An Assessment of the Drivers of Wetlands Transformation in Kisii Town, Kenya

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ABSTRACT

Wetlands are areas of importance according to Ramsar Convention. However, they are increasingly under threat as a result of unwise utilization which leads to undesired transformation. The study sought to assess how wetlands have been transformed, find out the main drivers of transformation, to establish the current status of natural wetlands and to explore stakeholders' recommendations on mitigation and rehabilitation measures of the affected wetlands in Kisii town. The target population was 440 households whose land parcels were adjacent to the wetlands of study, 7 Key informants and farmers divided into two groups for discussions. The methodology entailed use of stratified random sampling and data was collected by use of questionnaires, document reviews, interviews, group discussions and observation. Data from questionnaire were cleaned, coded and then fed into the Statistical Package for Social Sciences (SPSS) version 20 and Microsoft Excel version 2010. The analysis was then accomplished through the computation of frequencies and percentages that are presented in form of tables and figures to facilitate further interpretation, the rest of the data were analyzed through content analysis. Results indicate that 60% of the respondents were of the view that wetlands in the study area have been degraded and there have been little or no efforts of rehabilitation and restoration. The study further found out that considerable loss of biodiversity had been occasioned by negative wetland transformation. It was found out that the main drivers of wetlands transformation in Kisii town are massive development activities (15.8%), invasive species (12.5%) and overgrazing by livestock (12.5%). The study recommends that 1) Government agencies should focus on mitigation programmes to deter further degradation through multi-sectoral approach, 2) establishment of a one stop development approval center by the County government to deter development on riparian and wetland areas, and 3) gazettement of wetland areas for conservation activities. These can be achieved through formulation of wetland policy for Kisii as a County to take care of the existing policy gaps.

Keywords: Wetlands, drivers of transformation, conservation, policy awareness, Kisii Town

INTRODUCTION

Wetlands occupy approximately 6% of the earth's surface area (Ramsar Convention Secretariat, 2010). Although wetlands constitute only around 1% of Africa's total surface area, (excluding coral reefs and some of the smaller seasonal wetlands), this is likely to change drastically if appropriate conservation of wetlands is not undertaken because of the rapid wetland degradation all over the world

According to the Kenya Wetlands Regulation of 2009, wetlands cover approximately 4% of Kenya's land surface area, which increase to 6% during rainy periods. Eighty percent of wetlands are outside protected areas. Traditionally wetlands were utilized as sources of materials for construction, food, medicine, handcrafts and furniture. They also serve as important fishing areas, grazing grounds and sources of water for domestic use as well as livestock watering and also harbor huge biodiversity components (Government of Kenya, 2009).

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In the recent past, wetlands have been degraded at a rapid pace through conversion to other land uses and cover. Fifty percent of the world's wetlands have been lost in the past century (World Conservation Union, 2007). For instance, by 1990 when Kenya ratified the Ramsar convention, most of the country's wetlands had been degraded due to conversion to other land uses and cover (World Conservation Union, 2007).

Various studies have been carried out focusing on wetlands including those in Kisii. Mironga (2005a) studied the effects of farming practises on wetlands of Kisii and another study (Mironga 2005b) on wetland conservation attitudes of users in the same area. In his study of 2006, Miroga focused on the degradation of wetland ecosystems of Kisii District (Mironga 2006b). Mecha (2010) studied how households utilize riverine wetlands and how this contributes to food security in Nyamira. He found that wetlands were used to generate food products thus contributing to household food security. In addition, Masese (2012) studied the implication of human perception on the conservation of Sironga and Kianginda wetlands where she found that majority of household's perceived wetlands as an economic resource therefore exploiting them for monetary gain. However, the role of other drivers of change like climate change, water diversion for other purposes, development activity, catchment disturbance, weeds and invasive plants and their possible contribution have not been explored by earlier studies conducted in the study area.

In the recent past, the Directorate of Environment of Kisii County Government has raised concern over the rate of degradation of wetland, The conversion rate (from 70% to 100% table 7) of the riparian areas to other uses is alarming (Sate of the Environment report, Kisii 2013). Anthropogenic activities such as human settlements, brick making, overgrazing, cultivation, planting of eucalyptus trees and unsustainable exploitation of wetland resources were identified causes of pressure on the wetlands.

METHODOLOGY

Mixed methods design was adopted in this study. Quantitative data was obtained from observation checklists and questionnaires while qualitative data was obtained from interviews with key informants, group discussions with people aged 60 years and above. The study area was Kisii town, located in south-western Kenya. It is the main urban and commercial centre and the headquarter of Kisii County. Wetland areas located at Daraja Mbili, Denmanrk petrol station, Main transportation stage, Makutano petrol station area, Daraja Moja and Kereri were studied (Fig. 1).

Figure 1: Satellite imagery of Kisii town showing the location of the studied wetland

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The study targeted 440 households with land holdings adjacent to wetlands as shown in Table 1.

Table 1: Landholdings with Wetlands

Wetland type	**No.**	**Landholdings**
Riverine (streams and rivers)	5	250
Paustine (Marsh areas)	7	100
Manmade (fish ponds, water pans and shallow dams)	32	90
TOTAL	44	440

Source: Directorate of Physical planning – Kisii County

Key informants from the following institutions were also targeted; Gusii Water and Sanitation Company, National Environment Management Authority, Water Resources Authority, Physical planning department, Environment department, Fisheries department and Town administration. This is because their work is directly or indirectly linked to the health of the wetlands.

According to Mugenda and Mugenda (2013), 30% of the population is sufficient for most studies. Therefore, 132 of the residents with land holdings touching wetlands were selected for this study. This number represents 30% of the study population (Table 2). Respondents for the household survey were selected using stratified simple random sampling technique while key informants were purposively sampled.

Table 2: Sampling Strategy and Sample Size

Data Source	**Population Size**	**Number of Households next to wetland**	**Sample of Households adjacent to wetlands**	**Sampling method for households**
Riverine Wetlands	5	250	75	Stratified Random Sampling
Marshy wetlands	7	100	30	
Manmade wetlands (Ponds)	32	90	27	
Sample size			132	

Questionnaires were administered to the 132 respondents with 75 questionnaires being issued to those on Riverine wetlands, 30 questionnaires to those on marshy and 27 questionnaires were issued to those who had manmade wetlands (Ponds). (Table 3).

Table 3. Proportionate sampling

Stratum	Size of Unit	Proportionate Sampling	Total
Riverline (streams & Rivers)	250/440 * 100% = 57%	57% of 132	75
Paustine (Marsh areas)	100/440*100% = 23%	23% of 132	30
Manmade (Ponds)	90/440 *100% =20%	20% of 132	27

In focused group discussions, the researcher used purposive sampling to select older household heads with landholdings adjacent to wetlands. Both males and females from the strata size of riverine, marshy areas and ponds, 2 focused group discussions were held has indicated in table 4

Table 4. Focused group respondents

Focus group	Number of respondents	Male	Female
1	12	8	4
2	10	7	3

Data collection was undertaken by means of questionnaires which were administered to 132 respondents. Key informants were Environmental officers from National Environment Management Authority, Physical planning, Department of Kisii Municipality, and Fisheries and Water Resources Authority. Key informants from Government departments advised on the initial boundaries of the wetlands as per the 1971 Physical Development Plan of Kisii town Two group discussions were held with land parcel owners who were aged 60 years and above for information on the status of the wetlands from their childhood and how they have changed in their lifetime. Physical observations of the wetlands were also made and relevant data captured as notes. Secondary data was obtained from the departments of physical planning and Kisii Municipal services

Google maps were used to calculate the initial and the current size of the affected wetland using the standard procedure of doing so (Frančula, N., Lapaine, M., Župan, R., Kljajić, I., Poslončec-Petrić, V., Vinković, A., & Cibilić, I. 2021).

Data from questionnaire were cleaned, coded and then fed into the Statistical Package for Social Sciences (SPSS) version 20 and Microsoft Excel version 2010. The analysis was then accomplished through the computation of frequencies and percentages that were then presented in form of tables and figures to facilitate interpretation.

REULST AND DISCUSSION

One hundred and twenty respondents managed to return their questionnaires. This represented a 91% return rate which was considered sufficient for analysis. Most of the people interviewed were males (53%) while the females accounted for 47%. Most of the people given questionnaires were below 40 years of age. Table 5 shows the demographic features of the respondents.

Table 5: Demographic Characteristics of Respondents

Variable	**Categories**	**Number of Respondents**	**Percentage**
Gender	Male	63	52.5
	Female	57	47.5
Age	18-24	28	23.33
	25-30	32	26.67
	31-40	31	25.83
	41-65	18	15
	66-70	9	7.5
	71+	2	1.67

Wetland Transformation

Concerning wetlands transformation, Table 6 gives the data obtained from the field**.**

Table 6: Wetland Transformation

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	72	60.0	60.0	60.0
	No	48	40.0	40.0	100.0
	Total	120	100.0	100.0	

As shown in Table 6, sixty percent of the respondents admitted that the wetlands have transformed while 40 percent respondent that they have not transformed.

The respondents who accepted that wetlands have transformed, were further asked to describe the nature of transformation, 71.67% agreed that there has been a decrease in wetland size. For decline in water volume 79.17% were of the view that water volume has decreased and by use of physical parameters of colour and oduor 61.67% were of the perception that there has been change in wetland water quality. Water logged areas in the past had a variety of plants ranging from sedges, reeds and bulrushes which are no longer in existence and now wetland areas are planted with eucalyptus trees.

The current status of wetlands as regards to size has declined (table 7) with a percentage change of over 70%, physical water quality has deteriorated with floating objects, turbid and smelly (Table 8) with biodiversity and plant cover having mostly introduced species (Table 9)

Table 7: Summary table of the current status of change of size of natural wetlands in Kisii town

WETLAND NAME	**Initial wetland Size (M^2)**	**Current size (M^2)**	**Direction of change and percentage change**	
	(as per 1971 Physical Development Plan – PDP for Kisii Town)	**(as per year 2022)[5]**	**(-ve/+ve change)**	**# of respondents[1]**
Riverine 1 (Nyakomisaro riparian)	106,700	32,010	Negative Change -74,690M^2 70%	72
Riverine 2 (Masosa/Makutano riparian)	12,000	3,600	Negative Change -8,400M^2 70%	72
Riverine 3 (Kalro/Kisii University riparian)	21,200	21,200	Neutral	48
Riverine 4 (Kereri/Fort Jesus riparian)	18,500	5,550	Negative Change -12,950M^2 70%	72

[1] From questionnaire respondents
5. current size of wetland area calculated using Google maps

Riverine 5 (Nyanchwa riparian)	43,200	12,960	Negative Change -30,240M^2 70%	72
Mash 1 (Daraja Mbili)	33,248.53	504.63	Negative Change -32,744M^2 98%	72
Mash 2 (Daraja Moja)	61,898.50	0	Negative Change -61,898.5M^2 100%	72
Mash 3 (Prisons)	16,354.57	0	Negative Change -16,354.57M^2 100%	72
Mash 4 (Denmark/Kenya power)	25,009.77	9	Negative Change -25,000.77M^2 99.9%	72
Mash 5 (Kereri)	12,942.41	960.00	Negative Change -11,982.41 M^2 93%	72
Mash 6 (Makutano/Fisheries fish ponds)	58,287.23	0	Negative Change 100%	72
Mash 7 (Main stage)	19,281.56	0	Negative Change 100%	72

Table 8: Summary table of the current status of physical water quality of natural wetlands in kisii town

WETLAND NAME	**Physical water quality**		**Remarks[2]**
	Quality Index[3]	**Probable Cause[4]**	
Riverine 1 (Nyakomisaro riparian)	Smelly Turbid With floating objects	Sewage disposal Soil erosion Solid waste disposal	Pollution and encroachment of the riparian area from those adjacent to the stream

[2] Remarks includes any other significant observation

[3] Clear, turbid, smelly, with floating objects, eutrophicated,

[4] Soil erosion, solid waste disposal, sewage disposal, soil/debri deposition

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Riverine 2 (Masosa/Makutano riparian)	Smelly Turbid With floating objects	Sewage disposal Soil erosion Solid waste disposal	Pollution and encroachment of the riparian area from those adjacent to the stream River bank farming
Riverine 3 (Kalro/Kisii University riparian)	Clear during dry spell Turbid during rainy season	Conservation efforts from Kisii University administration Turbid of upstream agricultural practices leading to soil erosion	The stretch of the stream along the university is well conserved through planting of indigenous trees along the riparian area, No activity along the riparian area within this stretch One spring for supply of water to area residents
Riverine 4 (Kereri/Fort Jesus riparian)	Smelly Turbid With floating objects	Sewage disposal Soil erosion Solid waste disposal Soil dumping from construction excavation works Crop farming along the river banks	Pollution and encroachment of the riparian area from those adjacent to the stream There are 2 springs along the riparian area which the residents along these stretch rely on domestic water supply
Riverine 5 (Nyanchwa riparian)	Smelly Turbid With floating objects	Sewage disposal Soil erosion Solid waste disposal	Pollution and encroachment of the riparian area from those adjacent to the stream Soil dumping for reclamation at Kisii primary Construction of Churches along the riparian area There are 3 springs along the riparian area which the residents along these stretch rely on domestic water supply The area along the Kisii Golf remains undisturbed although this covers a small section but which has massive plantation of eucalyptus trees which impact on the water resource
Mash 1 (Daraja Mbili)	Turbid during rainy season Clear near the water spring area	Soil/ debri deposition	Currently being used as a public primary school The 1971 Physical Development Plan for Kisii Town set aside this area as a recreational area as it was marshy Other section of the area is used as a market, market parking area and a small section is having residential and commercial buildings The wetland has two springs which the

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			Town residents fetch water from for domestic use Vegetation observed is Echinochica pyramidalis (Esasati) The wetland has been converted to a school playing ground through soil dumping and levelizing
Mash 2 (Daraja Moja)	Turbid	Soil erosion Car washing activities Peoples' park Commercial and residential buildings Garage	Currently being used as a public open space after reclamation by soil deposition and tree planting The 1971 Physical Development Plan for Kisii Town set aside this area as a recreational area and some section its use was deferred as it was marshy area There are 4 springs along the Daraja Moja area which the residents along these stretch rely on domestic water supply – Mkototeni Youths fetch water from these springs to supply to the town on a fee The wetland area has completely been reclaimed to open green space with some section of the wetland having garages, car wash areas, road, fire station, residential and commercial buildings
Mash 3 (Prisons)	Clear at the water intake point Turbid With floating objects along the river bank	Solid waste along the river at the bridge	Currently being utilized as a fish farming area, occupied by fish ponds by the prisons department Area initial PDP planned use deferred since it was swampy
Mash 4 (Denmark/Kenya power)	Turbid With floating objects Clear water from the 2 unprotected springs at the area	Soil erosion Car washing activities Solid waste disposal	Currently the area is referred to as Denmark area and former Kenya power offices Area initial PDP planned use deferred since it was swampy There is a water intake point for Nyambera group of schools Grazing of livestock especially goats and cows Soil dumping especially on the area that is along the road The area has commercial developments including petrol station, Vehicle parking area, car wash, Kenya power offices and a vehicle garage

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Mash 5 (Kereri)	Clear – spring section Other section has floating objects with turbid water	Conservation efforts from Kereri Girls School administration Solid waste disposal Soil erosion	The wetland currently being used as a source of water for domestic use within the neighbouring residents of the institution Area initial Kisii town PDP planned use is educational, Girls school
Mash 6 (Makutano/Fisheries fish ponds)	Clear for the area near Fisheries Fish ponds Eutrophicated area at Makutano	Area under Fisheries department with clear water due to conservation efforts Makutano area has sewage disposal and solid waste disposal	Currently being utelised as a fish farming area, occupied by fish ponds by the Fisheries department – Fish multiplication center and a large section is a built up area with storey buildings and a petrol station Area initial PDP planned use for recreational purpose as a public open space The area has a garage and Makutano juakali sheds
Mash 7 (Main stage)			Currently being used as the Kisii town main stage The 1971 Physical Development Plan for Kisii Town set aside this area as deferred as it was marshy

Table 9: Summary Table of the Current Status on Biodiversity and Plant Cover of Natural Wetlands in Kisii Town

WETLAND NAME	**Biodiversity**		
	Fauna	**Plant population[6]**	**Canopy cover[7]**
Riverine 1 (Nyakomisaro riparian)	Fish Frogs Snakes	Eucalyptus along the river bank (67%) Tithonia (23%) Croton Machrostachus (7%) **n=1357** Bamboo (3%)	Indigenous 1% Introduced 74% Open 25% **n= 32,010M^2**
Riverine 2 (Masosa/Makutano riparian)	Fish Frogs Snakes	Eucalyptus along the river bank (18%) Tithonia (40%) Napier grass (9%) **n=41** Bamboo (32%) Kales (1%)	Indigenous 10% Introduced 20% Open 70% **n= 3600M^2**
Riverine 3 (Kalro/Kisii University riparian)	Fish Frogs Snakes – green Mambas	Eucalyptus along the river banks (5%) Tithonia (5%) Prunus Africana (20%) **n=2139** Croton Machrostachus (10%) Bamboo (20%) and Herbs (40%)	Indigenous 40% Introduced 20% Open 40% **n= 21,200M^2**

Riverine 4 (Kereri/Fort Jesus riparian)	Fish Frogs Snakes	Eucalyptus along the river bank (18%) Yams (6%) Pine tree (2%) **n=2636** Grevellia robusta (21%) Napier grass (3%) Croton (5%) Echinochica pyramidalis (Esasati) – (44%) Ferns (1%)	Indigenous 1% Introduced 19% Open 80% **n=5550M^2**
Riverine 5 (Nyanchwa riparian)	Fish Frogs Snakes	Eucalyptus along the river bank (27%) Tithonia (47%) **n=900** Napier grass (23%) and Bananas (3%)	Indigenous 5% Introduced 55% Open – 40% **n= 12960 M^2**
Mash 1 (Daraja Mbili)	Amphibians	Echinochica pyramidalis (Esasati) - (99%) Herbs (1%) **n=182**	Indigenous Introduced Open 100% **n= 506.63 M^2**
Mash 2 (Daraja Moja)	Amphibians	Echinochica pyramidalis (Esasati)- (6%) Herbs (14%) Bishop tree (20%) Nandi frame (20%) **n=200** Whistling pine (20) Gravellia robusta (20%)	Indigenous - Introduced 90% Open 10%
Mash 3 (Prisons)	Fish Frogs	Eucalyptus at the boundary (80%) Gravellia robusta (7%) **n=200** Echinochica pyramidalis (Esasati) – (13%)	Indigenous - Introduced 88% Open 22%
Mash 4 (Denmark/Kenya power)	Amphibians Mudfish snakes	Echinochica pyramidalis (Esasati) – (47%) Tithonia (16%) Napier grass (21%) **n=190** Papyrus Spp (7%) and Eucalyptus (9%)	Indigenous - Introduced - Open 100% **n= 9m^2**
Mash 5 (Kereri)	Fish Frogs Snakes	Eucalyptus at the boundary (20%) Yams (5%) Croton (2%) Pine tree (4%) **n=180**	Indigenous - Introduced 43% Open 57%

		Grevellia robusta (5%) Echinochica pyramidalis (Esasati) 60% Ferns 4%	**n= 960M^2**
Mash 6 (Makutano/Fisheries fish ponds)	Amphibians Fish	Croton Macrostachus (11%) **n=45** Grevellia robusta (20%) Tithonia (39%) Napier Grass (16%) and Eucalyptus (14%)	Indigenous 30% Introduced - Open 70%
Mash 7 (Main stage)	None	Grevellia robusta (75%) Croton macrostatus (25%) **n=4**	No canopy

[6] Indicates the population of the flora relative to the rest except small grasses using data obtained from field observation

[7] Indicates the approximate percentage of canopy cover of the flora With regard to key drivers of transformation of wetlands, the study established the following as shown in Table 10.

Table 10: Key drivers of wetlands change

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Sewerage discharge	6	5.0	5.0	5.0
	Timber harvesting	7	5.8	5.8	10.8
	Wood fuel harvesting	7	5.8	5.8	16.7
	Fish farming	2	1.7	1.7	18.3
	Crop farming	7	5.8	5.8	24.2
	Wildlife harvesting	3	2.5	2.5	26.7
	Soil harvesting	9	7.5	7.5	34.2
	Water diversion	10	8.3	8.3	42.5
	Climate change	10	8.3	8.3	50.8
	Development activities	19	15.8	15.8	66.7
	Invasive species	15	12.5	12.5	79.2
	Solid waste disposal	10	8.3	8.3	87.5
	Livestock grazing	15	12.5	12.5	100.0
	Total	120	100.0	100.0	

Drivers of Wetland transformation

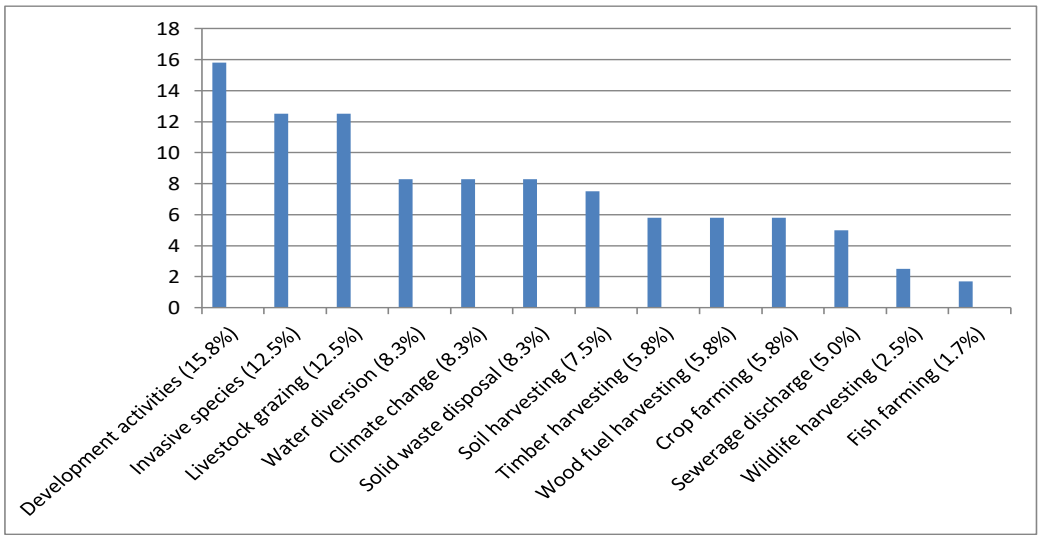

Figure 2: Respondents perception on the drivers of wetland transformation

For the drivers of wetland transformation development activities were the main drivers of change followed by invasive species then livestock grazing which has greatly affected wetland vegetation, climate change, water diversion and solid waste disposal as per the study findings stand at number four whereas soil harvesting and crop farming are at number five, wood and timber harvesting were at number six, sewage disposal at number seven, fish farming at number eight and wildlife harvesting at number nine (Figure 2).

The respondents identified climate change as one of the drivers of wetland change, a total of ten (10) respondents pointed out the issue and therefore 8.3% of the respondents were able to highlight the cause of wetland change to be climate change. Climate change alters hydrological regimes hence affecting wetlands; it leads to increased temperature and altered evapo-transpiration, altered biogeochemistry, altered amounts and patterns of suspended sediment loadings, fire and oxidation of organic sediments (International Panel on Climate Change 1998, Burkett &Kusler, 2000).

Concerning invasive species, a total of 15 respondents, representing 12.5% of the respondents identified invasive species to be the cause of wetland change, the main invasive species identified in Kisii Town by the majority are *Ecalyptus spp* locally known as Omoringamu or Omotandege. This invasive species has led to disappearance of old species from the wetlands.

On agricultural activities, Kisii region is majorly known to be an agricultural area. Therefore, water withdrawals for irrigation purposes can act to accelerate other effects of other stressors on the urban wetland ecosystems. Altinsacli and Griffiths (2001) in their study identified dewatering of wetlands for irrigation purposes; this has increased eutrophication levels especially within wetland areas hence endangering the ecosystem functions of the same wetlands.

Among the respondents, 19 of them identified development activities as a cause of wetland degradation which amounted to 15.8% of the entire population. Ten (10) respondents, representing 8.3% of the population identified wetlands as a place where people dump solid waste, six people of the respondents noted that there has been increased sewage discharge into wetlands in the recent past.

Based on the research findings, development activities contribute majorly to wetland degradation, 15.8% of the respondents identified development activities as the major contributor to degradation. The other domestic uses identified were soil harvesting (6.7%) for brick making and special soil for fine finishing of traditional houses, wood fuel harvesting (5.8 %) and timber harvesting (5.8%) for general domestic use.

CONCLUSION AND RECOMMENDATIONS

In conclusion, Kisii Town's wetlands have undergone negative transformation due to their decrease in size, which suggests that the drivers causing wetland change have been triggered, particularly development activities that have completely converted seven marshy areas to other uses, and the remaining two marshy areas have been converted to other uses by over 93%. This implies that almost all of Kisii Town's marshy areas have undergone negative transformation due to their shrinkage, with no effort or little effort on rehabilitation, as the conversion is between 93% and 100%.

The study recommends that government Agencies responsible for wetland protection should focus on the river rine of Kisii town in terms of mitigation programmes to deter further degradation. This can be achieved through a multi-sectoral approach whereby the Kisii County Government departments, NEMA, WRA and Lands work together to enhance enforcement of the riparian areas protection regulations of 2009, this should be done through multi-sectoral approach and establishment of a one stop development approval center by the County government to deter development on riparian and wetland areas. The gazettement of wetland areas for conservation activities which can be achieved through formulation of wetland policy is also recommended.

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