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Assessing the Potential Ecological Impacts of the Proposed Kazungula Border Development at Cassandra Farms

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Abstract

The governments of Botswana and Zambia desire a bridge to replace the current ferry boat that operates between the two countries. An environmental impact assessment was recently completed to assess the potential impacts this development might have on surrounding areas. This EIA was inadequate in its study of the wetland area called Cassandra Farms.

Analysis of the trees and vegetation in the area showed that the area was a mixed woodland dominated by sickle bush, an encroaching species that flourishes in degraded environments. There were also protected tree species that were present in the location of the proposed new border post. Over 100 different species of birds were found in the study site with a large number of water dwelling species such as lapwings, herons, jacanas, storks, and ducks. Other animals in the study site included waterbuck, elephant, buffalo, impala, and wild dogs.

The proposed construction is likely to have a significant impact on the wetland. The proposed new border post will be partially located within the current wetland creating a loss in wetland habitat and obstructing the flow of water to the area. The proposed railroad will pass through the wetland, potentially obstructing the flow of water to the wetland if mitigation measures are not taken. The railroad might also obstruct the movement of animals to and from the wetland. Construction of the railroad will also run into and through present and proposed commercial and residential sites.

Further research of vegetation, wildlife, hydrology, and soils will be required to adequately asses the potential impact of development in the Cassandra Farms area.

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Introduction

Cassandra Farms is located in the Kazungula area in the northern most part of Botswana, near the border with Namibia, Zambia, and Zimbabwe. It is an area of approximately 2.4 square kilometers locked between the road to Zimbabwe to the south and the road to Zambia to the north that lies west of the Zimbabwean border. The vast majority of the area lies within a few meters in elevation of the Zambezi River, the primary source of water for the wetland that is located within the area. The wetland provides habitat for a diverse population of birds and other wildlife.

Kazungula is a unique area where the countries of Botswana, Namibia, Zambia, and Zimbabwe meet. Botswana and Zambia are separated by the Zambezi River and the only direct mode of travel between the two nations is by ferry boat. The ferry may only carry one or two trucks across the river at one time making it an inefficient mode of travel between the two nations. The ferry is outdated and commonly breaks down leading to long queues for truckers wishing to cross the Chobe-Zambezi. Trucks may wait for weeks at a time to cross the river leading to queues as long as 2.5 kilometers. These long waits that have hindered the flow of goods between South African nations have led to increasing prostitution in the area and consequently the increased spread of HIV in the region.

There are currently plans to construct a bridge that would directly link Botswana and Zambia with the intent of increasing trade and efficiency of international travel in the region. The original plans for the development called for a straight bridge that would link the two countries, passing through a portion of Zimbabwe that extends into the river. Due to political issues, Zimbabwe has decided not to participate in the project. Now, the plans call for a curved bridge that would curve around the geopolitical boundaries of Zimbabwe that extend into the Zambezi River. The bridge would directly link the two countries by road and railroad, significantly increasing trade and travel between Botswana and Zambia.

An environmental impact assessment (EIA) must be completed for any development project in Botswana that may affect the environment. An EIA was completed for the proposed development of the Kazungula border however it was apparent that the environment had been poorly assessed. A notably small portion of the 350 page EIA had been devoted to bird life in the area and the consultants had spent a total of two days at the Cassandra Farms area. Bird presence can occur at different times of day and different times of year so it is likely that this portion of the EIA was inadequate in representing the bird populations that reside in the area.

The purpose of this study is to begin a reassessment of the wetland environment of Cassandra Farms as it was inadequately assessed by the first EIA. This study of the Cassandra Farms wetland is intended to be the first part of a larger project directed at assessing the potential impact that the proposed development might have on the environment and the wildlife in the area. This portion of the project will provide an inventory of the tree, bird, and other species that were observed during the time of study. It will also involve analysis of the varying water levels in the area as they provide habitat for the indigenous fauna in the region and are likely to be affected by the proposed development.

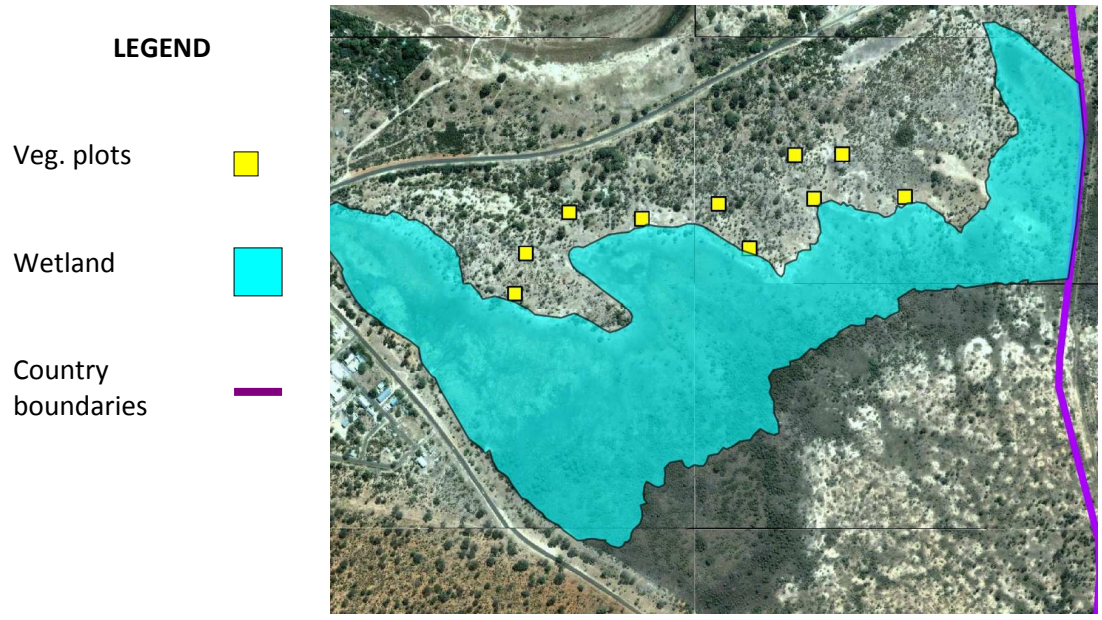
Methodology

A sufficient assessment of the environment involves taking inventory of vegetation, birds, and other animals. It requires identification at varying times of day and year in the instance that the wildlife is only present at certain times. A proper assessment also requires analysis of the hydrology and soils of the area. This study focused on taking inventory of the tree species, birds, and other fauna that were present during the time of the study, and mapping of different water levels. Although more data collection and study is required for a proper assessment, time constraints limited the scope of this study to 20 days in the field.

Vegetation

Vegetation analysis for this study was focused on the tree species in the study area because trees provide habitat for indigenous fauna. Certain tree species are also protected by laws in Botswana. This study involved taking inventory of different tree species as well as their abundance and special attention was placed on protected species in Botswana that are illegal to cut down.

Vegetation studies for this project were focused on the north side of the wetland area because construction of the proposed new border post will take place in that portion of the wetland. The vegetation in that area is likely to be most affected by construction. Safety was also taken into consideration when completing the vegetation analysis of this study because buffalo and elephant were commonly found throughout the area. These mammals were found in higher concentrations in the southern portion of the wetland so that area was avoided for this study.



Map 1: Locations of vegetation plots.

The purpose of this vegetation study was to find which species of trees were present and their abundance. Tree species were counted at 10 different sample plots that were chosen randomly within the area of interest (see Map 1 for plot locations). Sample plots were 20 meters wide by 40 meters long, having a total area of 800 square meters. Three people would stand in a line at 10 meter intervals along the 20 meter side of the plot. They walked the 40 meter length of the plot counting the type and abundance of tree species within the plot while remaining in a line and at a distance of 10 meters away from each other. The samples covered a total area of 8000 square meters.

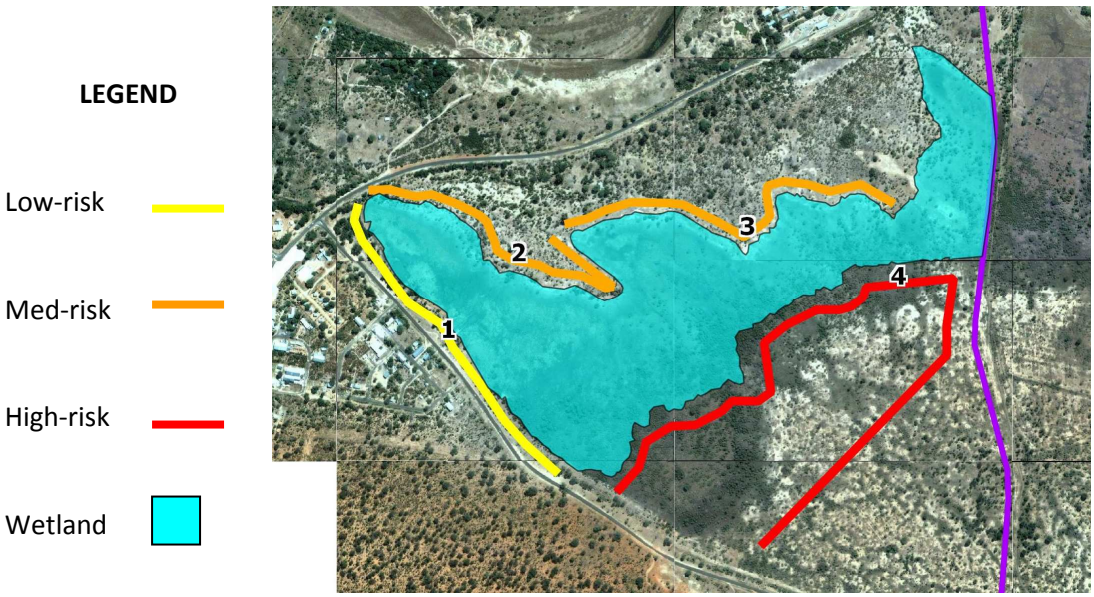
Tree species that were present in the study area but not present in the samples were also documented. GPS waypoints were taken at the locations of protected tree species that were discovered in the area.

Wildlife

Taking inventory of a wildlife population is crucial for determining the potential impact that a development might have on an environment. Line transects were utilized in taking inventory of the bird life and other animals in Cassandra Farms. Line transects allow one to observe which species are present and their relative density within the area.

Transect routes were designed with consideration of visibility, vegetation characteristics, location, and safety. The wetland area has three main coves that open to the southeast. The land that divides these coves obstructs viewing of more than one cove at a time. Each transect allows for full viewing of each section of the wetland area so that each different parts are adequately represented. Safety was always a concern during the study due to the high prevalence of buffalo and elephant. Routes were designed to fall within areas of different risk involved so that lower risk routes could be walked in their entirety with one person. Transects routes used in this study provided complete coverage of the perimeter of the wetland. The delineated transects follow the flood water level to allow for complete visibility of the wetland habitat (see Map 2 for delineated transect routes). Vegetation type was also taken into consideration when creating transect routes since the vegetation type is likely to play a role in determining which species are present. Areas of visibly different vegetation type were used to help determine the different routes.

Encounters with buffalo and elephant were common during the research period. The transect walk was typically ended or altered when such an encounter occurred. This would create partial transect data so that some parts of the routes were walked more than others. To account for this, the routes were broken up into areas depending upon how many times they had been walked. Each spotting in an area was given a certain weight depending upon the number of times walked. For example, sightings in an area that had only been walked one time were given a weight of 1. Sightings in an area that had been walked five times were given a weight of 1/5 so that each area was given equal weight. This same methodology was applied to each different area.



Map 2: Transect routes with flood water levels.

Water Level Mapping

Surface hydrology plays a crucial role in determining the habitat availability for water dwelling species and the behaviors of animals. Hydrological analysis of Cassandra Farms during this study focused on determining water levels of the wetland under varying rainfall conditions. This was necessary to determine the amount of available habitat for water dwelling fauna and the amount of wetland habitat that could be affected by development.

The flood water level at the time of study was determined using a Garmin GPS unit. This was accomplished by walking the shoreline and taking GPS waypoints along the perimeter of the wetland. The GPS unit had an error that ranged from 5 to 11 meters. Waypoints were taken at least every 15 meters so that the effects of this error would be minimized. These waypoints were uploaded into Quantum GIS and connected using a polygon tool to create the total wetland area for that flood season.

A hypothetical higher water level was also determined using satellite images. This hypothetical water level showed a possible higher water level that could occur during a period of higher rainfall. The water line for this hypothetical water level followed the visible differences in vegetation and soils as seen from satellite images. Quantum GIS was used to create a polygon of the total hypothetical wetland area.

The EIA that was completed in February of 2010 mapped out a 100 year flood level for the Cassandra Farms area. The Geo Referencing tool in Quantum GIS was used to map the 100 year flood level. The image from the EIA was geo referenced over the satellite images used for this study and a polygon of the wetland area for this scenario was created.

Development Plans

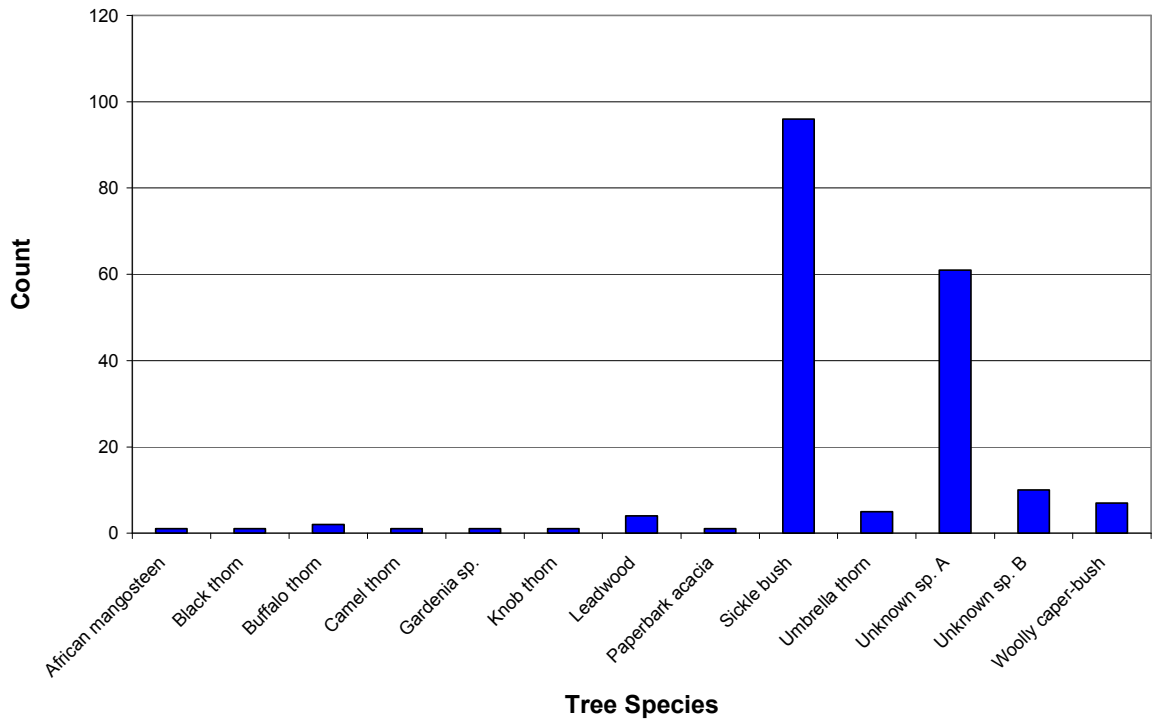
Information regarding the proposed development of the Kazungula border area was found through news sources, the EIA from February of 2010 for the proposed development, and through discussions with Kazungula and Kasane community members.

Results

Data regarding vegetation, wildlife, water levels, and construction plans was collected using the methods described above.

Tree Plots

The sample tree plots showed a high prevalence of sickle bush. An unknown species had the second highest abundance. A variety of acacias were also present in the study area but in low abundance relative to the sickle bush and unknown species (see Graph 1 for abundance of each species found in the sample plots). The area is best described as mixed woodland dominated by sickle bush.



Graph 1: Abundance of different tree species in vegetation plots.

Sickle bush is an encroaching species that thrives in degraded areas. The high density of sickle bush in the study site suggests that the area is degraded, most likely by browsing species such as impala, elephants, kudu, buffalo, and waterbuck. This suggests that the area is commonly used by such species.

Several species were documented that were not found in the sample plots (see the Table 1 below for a complete listing of the tree species found within the study area). A bird plum tree was found within the study area. Bird plum is a protected species in Botswana as stated by paragraph two of the Forest (Declaration Of Protected Trees) Order. It is likely that other species are present within the area, but were not found due to the limited scope of this study. Future research should be performed to take better inventory of the tree species present.

SCIENTIFIC NAME	COMMON NAME
Acacia erioloba	Camel thorn
Acacia fleckii	Plate thorn
Acacia mellifera	Black thorn
Acacia nigrescens	Knob thorn
Acacia sieberana	Paperbark acacia
Acacia tortilis	Umbrella thorn
Berchemia discolor	Bird Plum
Capparis tomentosa	Woolly caper-bush
Combretum imberbe	Leadwood
Dichrostachys cinerea	Sickle bush
Diospyros mespiliformis	Jackal berry
Garcinia livingstonei	African mangosteen
Gardenia spatulifolia	Bushveld gardinia
Trichilla emetica	Natel Mahogony
Ziziphus mucronata	Buffalo-thorn

Table 1: List of tree species found at the study site.

Birdlife

A diverse bird population was discovered through the use of line transects. Approximately 100 different species of birds were found in the Cassandra Farms area over a 10 day period. These species included endemic, vulnerable, near-threatened, and endangered species as stated by the *Roberts Bird Guide*. See Table 2 for a list of these species and their classification.

ENDEMIC	VULNERABLE	NEAR-THREATENED	ENDANGERED
Bradfields Hornbill	Bateleur	Greater Painted-snipe	Saddle-billed stork
Burchell's Starling	White-backed Vulture	African Openbill	
Red-billed Spurfowl			

Table 2: Key bird species found in the Cassandra Farms study site.

Other birds of interest including rufous-bellied heron, trumpeter hornbill, and Verreux's eagle owl.

All bird species found during the transects are listed in Appendix A. It is likely that further additions would be added to this if transects were continued during different times of year and at other locations in the wetlands, or had they not been confined due to safety reasons.

Different species were found at different locations in the wetland. For example, Saddle-billed storks were only sighted in one northeastern portion of the wetland. African Openbills were largely concentrated in the large, grassy wet area in the southwest. Glossy ibis were only found in the southern most part of the wetland. Based on these observations, different species could be found at different parts of the wetland depending upon their particular environmental preference or preferred distance from human activity. It is likely that other important species could be found in areas that were, due to safety reasons, not studied extensively.

In comparing the number of bird species found in this study with those discussed in the EIA completed in February of 2010, it is clear that the previous assessment under represented the diversity of bird species that were present in the area.

Other wildlife

Cassandra Farms similarly showed a high diversity of other wild life.

Waterbuck were common throughout the area. A small group was commonly found near the center of the wetland at any time of day. A herd of as many as 35 waterbuck were observed at one point; their common occurrence in the area suggests that there is a resident population in the area.

Impala were common in the area as well. Groups were regularly found in the area to the south east and between the wet area and the road to Zimbabwe during the evening, however, they were found throughout the study site. Although impala are not a threatened species, their presence does attract predators such as wild dogs which are threatened. A group of at least seven wild dogs were observed hunting impala in the area to the south east during this study.

Elephant and buffalo were found throughout the area although they were more likely to be spotted in the evening. In the absence of rain, elephant would come down from the hills located to the south of the study site for water during the evenings. Although elephant were not found during the morning and day time, fresh dung found during morning transects indicated that they could be found during the early morning hours as well. Transects were most often walked alone and were usually abandoned or altered if elephant or buffalo were spotted so as to avoid any encounters. For this reason, both elephant and buffalo were underrepresented in the data.

Other animals found the study site included warthogs, water monitors, crocodiles, and snakes. Hyaena spore was found in the study site as well.

Water

Satellite imagery shows that the Cassandra Farms wetland is fed by the Zambezi River. The Cassandra Farms wetland is an extension of a wetland located in Zimbabwe that receives its water from the adjacent Zambezi River.

Wetland areas are important resources for birds and other fauna. More wetland area results in more resources for wildlife. Three different water levels were mapped during this study to find varying quantities of wetland area: the flood water level at the time of the study, a hypothetical high water level, and the 100 year flood level. The total area of wetland for each scenario was found using Quantum GIS and can be found in Table 3.

	Area (ha)
Current Flood level	73.75
Hypothetical	94.7
100 year flood	177

Table 3: Total area for each water level scenario.

Based on the maps provided in the EIA that was completed in February of 2010, the 100 year flood plain covered the majority of the study site. This indicates that the water during flood season will likely reach this level once during a 100 year period.

Discussion

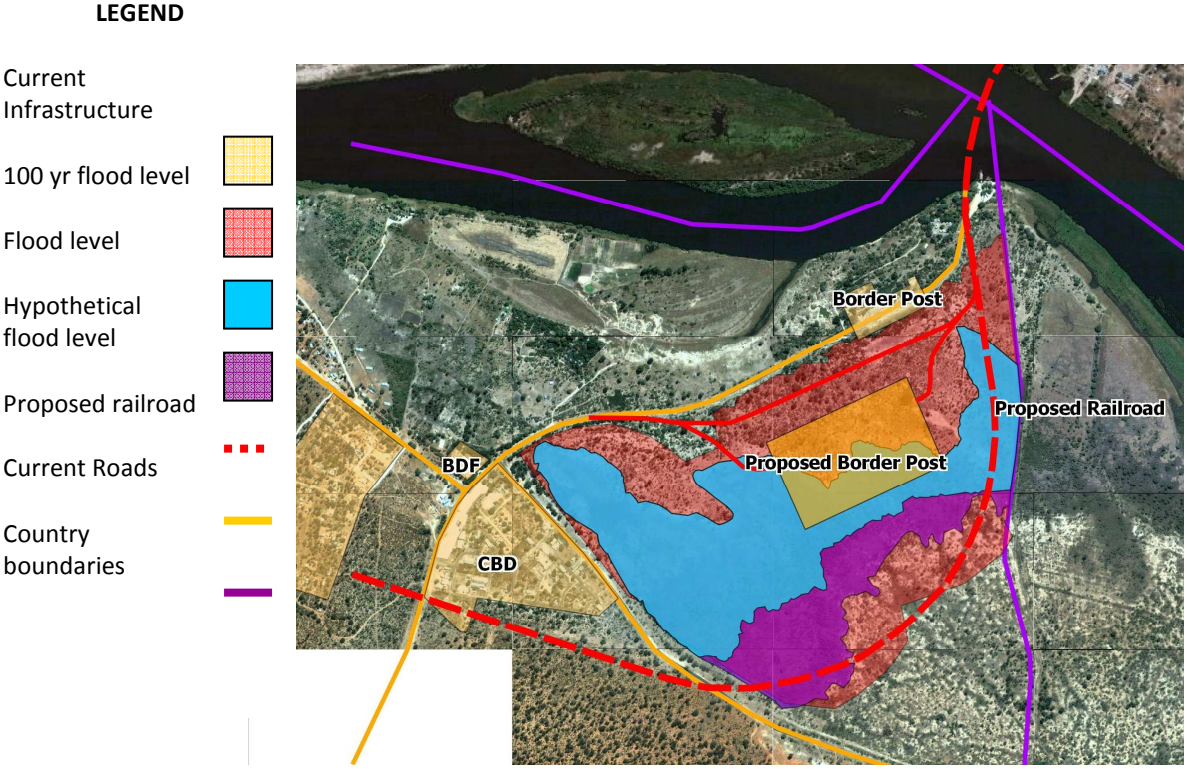
Based on the data obtained in this study, field observations, and information found in the EIA that was completed in February of 2010, the proposed Kazungula railroad and border post will negatively impact the wetland environment in Cassandra Farms in several ways, including loss of indigenous fauna, habitat fragmentation, and reduced access to habitat. These development plans bring up some very important environmental issues regarding the wetlands of Cassandra Farms and several social and economic issues as well. This portion of the report will focus on the different environmental, social, and economic issues that may arise from the construction of the new border post and railroad in the Cassandra Farms wetland area.

The proposed bridge design will be built with both a road and a railway, but only the road will be immediately accessible. Continued construction of the railway beyond the bridge will be set aside until later. The ultimate goal is to extend the railroad from the proposed bridge to Francistown. The future railroad route, as proposed by the previous EIA, seems to have been designed with little regard to the environment, current human infrastructure, and the economic costs that will be needed to construct the railroad. The anticipated railroad route seems to be lacking in detail and, due to the physical limitations of trains, the design of the curved bridge will likely constrict future railroad construction options.

Border Post

The new border post will be located on the northern side of the wetland and will occupy a total area of 21.5 hectares with 9.5 hectares (44%) lying within the current flood water level. Construction of a new border post of this size in the location proposed in the EIA for this development project is likely to significantly affect the Cassandra Farms wetland environment as it will be built partially within the wet area.

As seen in Map 3, the proposed new border post will fall within all three previously mentioned water levels. Nearly one of half of the new border post will fall within the current flood water level and the entire post will fall within the 100 year flood level presented by the EIA. This is likely to have significant costs on the environment as it will require building the structure within the wet area. Building infrastructure within a flood plain and within a wetland will have significant costs. both economically and environmentally.



Map 3: Proposed new border post and railroad, current infrastructure, and water levels.

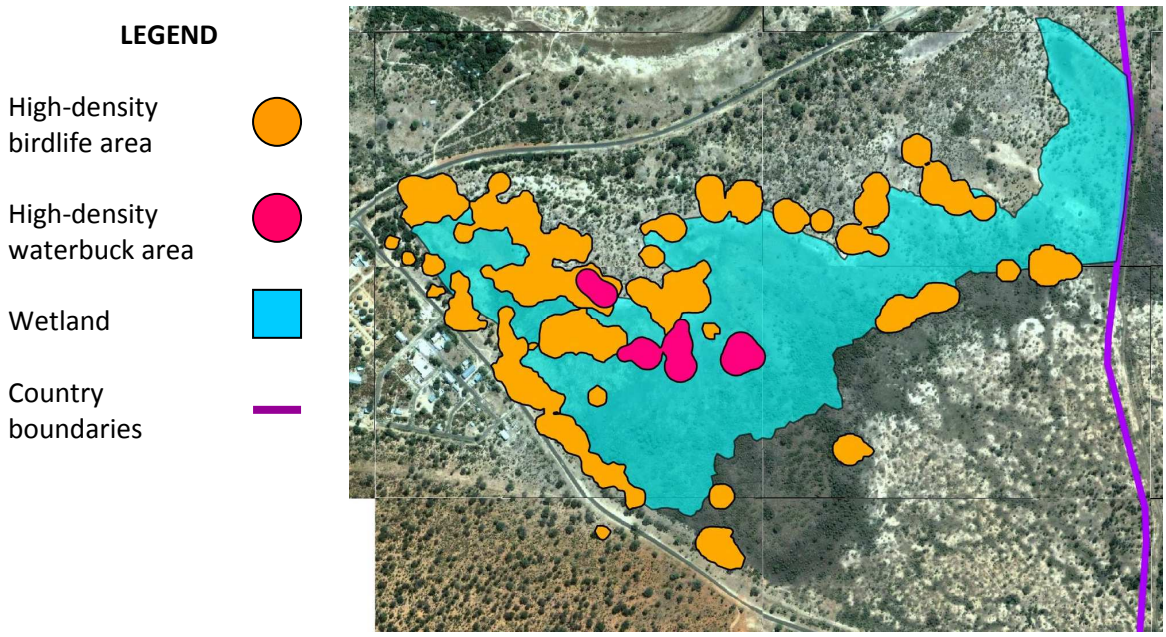
The proposed new border post would be located in an area that lies between 926 and 927 meters in elevation with a water depth that ranges up to 1 meter. The 100 year flood plain extends as high as 930 meters in elevation. In order to build the new border post above the 100 year flood plain, the earth must be raised as much as 5 meters to keep the new infrastructure from being submerged during a very high flood period. This would require a vast amount of earth to raise the site high enough to overcome the 100 year flood level. This will be costly in terms of economics and the environment. Earth must be relocated from some other site which is likely to be a very costly procedure, both economically and environmentally, considering the amount of earth that must be relocated. Assuming that the proposed site has a uniform height

of 4 meters, the total volume of earth required to raise just the new border post above the 100 year flood level (not to mention what would be required to raise the new roads that will lead to the border post) would be approximately 860,000 cubic meters of soil. Approximately 1,075,000 cubic meters of soil would be required to raise the site 5 meters, assuming the site had a uniform height. That means roughly 1,000,000 cubic meters of earth must be taken from some other location resulting in the degradation of a second site. The economic cost of moving a volume of that much earth from one location to another is likely to be very significant.

The proposed new border post will have an area of roughly 21.5 hectares. Based on the blueprints provided in the EIA, the area will be largely occupied by buildings and paving which means that the vegetation in the site must be cleared for construction. Clearing of vegetation will expose the soil in the area making it more susceptible to soil erosion. Vegetation can significantly reduce the effects of soil erosion. Removal of the vegetation at the proposed locations is likely to increase the erosion of soil, at least during the construction period, but also after construction supposing mitigation measures are not considered.

During the course of the vegetation study, protected tree species—specifically the bird plum--were identified in the study site. This protected bird plum was discovered just north of the wetland area, falling within the plot designated as the location of the new border post. Protected tree species in Botswana such as the bird plum are illegal to cut down. Based on the border post blueprints that were offered in the EIA, infrastructure and parking lots will occupy the entirety of the area so the tree would have to be removed. The EIA did not mention how this issue would be resolved nor did it mention that bird plum even existed within the study area. It is likely that other conflicts with protected vegetation could arise if a more extensive vegetation study were completed within the study site, specifically in the proposed sites of the border post and railroad.

Construction of the new border post in the proposed location is also result in the loss of habitat for birdlife and other fauna. Areas in and around the wetland showed the highest diversity and density of birdlife. The new border post is likely to obstruct water flow into the wetland area and will result in a direct loss of 9.5 hectares or 13% of wetland area at current water levels. The proposed site occupies the one area where endangered saddle-billed storks were found during the 10 days when line transects were completed. Groups of waterbuck were also found in high concentrations in the same area of the wetland that would be occupied by the proposed border post. Map 4 shows the areas of Cassandra Farms with the highest densities of birdlife and waterbuck. This wetland area provides important habitat for the indigenous fauna so building near and within the wetland will have negative impacts on the wildlife.



Map 4: Areas with high-density of birdlife and high-density of waterbuck.

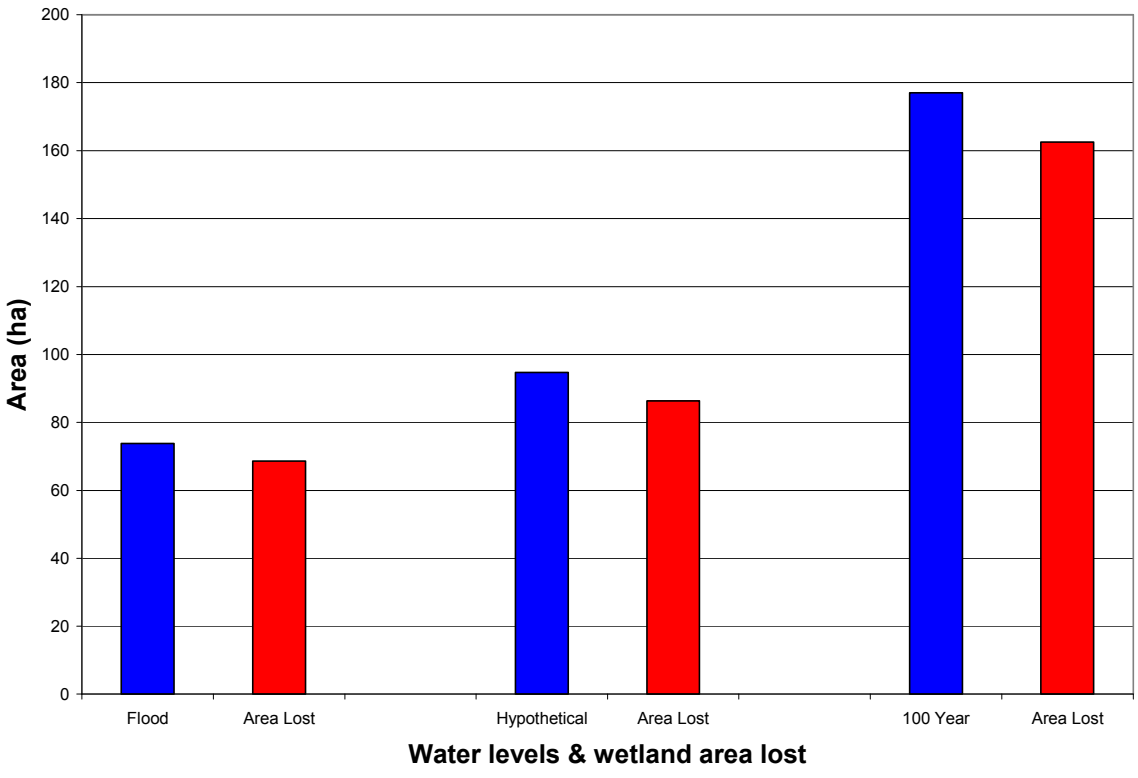
Building a border post within a wetland area is also likely to lead to contamination. The EIA took this issue into consideration in their railroad proposal. Railroad embankments will be used to not only raise the railroad above the flood plain and to the necessary height to overcome the hills to the south, but they are also intended to isolate the wetland so that water contamination from the new border post will not flow into the Zambezi River. This will significantly impact the wetland ecosystem since the flow from the Zambezi is the main water source for the wetland. Isolating the wetland from its main water source will significantly reduce the flow of water into the site, resulting in severe negative impacts on the wetland ecosystem and the indigenous fauna that reside there.

Railroad

Construction of the proposed railroad according to the designated route presented in the EIA will similarly lead to several issues regarding the environment, economics, as well as with existing human infrastructure.

The planned route for the future railroad will follow near the border with Zimbabwe, passing through the eastern portion of the wetland and eventually curving back to the west to pass behind the Central Business District. Most of the planned route will be located within the 100 year flood plain and a portion of it will pass directly through wetland area. As stated by the EIA for this construction project, " this will necessitate modification of the local drainage by building railway embankments […]. (147)" The construction of railway embankments will have severe impacts on the wetland ecosystem including obstructing the flow of water to the wetland, loss of habitat, habitat fragmentation, and reduced access to habitat through the creation of physical barriers.

Building the new border post within the 100 year flood plain and current wetland area is expected to result in contamination of water within the area. As stated by the EIA, the railway embankments are to "be incorporated and used along with the natural drainage patterns to reduce any direct flow of contaminants into the river (148)." The embankments will act as a physical barrier, keeping contaminants within the Cassandra Farms study site, but this will also obstruct the flow of water into the wetland from its main source, the Zambezi River. The study site included all of the wetland area found within Botswana, however, the wetland extends into Zimbabwe where it eventually connects with the Zambezi River. Building railway embankments like those proposed in the EIA would essentially cut off the flow of water to the wetland because the proposed rail would pass through the wetland, close to the border with Zimbabwe. Embankments constructed at the proposed site would isolate 93% of the current wetland area found on the Botswana side of the border. Graph 2 shows the total area of wetland for each water level discussed earlier and the amount of wetland area that would be isolated with the proposed rail. Nearly 90 to 95 percent of wetland area would be isolated with each scenario. The wetland area provides important habitat and resources for birdlife, especially water dwelling species like herons, ducks, and lapwings, as well as larger fauna such as waterbuck so altering the flow of water to the wetland would negatively impact the indigenous fauna.



Graph 2: Total wetland area for various water level scenarios and wetland area lost for each scenario resulting from proposed railroad construction.

The development plans proposed in the EIA call for railway embankments to be constructed in order to raise the rail above the 100 year flood plain and to climb the hills to the south. The railroad must travel upslope from an elevation of 923 meters at the site of the proposed border

bridge to 940 meters at the point where the railroad will cross the road to the Zimbabwean border. This will require that the earth be raised along the proposed path so that the trail may reach the required elevation to pass behind the Central Business District. Raising the railroad from the bridge elevation to the same elevation of the road will be very costly in terms of economics and environment, for the same reasons discussed earlier concerning the border post.

Animal movement to, from, and within the study site is likely to be significantly affected by the creation of a physical barrier such as the railway embankment. Elephants, buffalo, kudu, and impala were found in higher concentrations in the wetland area during the evenings but were observed less frequently during the daytime, indicating that the wildlife moved to and from the wetland at different times of the day. Most wildlife would cross the border with Zimbabwe or come down from the hills to the south for water and other resources provided by the wetland. A troupe of at least 70 baboons would also use the study site during the evenings. The troupe would come down to the southern shore of the wetland from behind the CBD around 5:30 PM every evening. These animals were more active during the evenings when it was cooler and when it had not rained for several days. A large embankment would significantly hinder the movement of these animals to and from the wetland. Archways were proposed as a mitigation technique, allowing animals to move underneath the railway. This would allow for limited access to the wetland for some species, but other more skittish species like waterbuck are likely to find this unappealing. It is likely that this reduced access to wetland resources would significantly limit the wildlife populations found in the area. Railway embankments would create significant obstructions to the movement of animals in the area.

It has been said that the railroad is intended to lead south to Francistown, but based on the plans presented in the EIA, it leads westward towards Kasane. The railroad runs perpendicular to the road leading to Francistown. Based on the map of the proposed railroad plans found in the EIA, it does not appear to be heading in a southern direction. There is a valley located just to the southwest of where the proposed plans end so it is possible that that is the intended route for the railroad as it would not require the train to climb the steeper slopes of surrounding hills. This was not discussed in the EIA so it is still uncertain as to where the railroad will lead.

Another significant issue with the proposed railroad is that the planned route will create conflicts with existing human infrastructure. As seen in Map 3, the current plans lead the railroad directly into an area that is currently developed for residential or commercial purposes. The current planned route for the railroad will pass through part of the southern CBD where infrastructure currently exists. As the rail crosses perpendicular to the road to Francistown, it will run directly through a site that is currently being developed and will contain a large shopping center. The plans for the railroad end as the proposed railway runs into a residential or commercial area. The satellite images used for this research are not current so it is likely that more infrastructure in the region has been created since the photo was taken. Development of a new large shopping center in that very area may also create significant issues for railroad construction.

Recommendations

Based on the limited scope of this project, alternatives and methods for mitigation were not adequately researched and will not be presented in this report. The previously completed EIA of the development project was inadequate in describing the current existing environment in Cassandra Farms.

It is clear that this project was inadequately researched with regards to its impacts on the existing environment in Cassandra Farms—especially the wetland area—as well as the social and economic implications of building the new border post and railroad in the proposed locations. For these reasons, it is recommended that construction of the project be postponed so that a sufficient EIA and proper planning may be completed. If construction commences before this is done, the project is likely to result in unforeseen environmental, social, and economic costs.

Future Research

Due to time limitations for this study, there is future research required in order to adequately assess the environmental impact of developing the Kazungula border.

Safety should always be a primary concern when conducting research in this area. The area has a high concentration of buffalo and elephant. They were most commonly seen in the southeast corner of Cassandra Farms, however, they have been seen throughout the area and spore are present in all areas of the study site. Other wildlife sightings included crocodile, wild dogs, lion, and snakes. Hyena spore have also been found in the area. This wetland site attracts a large amount of wildlife so caution should be exercised at all times when in the field.

Vegetation analysis for this study only focused on the tree species in one area of Cassandra Farms. Only 10 sample plots were taken during this study due to time limitations. A more representative data set would include a higher number of plots within the study area and these should be taken throughout the area as opposed to just one location.
The main focus should be on areas where new construction is likely to have the strongest impact, such as the areas lying west of the proposed of the railroad. Locations of protected tree species in the area are of particular interest.

A more comprehensive study of vegetation in the area should be broadened to include other types of vegetation and other areas of the study site. Vegetation in wet areas should also be analyzed as it is likely to be significantly impacted by a reduction in water. The area showed a large number of water birds such as African Jakana, herons, African Openbills, and ducks so these are likely to be significantly affected by changes in water levels.

This study was completed in April and May of 2010, during the flood season. Further hydrological analysis of water levels should be completed at different times of the year when the precipitation, specifically during the dry season when the water levels will be at their lowest. This would be useful in determining if permanent pools of water are present in the wetland and

how the biodiversity correlates to the water level. Future recommended water studies should focus on mapping of water levels when they are lowest, most likely during October or November during the dry season.

Transects should also continue to be completed at different times of the year. The presence of water is likely to be a factor in determining if or which species are present in the wetland. It is recommended that line transects be continued into the future. The time of year is likely to bring other species so transects should be continued at different times of year. Its is recommended to complete transects 1,2, and 3 three times once a month.

Conclusion

Due to the inefficiency of the current ferry boat that provides transport from Botswana to Zambia, there is definite need to find a more efficient way to travel between the two countries. Hindered trade and the high prevalence of HIV in the region indicate a need find an alternative to the Kazungula ferry. The previous EIA did a poor job of describing the environmental impact that could result in developing the Kazungula border.
Field work during this study showed that there was a very diverse bird population in the area and continued field work in this area at different times during the year would likely show even greater diversity. Other fauna such as elephants, buffalo, waterbuck, and even wild dogs were also seen utilizing the resources of the Cassandra Farms wetland. It is clear that the EIA inadequately represented the diversity of fauna that was actually present at the study site. Field work for the EIA only focused on the project sites leaving other areas were neglected (EIA, pg. 90). A proper inventory of indigenous fauna requires more extensive field work and at different times of the year—it cannot be done within a few days.

There are a number of environmental, social, and economic issues associated with the current construction plans for the new border post and railroad. Building within a flood plain will require that the sites be raised which will be costly to the environment and costly to those who are funding the project. Constructing railway embankments will also isolate the wetland area and obstruct the flow of water from the Zambezi River. Animal movement too and from the wetland will also be obstructed and this is bound to negatively affect the rich diversity in the area.

The bridge was the main focus of the EIA as it included precise design details even for the preferred lighting. It seems that little planning was done for the border post and the railroad. Aside from the obvious environmental issues, the conflicts with existing infrastructure must also be addressed before construction of this project commences.

If construction begins on this project, a diverse wetland habitat will be reduced to a lifeless contaminated pool, and this will be the first thing that international travelers see as they come into Botswana from Zambia or Zimbabwe.

Appendix A

Bird Species

COMMON NAME		
African Fish Eagle	Fork-tailed Drongo	Red-billed Oxpecker
African Grey Hornbill	Glossy Ibis	Red-billed Quelea
African Harrier Hawk	Golden Weaver	Red-billed Spurfowl
African Jacana	Goliath Heron	Red-billed Teal
African Openbill	Great Egret	Red-chested Cuckoo
African Paradise Flycatcher	Greater Blue-eared Starling	Red-eyed Dove
African Pipit	Greater Painted-snipe	Reed Cormorant
African Wattled Lapwing	Greater Striped Swallow	Ruff
Bateleur	Green Wood-Hoopoe	Rufous-bellied Heron
Black Crake	Green-backed Heron	Saddle-billed Stork
Black Heron	Green-winged Pytilia	Scarlet-chested Sunbird
Black-chested Snake Eagle	Grey Go-away Bird	Southern Grey-headed Sparrow
Black-crowned Tchagra	Grey Heron	Spur-winged Goose
Black-headed Heron	Grey-backed Camaroptera	Spur-winged Lapwing
Blacksmith Lapwing	Grey-headed Kingfisher	Squacco Heron
Blue Waxbill	Grey-rumped Swallow	Swainson's Spurfowl
Bradfield's Hornbill	Helmeted Guineafowl	Swamp Boubou
Broad-tailed Paradise-Whydah	Jacobin Cuckoo	Three-banded Plover
Brown-crowned Tchagra	Jameson's Firefinch	Tropical Boubou
Brown-hooded Kingfisher	Klaas's Cuckoo	Trumpeter Hornbill
Brown-throated Martin	Kurrichane Thrush	Verreuax's Eagle Owl
Burchell's Starling	Laughing Dove	Vervet Monkey
Cape Glossy Starling	Lilac-breasted Roller	Villiage Indigobird
Cape Turtle Dove	Little Bee-eater	White-backed Vulture
Cape Wagtail	Little Egret	White-browed Coucal
Cardinal Woodpecker	Long-tailed Paradise-Whydah	White-browed Robin-Chat
Cattle Egret	Long-toed Lapwing	White-browed Sparrow-Weaver
Common Moorhen	Magpie Shrike	White-faced Duck
Common Sandpiper	Meves's Starling	White-fronted Bee-Eater
Copper Sunbird	Meyer's Parrot	Wood Sandpiper
Coppery-tailed Coucal	Namaqua Dove	Woodland Kingfisher
Crested Francolin	Pied Kingfisher	Yellow-billed Egret
Diderick Cuckoo	Red-backed Shrike	Yellow-billed Kite
Dwarf Bittern	Red-billed Firefinch	
Emerald-spotted Wood Dove	Red-billed Hornbill	

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