into veterinary camps, which are larger than the agricultural camps where each veterinary camp usually comprises 3-4 agricultural camps.

Besides governmental institutions the area is also divided into traditional chiefdoms. These are by tradition headed by a chief who is elected from the royal family. Chiefdoms are recognized as governing institutions by the government of Zambia and the chiefs receive a salary from the government. Matters handled by the chief are normally land-owner disputes, land rights and community concerns. Chiefs are also supposed to act as a link between the community and the municipality's council.

There is limited coordination between the different stakeholders in the water sector in Zambia (COWI & SWECO 2009:47). The efficient management of the water sector is also hindered by the lack of information on: hydrology, hydrogeology, water quality, meteorology, and water usage (COWI & SWECO 2009:47). This lack of a common information system has led some stakeholders, such as ZESCO, to establish their own information system (ibid.).

A stakeholder forum has been created under the Ministry of Energy and Water Development (MEWD) in the region to manage water resources in the catchment area for Magoye River. It was created in 2010 and meets every two months. It is a pilot project within a program on integrated water resource management run by the government of Zambia and the Danish Development Agency (DANIDA). The project is officially set to end by the end of 2010, although there are possibilities for extension as the project was started two years after schedule (MEWD 2010a:3).The forum is intended to act as a meeting point where stakeholders should have the opportunity to discuss water issues concerning the catchment area. Members of the forum are representatives from: district councils, small-scale farmers, commercial farmers, traditional authorities, civic leaders, industry, NGOs, MEWD, Ministry of Agriculture and Co-operatives, Ministry of Environment Tourism and Natural Resources, Ministry of Lands, and Ministry of Health (ibid. :6). One major function of the forum is to identify sites for potential new weirs and dams to improve livelihoods in the region. As mentioned before, the weir site that this report investigates was proposed from stakeholders in this forum.

5. Theoretical framework

5.1. Dam constructions and agriculture

Water storage constructions in flowing waters can fill many purposes for the surrounding communities. Potential areas of usage of the stored water are: irrigation for agriculture, fish farming, livestock and domestic water purposes, groundwater recharge, and flood amelioration (FAO 2010:5). The advantages of having constructions storing water are especially apparent when the annual rain cycle is concentrated in certain periods, followed by drought periods. Excessive rains in concentrated periods may result in floods, and the lack of rain in other periods can result in a water shortage for vital activities and livelihoods such as domestic- and livestock consumption and agriculture. This is the case in southern Zambia where the rain season occurs from November to April followed by a dry season. With water storing constructions water that would otherwise flow through an area can be stored for usage during dry season.

Depending on the amount of water stored behind a dam or a weir the effects on the flow regime can be substantial. Of special concern is how the storing of water affects the flow regime downstream of the construction. As the downstream effects are so directly correlated with upstream activities, the impacts of such constructions must always be assessed along the whole water body. Such an analysis should not only concern the direct impacts on stakeholders, but also more broadly on ecology. A dam or weir construction can result in substantial changes of a flow regime, and thus severely alter a historically developed ecological equilibrium.

Storing water will also affect the evaporation from the water body. Depending on the area or facilities where water is stored the water surface area will be altered. And with larger water surface area there will be more evaporation. To keep the water stored it is thus crucial to plan the storing area or facilities with this in mind. Local topography is one important factor that has to be considered.

Earth embankment dams are deemed to be the most appropriate dam type for farm and other rural situations, as these are generally cheaper than concrete structures and can be built using local equipment such as farm tractors (FAO 2010:7). They rely on their mass to resist sliding and overturning, which they resist better than more rigid structures, and are the most common type of dam found worldwide (ibid. :13). Further advantages are gained if the embankment is constructed using material excavated from the reservoir area, which provides a small increased storage capacity and reduces costs (ibid. :7). Foundation requirements are less stringent than for other dams as its broad base spreads the load on the foundation (ibid. :13). Negative aspects of an earth embankment

are: it is easily damaged by water which requires a spillway and adequate upstream protection, constructing adequate spillways can be technically difficult, not properly compacted it risks offering channels for seepage, it requires continual maintenance to prevent erosion, tree growth, subsidence, animal and insect damage (ibid. :13).

For a dam construction a dam committee comprising local stakeholders should be established to take part in planning, construction, operation and maintenance (ibid. :9). Training and capacity building may be required for local stakeholders taking part in such a committee. Factors that need to be taken into account when choosing the site for a dam or weir construction are: potential end usage, availability of materials, land tenure issues, environmental concerns, community needs, distance to nearest power source, inundation of roads, bridges and buildings and flow regime alterations ibid. :31).

For household and livestock consumption boreholes and wells can be constructed downstream of an embankment to benefit from any underground seepage, although this will require restricted access to the reservoir upstream to avoid contamination (ibid. :10). Pipes with simple sand filters with water outlets could be constructed to divert water from the reservoir to drinking points were household and livestock consumption could take place without risking contaminating the reservoir and damaging the river bed (ibid.). Good fencing around the reservoir will keep animals and humans from tracking in the immediate surroundings and thereby maintaining the grass-cover and minimizing erosion (ibid.:81,84). If a reservoir is to be used for fish production there are certain aspects that have to be considered. Generally reservoirs of 3-5 m depth are ideal for fish production, greater depth than this or with significant through flow gives limited potential for fish production (FAO 2010:113). In shallow water it can be feasible to use fertilizers to encourage the growth of algae, plankton and for supplementary feeding for the fish (ibid.). Although the quantities of fertilizers must be controlled to avoid pollution (ibid.). Vegetation can provide shelter for smaller fish and insects, keep the water oxygenated and decaying plants provides a source of fertilizer (ibid.). Excessive growth of weeds will lead to lower fish populations, will use nutrients that would otherwise produce plankton and might encourage water borne diseases such as malaria and bilharzias (ibid.).

5.2. Cattle health

The health of cattle is an important factor for the farmers who depend on their animals for several purposes. Besides providing direct income and food they also: serve as a store of wealth, safety net during crisis, collateral for credit, provide draught power, in mixed farming systems they consume waste products from crop and food production, help control insects and weeds, and produce manure for fertilizing (FAO 2009:3). There are several kinds of diseases that can have severe effects on cattle

population. Outbreaks of some diseases can wipe out a whole population, while the spreading of others can be more easily prevented. To have healthy cattle there are extensive vaccination programs and caring procedures in the region that farmers are recommended to follow. Relevant diseases and health problems for cattle in the studied area are:

- Blackquarter – an acute fatal disease caused by bacteria ubiquitous in soil mostly affecting young animals in good conditions (Onderstepoort 2010).

- Pasteurellosis – bacteria that can cause: fever, depression, anorexia, rapid weight loss. Events that can lead up to infection are: transportation, mixing of cattle from different sources, confinement of cattle, and ineffective housing and ventilation (Hunter Nutrition 2005).

- Lumpy skin disease – is an acute infectious disease of cattle of all ages (Davies 1991). It can cause severe damage to hides, mouth, pharynx, respiratory tract as well as depression and anorexia (ibid.; OIE 2002). Mortality rate up to 40 % has been reported although it is usually less (Davies 1991). No specific vector has been identified although mosquitoes and flies could play a major role (OIE 2002). Vaccination exists, but no treatment is known for already infected animals and if outbreaks occur isolation is recommended (ibid.).

- Tick borne diseases – such as: *heartwater* leading to nervous behavior, loss of balance and in some cases death; *redwater* leading to fever and in some cases death; *gall sickness*; *east coast fever* resulting in for instance high fever and diarrhea and has high mortality ; and *corridor disease* with similar symptoms as east coast fever (Turton 1999). The risk for infection increases after good rains and when animals are moved from disease-free to disease areas (Turton 1999; New Agriculturist 2001). A tick borne disease has to be treated quickly after it is noticed; otherwise the risk of death will increase (ibid.). Good methods for preventing the disease is to: expose animals at an early age to the parasites so that they can develop a natural immunity, tick control by dipping (cleaning animals in small pools) or spraying the animals with pesticides, and vaccination (ibid.). Dipping during wet seasons may need to be conducted as often as once a week, and during dry season every second week (Turton 2001).

Both wet and dry environments cause diseases. Dry because of communal grazing and lack of food, and wet because of moist, tick-friendly environments. And where there is low grazing availability it means that cattle has to eat short grass which increases the risk of getting bacterial diseases from spores in the soil.

6. Results

6.1. Water demand assessment

As the proposed weir construction on the Magoye River is intended to be used for agricultural purposes, the water demand assessment was done solely on the basis of the projected demand from this sector.

Table 1 – Number of farmers in agricultural camps in Magoye

Camp	Small scale	Medium scale	Large scale	Total
Ngwezi	284	0	8	292
Dumba	269	10	0	279
Chalimbana	673	26	0	699
Munenga	824	37	0	861
Mwanachingwala	1011	33	0	1044
Mbiya	494	8	0	502
Total	**3555**	**114**	**8**	**3677**

Small scale farmers are farmers holding land less than 4 ha, medium scale between 4-10ha and large scale above 10 ha. According to DACO it is assumed that small scale farmers on average have 3 cattle, medium scale 9 and large scale 40. Based on these assumptions the number of animals is presented in table 2.

Table 2 – Amount of cattle using the Magoye River

Camp	Total assumed amount of cattle
Ngwezi	1172
Dumba	887
Chalimbana	2227
Munenga	2768
Mwanachingwala	3297
Mbiya	1546
Total	**11897**

The district's veterinary office assumed the number of cattle using the Magoye River to be around 17,000. The board chairman of the local milk co-operative MSDFC assumed the number to be around

10,000. Out of these three different sources, it would be safe to say that there are at least 10,000 cattle in the area using the Magoye River as a source of water.

Cattle water consumption depend on size and health of the animal, lactation, forage water content, and temperature (Masike & Urich 2009:598). For a study conducted in Botswana daily cattle water consumption at 25°C was estimated at around 30 liters (ibid.). For the cattle in the area (10,000) this would add up to a daily water requirement of 300m^3. For a proposed dam construction to supply water throughout the dry season, this is the minimum daily volume it should be able to provide.

6.2. Water availability

The Magoye River usually dries up around September/October and starts to flow again with the hot rainy season starting around November. When it dries up, the animals that have been using the river as their water source have to be pushed to different areas which provide water during the dry season. Cattle from Dumba Camp, the most southern camp, are generally pushed upstream (south), where water is held by dam constructions all year round (for a map of the area with the camps see figure 1). Cattle from Mbiya Camp use a swamp located about 40-60km east of the camp. The majority of the cattle from Ngwezi Camp use the Ngwezi stream for water consumption where a dam has been constructed to increase the water availability in the area. However, this reservoir dries up around August at which point the cattle are pushed 5-6 km to get water from the Cotton Development Trust weir on the Magoye River. Those who are not using the streams in Ngwezi camp, approximately 25% ≈ 300, are using wells in the area. Cattle from Mwanachingwala Camp are pushed around 30km downstream (north) to reach the Kafue Flats during dry season when the water in the Magoye River dries up. The procedure is the same for cattle from Chalimbana Camp, but with a distance of around 40km. Almost all of the cattle from Munenga Camp, the most northern camp, use the Kafue Flats as a water source during dry season, located about 20km north of the camp.

Based on camp locations and dry season water points, the distances cattle have to walk during these periods are approximated and presented in table 3.

Table 3 – Distance to reach water point during dry season

Camp	Distance to reach water point during dry seasons (km)
Ngwezi	5 - 6
Dumba	5
Chalimbana	40
Munenga	20
Mwanachingwala	30
Mbiya	40 - 60

As stated previously only few cattle from the camps stay in the camps during the dry season and it is reported that it is mostly the dairy animals that stay, as these are not as capable of walking long distances as the beef animals are. Beef animals are also more capable of grazing on their own. The agricultural extensions officers (AEO) for Chalimbana and Munenga camp report that some households share their water source, often wells, with their cattle during dry season. In this way the low water availability for cattle is also affecting the water availability for the humans in the area.

There is some sand mining being conducted on several sites along the banks of Magoye River. This sand is sold for construction purposes in the proximity as well as in Mazabuka and Monze town. Sand mining along the river bank risks increasing erosion which can alter the topography and make the area more vulnerable to flooding.

Officers at DACO report that the flow regime in Magoye River is so high during the rainy season that increased water storage, for instance due to a weir, will not pose any problems for downstream water users. This is due to the fact that there is an excessive amount of water available during the wet season, and reducing the water availability in this season by storing water would thus not negatively affect the downstream users. The water that such constructions would store is water that otherwise would flow past the river and into the Kafue Flats, and if this water would be stored it would not adversely affect downstream water users in the Magoye River. Water storage will however affect the water availability beyond the river, in the Kafue Flats, and the general hydrological cycle in the region. How the water availability in the Kafue Flats would be altered is a complex question and beyond the scope of this study to assess, among other things due to the fact that reduced flow to the flats would reduce the flooding with subsequent reduction of evaporation, which in its turn would depend on for instance local topography and temperature.

6.3. Grazing availability

For an assessment of how a weir would affect agriculture in the region it is crucial to study the grazing availability. As the cattle depend both on water and grazing for their health and survival, both would have to be available for cattle to be able to stay in one location throughout the year.

The district veterinary officer claims that natural grazing in the area cannot sustain the current animal population and that an increase of the amount of animals is not recommended without increased food availability for them. According to the Magoye Smallholder Dairy Farmers Cooperative (MSDFC), beef animals can graze by themselves but dairy animals need farmer supervision and can not walk long distances for food.

Table 4 presents the respective AEO's assessment of the grazing availability and usage in their camps.

Table 4 – Grazing availability in the agricultural camps

AEO from camp	How is the grazing availability in the camp?	Are other areas than the camp's used for grazing, and if so where are they?
Mbiya	"The camp lacks grass to feed its animal population."	"Cattle stay in the camp but struggle"
Dumba	"The number of animals is exceeding land availability, and most of the land is overgrazed."	"During dry season some of the cattle are using the Kafue Flats."
Mwanachingwala	"Available for 2-3 months per year"	"Beef animals are pushed to the Kafue Flats, some cattle are kept at Kafue Flats all year."
Ngwezi	"There is not enough grazing to feed the cattle in the camp."	"During dry season cattle are pushed to Kafue Flats."
Chalimbana	"No grazing available, even during rain season. After harvesting around May cattle feed on crops for 2-3 months before running out."	"After the crops are depleted around August cattle are pushed to Kafue Flats where they stay until the next harvest around May."
Munenga	"There is a communal grazing area in the camp, but this can not supply grazing for the whole year."	"After grazing depletes in the camp cattle are pushed to Kafue Flats."

All of the 6 interviewed agricultural extension officers assert that grazing availability is low in the area around Magoye River. As a result of this, most animals are forced to spend large parts of the year, some only over the dry season, at distance places such as Kafue Flats where grazing availability is better. The practice is such that when grazing areas are depleted in the home area the cattle are pushed to other areas where they spend long periods away from their farm. This means that there

are cattle from a very big area that during certain periods of the year come together and graze in the same area, i.e. practicing communal grazing. This practice has the following adverse affects on cattle health:

- As cattle from different areas come together they risk spreading diseases that some groups of them carry
- Some cattle are better looked after than some resulting in that poorly treated animals risk spreading diseases to better treated ones
- Being far away from the farm makes it harder for the farmers to look after the animals. The district veterinary officer states that having cattle in the Kafue Flats over the dry season reduces dipping of the animals as farmers are far away from their cattle and as there are fewer facilities for dipping there, resulting in increased prevalence of TBD and worm infections.

6.4. Animal health

As both water and grazing availability is low under certain periods of the year, the animals in the area are forced to live under conditions that jeopardize their health and survival. General animal health issues thus become an aspect to be taken into account for the socio-economical assessment of the proposed weir.

In Mazabuka district the District Veterinary Office provides guidance to farmers and issues annual vaccination programs. They also perform vaccinations and provide drugs. There are a lot of health problems reported for the animals in the area. During 2007 and 2008 the cattle population in the district was reduced from 143,000 to 130,000, mostly due to an outbreak of foot-and-mouth disease (District Veterinary Office 2010). Since then the number of cattle has increased and in 2009 reached 137,000 (ibid.). Overall the district has seen a sharp increase in the amount of cattle, going from 118,000 in 2005 to 137,000 in 2009 (ibid.). Table 5 presents the information received from AEOs on cattle health in their camps.

Table 5 – Cattle health status in agricultural camps

AEO from camp	Cattle health status in the camp
Mbiya	"Animal health good during rain season, but worse during dry season when grazing is limited, which forces animals to do communal grazing where TBD is easily spread. There are reported cases of foot-draught when cattle are held in wet areas, causing animals to limp and not being able to feed properly. The wet environment also leads to higher prevalence of tick borne diseases."
Ngwezi	"2 out of 5 of the camp's cattle die each year out of East Coast Fever."
Mwanachingwala	"There are around 2-3 tick born disease outbreaks per year, occurring during the hot season in the beginning of the rain season, where approximately 25% of the animals are affected during each outbreak, resulting in death. 10% of the cattle are affected by Black Leg, also most frequently during the hot season
Chalimbana	"There are examples of group of farmers losing 25 out of 100, 25 out of 130, and 200 out of 400 cattle respectively. These deaths were caused by TBD."
Munenga	"75% of the camp's cattle are affected by some kind of disease. The health situation could be improved by increased vaccination and deworming"
Mbiya	"There are usually 5-10 deaths each year (≈0.6% of camp cattle pop.). Although this year there was an unusual outbreak of TBD in the camp which increased the number of deaths, one farmer lost 30 out of 50 cattle."

The officer for Ngwezi veterinary camp, consisting of Ngwezi and Dumba agricultural camp, reports that 75% of cattle get TBD, affecting approximately 50% of the farmers. The mortality rate for these incidences is around 1/30, with an increased rate over the rain season. The district veterinary officer reports that animal health in the region to a large extent is a cost issue for the farmers as they have to buy drugs. Due to this, increased income levels could increase the farmers spending on their animals and thereby improving their health. Lack of sufficient food for animals in the area affects the beef and milk production, even though no animals are reported to starve to death.

So it can safely be concluded that diseases are widespread for cattle in the area and has severe effects on the farmer's livelihoods. The data also shows that cattle health could be improved if more

funds and better management were available for the farmers. Limited grazing and subsequent communal grazing is reported to be one of the factors behind the outbreak of diseases. Cattle held in wet environments also seem to be a major health issue.

6.5. Irrigation

With the construction of irrigation schemes land could be used more efficiently and crop production and grazing availability could potentially be increased. According to the agricultural camp officers in the area there are only two farmers, both large scale commercial, that have irrigation schemes. As described above most farmers are small scale and cannot afford the costs that establishment of irrigation schemes would require. The low usage of irrigation schemes also raise concerns over the farmers' capacity to use such schemes efficiently if constructed. According to DACO several constructed dams in the province still are not used to their full potential as few irrigation schemes have been connected to these reservoirs. As described above, it is the Ministry of Energy and Water (MEWD) that are mandated to construct new dams. Concerns have been raised about DACO not being involved enough in the process, resulting in that many dams have been constructed without much focus on its agricultural end usage. Officials at DACO now claim that they are more involved in the planning process and that this institutional problem was more severe in the past, and that the two ministries now work closer together. This development sounds promising, although these past problems raise concerns about the institutional capacity to construct dams and weirs with efficient irrigation schemes. For an irrigation scheme to be constructed together with a dam, it would therefore be wise to have these plans set before the construction phase of any part begin, to ensure that the created reservoir actually benefits the area to an extent that can justify its costs.

7. Discussion

7.1. Water availability

As the water that would be stored by a weir is intended to be used by the cattle that are now getting water from other points, there would not necessarily be any increase in the amount of water consumed in the area; it would just be consumed at other points than today. Such a construction would thus be justified by the fact that the animals would not have to walk as long distances to get water, implying substantial health benefits for cattle. However, if it is argued that the water availability should be increased in the area for the purpose of giving farmers possibilities to expand their livelihoods, then there would probably be an increased water consumption, which would have to be taken into account in a further analysis. Based on the assessments from DACO storing more

water in one part of the Magoye River would not adversely affect water availability downstream in the river. As such, it can be argued that a weir would improve the water situation for the nearby communities.

For a potential dam construction with irrigation schemes the location will have to be carefully selected. Even though this study has assessed the socio-economical impacts of a weir proposed on a specific site, no assessment has been made on the site itself, but only on the overall impacts on the area. For the proposition to proceed, the specific site has to be more thoroughly assessed, not only for its physical aspects but also to optimize its socio-economical impacts.

7.2. Grazing availability

The low grazing availability in the area however raises concerns over whether increased water availability will affect the situation for the cattle, as they will still have to travel long distances to forage. The results clearly show that grazing is not enough in the area to sustain the current cattle population throughout the year. So if the increased water availability that would come with a weir does not improve the grazing availability it will not do much good for the area. One way that increased water availability could improve grazing availability is through irrigation schemes or expanded crop production adjacent to the river. Both these measures would effectively increase the water withdrawal from the river. As stated above concerns are raised from the stakeholders of the Zambezi River that the potential for further water withdrawal from water bodies in the region is limited and that such measures could have negative economical effects. For irrigation plans it would thus have be to assessed how much water that would be withdrawn, and how this would affect water availability in the region as a whole. Such an assessment is beyond the scope of this project, and will have to be directed to further studies. Another relevant aspect is the lack of collaboration between MEWD and DACO in the region that has led to several dam constructions without connected irrigation schemes.

There are severe animal health issues in the area. One argument for the weir is that it might lead to a situation where cattle does not have to resort to distant communal grazing, where diseases spread easily between herds from different areas and farmers have little supervision. Increased water availability could also provide potential for improved dipping and cleaning facilities for cattle.

8. Conclusions and recommendations for further studies

The research questions for this study were:

- How will a weir in the proposed area affect water availability?

- How will this altered water availability affect local livelihoods in the area?

Based on these questions the following conclusions can be drawn from this study:

- Agriculture in the area is currently negatively affected by low water availability, mostly as it forces cattle to travel long distances and spend long periods away from their farm
- A weir could effectively increase water availability without obvious adverse effects on downstream stakeholders
- Increased water availability will not benefit the communities much unless it is followed by an increased grazing availability.
- A weir with an associated irrigation scheme to increase grazing availability would have noticeable positive impacts on agriculture in the area but might have negative downstream effects depending on the magnitude of added water withdrawals

These conclusions concern just the initial phase of a potential weir project in the area. For the project to proceed more thorough studies have to be conducted concerning: costs of construction and maintenance, management and institutional aspects, comparison between other proposed sites, environmental impacts and the potential for irrigation schemes

9. References

Baumle Roland, Nkhoma Jack, Silembo Oscar, Nekum Christop. 2007. *Groundwater resources for southern province - a brief description of physiography, climate, hydrology, geology and groundwater systems of the southern province.* First edition, October 2007.

COWI & SWECO International AB. 2009a. "Availability of water resources for sugar cane production expansion in Zambia in the context of competing hydropower and other users". 24 april 2009. Contract number SUCRE/2009/169-446.

COWI & SWECO International AB. 2009b. "Availability of water resources for sugar cane production expansion in Zambia in the context of competing hydropower and other users – Annex 1: Water Availability". 24 April 2009. Contract number SUCRE/2009/169-446.

Davies F. Glyn, 1991. "Lumpy skin disease of cattle: A growing problem in Africa and the Near East". *World animal review.* Vol. 68. http://www.fao.org/docrep/u4900t/u4900T0d.htm. Accessed 2010-08-17.

District Veterinary Office. 2010. "Livestock census 2005-2009". Mazabuka, Republic of Zambia.

FAO. 2009. "The state of food and agriculture". Electronic publishing policy and support branch, Communication division, FAO. Food and Agriculture Organization of the United Nations.

FAO. 2010. "Manual on small earth dams – A guide to siting, design and construction". By Tim Stephens, Investment Centre Division. Food and Agriculture Organization of the United Nations.

Hunter Nutrition. 2005. "Pasteurellosis in livestock". http://www.hunternutrition.com/artpasteurellosis.html. Accessed 2010-08-17.

Masike Sennye & Urich Peter. 2009. "The projected cost of climate change to livestock water supply and implications in Kgatleng District, Botswana". *World Journal of Agricultural Sciences*, Vol. 5, p. 597-603. IDOSI Publications 2009.

Mazabuka Municipal Council. 2008. *Urban integrated development plan Mazabuka 2009-2013, status quo report.* Mazabuka municipal council with the assistance of VSO, 2008, Republic of Zambia.

MEWD, 2010a. "Documents for the first business meeting of the Magoye sub-catchment water resources management forum – 26th of February 2010, Mazabuka". Ministry of Energy and Water Development, Republic of Zambia.

MEWD, 2010b. "Description of Water Resource Management Forum – Functions and rules of procedure". Ministry of Energy and Water Development, Republic of Zambia.

New Agriculturalist, 2001. "Closing doors on corridor disease". Vol. 6. http://www.new-ag.info/01-6/newsbr.html. Accessed 2010-08-18.

OIE – World Organisation for Animal Health, 2002. "Lumpy skin disease". http://www.oie.int/eng/maladies/fiches/a_a070.htm. Accessed 2010-08-17.

Onderstepoort 2010. "Onderstepoort Biological Products". http://www.obpvaccines.co.za/disease_cattleinfo.htm. Accessed 2010-08-17.

Turton Jenny. 1999. "Tick-borne diseases in ruminants". Directorate Communication, South African National Department of Agriculture in cooperation with ARC-Onderstepoort Veterinary Institute.

Turton J.A. 2001. "Common and important diseases of cattle". Directorate Communication, South African National Department of Agriculture in cooperation with ARC-Onderstepoort Veterinary Institute.