Dissemination of the sustainable wastewater technology of constructed wetlands in Tanzania
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Policy, Regulatory and Administrative Institutional Framework for Possible Promotion of CW Technology in Tanzania

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Dissemination of the Sustainable Wastewater Technology of Constructed Wetland in Tanzania (VLIR Research Project)

POLICY, REGULATORY AND ADMINISTRATIVEINSTITUTIONAL FRAMEWORK FOR POSSIBLE PROMOTION OF CW TECHNOLOGY IN TANZANIA

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LIST OF ABBREVIATIONS AND ACRONOMS

BOD Biological Oxygen Demand

COSTECH Commission for Science and Technology

CWConstructed Wetland

DAWASA Dar es salaam Water and Sewerage Authority

DoE Division of Environment

EIA Environmental Impact Assessment

EMAEnvironmental Management Act

IRUWASA Iringa Urban Water and Sewerage Authority

MEMMinistry of Environment and Minerals

MORUWASA Morogoro Urban Water and Sewerage Authority

MUWSA Moshi Urban Water and Sewerage Authority

NEMCNational Environmental Management Council

NEPNational Environmental Policy

SIDPSustainable Industrial Development Policy

TBSTanzania Bureau of Standard

UWSAUrban Water Supply and Sanitation Authority

WHOWorld Health Organisation

WSPWaste Stabilization Pond

WWT Wastewater Treatment

CHAPTER 1: LITERATURE REVIEW

1.0 POLICY, REGULATORY AND ADMINISTRATIVE / INSTITUTIONAL FRAMEWORK THAT CAN BE USED TO PROMOTE CW IN TANZANIA

1.1 INTRODUCTION

Wastewater treatment in Tanzania is governed by different policies and laws. Furthermore these laws mandate different institutions to manage wastewater in Tanzania. In order to be of influence CW should be in harmony with national policies and laws.It was therefore decided to review the policies and laws to establish to what extent they provide guidance to the type of technologies to be used for wastewater treatment in Tanzania. The analysis is providing the challenges and gaps that need to be addressed if the CW wetland is to be adopted as one of thepreferred technologies.

1.2 RELEVANT POLICIES

The following are relevant sectoral and cross–sectoral policies which have policy statements relevant to wastewater treatment.

1.2.1 National Environmental Policy (1997)

The National Environmental Policy (NEP) is the overarching policy that sets broad goals for environmental protection and committing Tanzania to sustainable development of its natural resources.The policy recognises pollution in towns and countryside and loss of productivity of lakes, coastal and marine waters as a result of pollution among major environmental problems facing Tanzania. Indiscriminate disposal of wastewater is one of the culprits of environmental pollution, particularly of aquatic and marine environment.One of the objectives of the policy is to prevent and control degradation of land, water, vegetation and air which constitute our life support systems.

The policy provides guidance on sectoral policies, among the policy statements discussed is the water and sanitation sector. The Policy advocates for prevention environmental pollution. Among the policy measures being advocated are: ***Promotion of technology*** for efficient and safe water use, particularly for water and wastewatre treatment and recycling; and preventing,

reducing and controlling pollution of the marine and coastal waters, including from land-based sources of pollution.Under health sector the policy provides guidance on the need for developing environmental instrastruture, such as safe and efficient water supplies, sewage treatment and waste disposal services.Under the mining sector the policy advocates for controlling mining discharges to grounds and water.Under industrial sector the policy advocates for installation of resource saving and waste recycling facilities and controlling industrial emissions. Although the policy do not specifically list the technologies to be used, it can be seen that under this policy window, CW has a major role to play and can be promoted using this policy.

Since Constructed Wetlands have potential to polish water to suitable quality for recycling andreuse, have potential to treat difficult industrial pollutants, have been used to treat acid mine drainage and have been applied to treat wastewater from health centres, they can therefore be promoted as technology that address the objectives of the Policy.

1.2.2 National Water Policy (2002)

The Policy provides guidance on water resources management. One of the policy objectives is to protect water quality and to control water pollution.The Policy specifically states that "Pollution from point and non-point sources of water resources is responsible for the deterioration of the quality of water, makes water unusable and its treatment very costly. Increased human activities including poor land use practices, as well as uncontrolled abstractions and pollution of water bodies' impact on the quantity and quality of the available water resources. Generally, the options for using water depend on its water quality. The proliferation of water hyacinth in Lake Victoria, and in some rivers and reservoirs, is a result of high nutrient levels".

Another important objective of the Policy is the promotion of research and development in the water sector. The policy specifically states that "Very little research or identification of ***low cost technologies*** is not done and is not sustainable" Due to these weaknesses, technologies which may not be appropriate to our country may have been used".

Because of the significant potential of CW in removing nutrients from wastewater, and it's low cost investment, this policy can be used to promote the use of CW in wastewater treatment chains, besides ***CW is a low cost technology***.

1.2.3 The Sustainable Industrial Development Policy (1996 -2020)

One of the Policy objectives is to enhance industrial development while ensuring environmental sustainability.Under environmental protection the policy states that "The government will promote the continuous application of an integrated preventive environmental strategy to industrial processes, products and services. This strategy will include efficient use of raw materials and energy; elimination of toxic or dangerous materials, as well as reduction of emissions and wastes at source". CW has been demonstrated to fit in such configuration; a case in point is "the Integrated Process for Sustainable Agro-Process Waste Treatment and Climate Change Mitigation In Eastern Africa in Arusha". This project has been developed under the BIOINNOVATE programme with the generous sponsorship of SIDP. The results from this project can be used to demonstrate and promote the CW technology, and this will be in line with the SIDP.

Equalization tank

Primary clarifier

Bio-digester

Figure 1: Constructed wetland along with equalization tank, primary clarifier and bio-digester under bioinnovate programme in Arusha

1.2.4 The National Tourism Policy (1999)

Under this policy protection of environmnet is given due consideration. The policy states that "The relationship between the environment and development of sustainable tourism is closely knit that the two cannot be dealt with in isolation. Protection, enhancement of various components of man's environment are therefore among fundamental conditions for harmonious developmen of tourism". Considering that most of tourist hospitality facilities are isolated, it is not easy to install central wastewater treatment systems. However, CW may play an important

role in protecting the environment at the same time deliver good water that may be used for grass watering, and thus beutifying hotel environment.

Figure 2: Zanzibar Red Bishop (Kweche mwekundu) and Black and White Mannikins fly from stem to stem.

1.2.5 The National Fisheries Sector Policy and Strategy Statement (1997)

Among the constraints the policy is acknowledging to impact the fishery industry is "environmental degradation and inability to integrate environmental protection with development". Although wastewater is not mentioned specifically, it is a known fact that untreated wastewater is a major cause of aquatic pollution and hence responsible for the mentioned constraint. Among strategies being considered to manage this problem is to promote efforts that combat the spread of noxious-water weed e.g. water hyacinth. Indirectly what this statement means is to control nutrient levels in water bodies. Hence CW may be promoted as an approved technology to reduce nutrients in wastewaters.

1.2.6 The National Energy Policy, 2003

The energy policy recognized that all energy sub-sectors and all relevant sources of energy sources of the environmental impacts of energy exploration, production, distribution and consumption are potential sources of pollution. For example Wastewater from power plants may contain unwanted pollutants. CW may be used to minimise such pollutants

1.3 RELEVANT NATIONAL PLANS AND STRATEGIES

1.3.1 National Integrated Coast Environment Management Strategy (2003)

The strategy states that “Development activities including industries, agriculture, mariculture, tourism, urbanization and other activities are potential sources of pollution. Poor waste management (solid and liquid) from various institutions and residential areas has led to environmental pollution. Improper dumping has led to air pollution, and ground water pollution through seepage. ***Inadequacy of treatment plants*** of waste water in cities and towns along the coast has led to ***discharge of raw wastewater*** into rivers, eventually in the sea, therefore risking both human lives and coastal ecosystems”.The strategy provides several strategic options that can be used to protect the coast environment. CW can play a significant role. A case example is the mangrove constructed wetland.

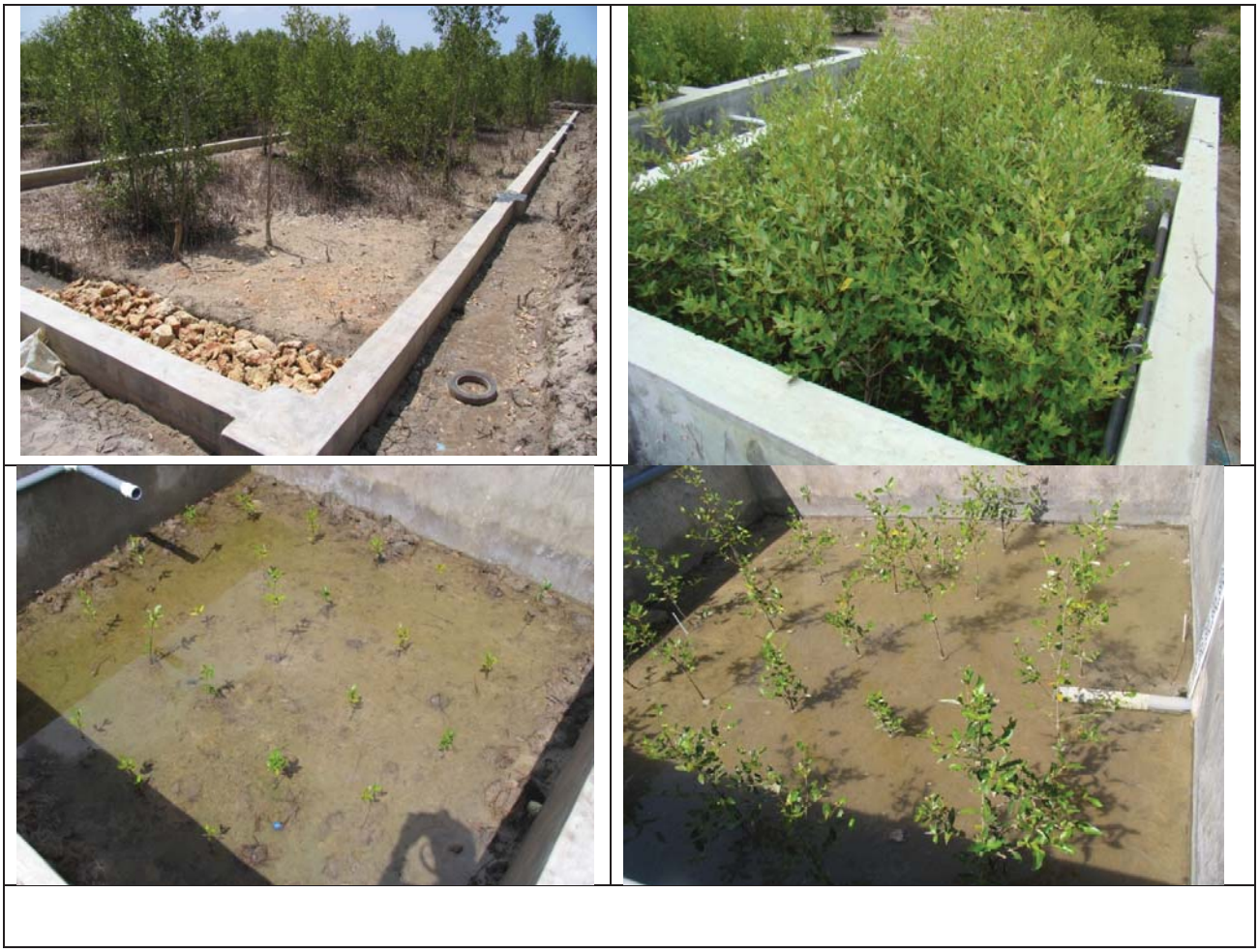

Figure 3: Mangrove Constructed Wetland

1.4 LEGISLATIONS

This section addresses the legal and regulatory conditions which may be relevant to the promotion of CW technology.

1.4.1 Environmental Management Act, Cap 191

The Environmental Management Act (EMA) Cap 191 seeks to provide for legal and institutional framework for sustainable management of the environment in the implementation of the National Environmental Policy (1997). It gives mandate to different institutions to manage environment. These In order to promote CW technology, it is important all the institutions mandated by the EMA Cap 191 to manage environment to be made aware of the CW technology. The Act also advocates for establishment of environmental units in sector ministries. At Regional level the Act

requires that Regional Environmental Management Experts to coordinate environmental management activities. The Act also mandates that Local Governments to have environmental committees at village level.

On wastewater treatment the Act states that "The local government authorities shall ensure that sewage is ***appropriately*** treated before it is finally discharged into water bodies or open land and that it does not increase the risks of infections or ecological disturbances and environmental degradation. The local government authorities shall designate and ***ensure compliance with designated disposal ponds, sewage treatment facilities and sewer points***". From this statement it can be seen that local governments may influence on which technologies to be used for wastewater. Therefore, the CW Research group should ensure the Local Governments are aware of the potential of CW in the treatment of wastewater, particularly their potential to enhance wastewater recycling and reuse.

1.4.2 The Water Resources Management Act No. 11 of 2009

This Act provides mandates of management of water resources to different institutions. Water Basins have strong mandate to manage use and quality of the water resources. A Water Board is responsible to control pollution of water resources. Since CW may provide this service, it may be advantageous to work with the Water Basins to promote the technology.

1.4.3 The Water Supply and Sanitation Act No. 12 (2009)

The Act provides for sustainable management and adequate operation and transparent regulation of water supply and sanitation services with a view to give effect to the National Water Policy, 2002. The Act established Water Supply and Sanitation Authorities. The Powers and duties of water supply and sanitation authority, include among others:

a) keep custody, acquire, including through compulsory purchase, ***construct and operate waterworks and sanitation works;***
b) enter into a trade waste agreement for the discharge of waste into a sewerage system;
c) prohibit the discharge of certain wastes into a sewerage system;

This Act categorically shows that the mandate to decide which technology should be procure for the wastewater works is the UWSA. Therefore CW technology can be and should be promoted by making aware the benefits of CW to UWSA.

1.4.4 Tanzania Bureau of Standards, Act No. 3 of 1975

The Tanzania Bureau of Standards is the designated national authority (TBS Act 1975) for developing all kinds of national standards, including environmental standards. The National Environment Management Act 2004, Part X enumerates the types of environmental standards to be established, they include among others water quality, discharge of effluent into water. Only 9 compulsory environmental standards (those that require compulsory compliance) have been developed so far. Relevant to wastewater treatment is the "TZS 860:2005 – Municipal and Industrial Wastewaters. This standard provides general tolerance limits for municipal and industrial wastewaters". As such, it may be argued that whenever standards are not met, CW may be used a polishing technology.

1.4.5 The Mining Act No. 5 of 1998

The Act requires the holder of the mining license to protect environment. The Act states that "The applicant's environmental management plan including his proposals for the prevention of pollution, the treatment of wastes, the protection and reclamation of land and water resources, and for eliminating or minimizing the adverse effects on the environment of mining operations". Since mines are known to be associated with acid mine drainage, and protection of environment against this pollution is the responsibility of the license holder CW can be promoted through sensitization of the Mining industry on the potential of CW to control acid mine drainage. However, as long as there is no law is forcing them to ensure that their discharge meets national standards, it may be difficult to deal with them directly. Therefore there is a need to work with NEMC, DoE and MEM.

CHAPTER 2: INSTITUTION ARRANGEMENT ON DECSION MAKING WHICH TECHNOLOGY TO BE USED

The EMA Cap 191 and EIA and EA Regulation G.N. 349 of 2005 give different functions and responsibilities to different institutions. **Error! Reference source not found.** provides a list of institutions and organisations and activities that have a bearing CW application.

Table 1: Key Institutions to the EIA Process

Level	Institution	Role and Responsibility
National level	Vice President's Office - Division of Environment	• Coordinates various environment management activities in Tanzania • Advises the Government on legislative and other measures for the management of the environment • Advices the Government of appropriate environmental technologies • Monitors and assesses activities, being carried out by relevant agencies in order to ensure that the environment is not degraded • Coordinates the implementation of the National Environmental Policy • Oversees the enforcement of EMA implementation
	Ministry of Water	• Issuing policy guidance on Water Resources management; Water Supply and Sanitation • Providing legal frameworks • Enforcement of laws and regulations • Environmental Unit coordinates environmental matter at ministerial level • May develop policy on the type of appropriate technologies to be used in wastewater treatment

Level	Institution	Role and Responsibility
	Ministry of Energy and Minerals	• Issuing policy guidance on energy matters • Providing legal frameworks • Issuing licenses, provisions of certificates of compliances • Enforcement of laws and regulations • Setting operation standards for energy projects • Project monitoring • Environmental Unit coordinate environmental matter at ministerial level which may include protection of environment
	Ministry of Local Governments Authorities	• Enforces/ Implements environmental policy, environmental Act at local level • Provides guidance on water treatment facilities
Regional level	Regional Secretariat	• Oversee and advice on implementation of national policies at Regional level • Oversee enforcement of laws & regulations • Advice on implementation of development projects and activities at Regional level
District level	District functional departments and extension services: Planning, Natural Resources, Lands, Fisheries, Community Development, etc.	• Issuance of different permits • Provides extension services • Facilitate public mobilization and awareness • Provides technical support and advice • Collects baseline data and information on social and economic conditions • Enforcement of laws & regulations at District Level
	Planning/Lands Departments	• Baseline data on social and economic conditions • Enforcement of laws & regulations at District Level

Level	Institution	Role and Responsibility
Community level	Village Environmental and Fisheries committee	• Watchdog for the environment, security and other community matters • Reporting on environmental performance • Provide information on local situation
UWSA	Urban Water Supply and Sanitation Authorities	• Owns and operates wastewater treatment facilities • Have mandate to procure and construct wastewater treatment facilities
Consultants	Association of Consulting Engineers Tanzania	• Advises clients on technologies to be used for wastewater treatment technologies
Academia	Tertiary Education Institutions	• Teachdifferent technologies, • Develops curricula, which may include curriculum in wastewater treatment • Conducts research in wastewater treatment technologies (particularly low cost technologies)
Media		• Involvement in awareness campaigns • Technology dissemination
Donors		• Funds wastewater treatment facilities • May influence decision on the type of technology used

CHAPTER 3: ASSESSMENT OF PROCEDURES THAT MAY BE USED TO IN DECIDING THE KIND OF TECHNOLOGY FOR WASTEWATER TREATMENT IN TANZANIA

3.0 INTRODUCTION

The information presented in this chapter is intended to assess the knowledge/understanding of government authorities and other stakeholders on the procedures used to select the type of technology to be used for wastewater treatment. The intention was to establish whether these procedures may be applied to introduce CW technology.

3.1 METHODOLOGY AND APPROACH

3.1.1 Information Collection

The information was collected from stakeholders in Dar es Salaam, Iringa, Moshi and Morogoro Regions. The stakeholders that were consulted include Ministry of water and Irrigation, Service providers i.e. Dar es Salaam Water and Sewerage Authority (DAWASA); Iringa Urban Water Supply and Sewerage Authority (IRUWASA);Moshi Urban Water Supply and Sewarage Authority (MUWSA), Morogoro Urban Water Supply and Sewarage Authority(MORUWASA) and Kinondoni, Ilala and Temeke Municipal Councils.

The total of fourteen questionnaires was sent out to different stakeholders in Dar es Salaam, Iringa, Dodoma, Morogoro, Mwanza, Tanga, Kilimanjaro/Moshi, Mbeya, Kigoma Arusha Shinyanga, Bukoba,Tabora and Mtwara Regions. In Dar es Salaam it includes Ministry of Water, Kinondoni, Ilala and Temeke Municipal Council. Among which only eight respondent which is 57% respondto the questionnaires and this include the following, Ministry of Water, DAWASA, IRUWASA(Iringa), MORUWASA(Morogoro), MUWSA(Moshi) Ilala, Kinondoni and Temeke Municipal Council. Also among these 2 respondent which is 14.3% said they are not practised any wastewater treatment in their regions i.e. Kigoma and Shinyanga.

3.1.2 Questionnaire preparation

A questionnaire was designed and reviewed by team members before it was tested. It included questions to assess the knowledge/understanding of government authorities and other stakeholders on the suitability of Constructed Wetland in the treatment of wastewaters. Also the study assessed procedures used to introduce new technologies in wastewater

treatment in Tanzania. The main interest was to establish the understanding of decision makers of the wastewater treatment technologies in general and wetland in particular. The intentions was to come up with information on understand in, on how the CW technology can be promoted for wide application of wastewater treatment in Tanzania using existing procedures. A copy of the questionnaire is attached in (Appendix).

3.2 RESULTS

3.2.1 General Knowledge on Wastewater and Its Treatment

3.2.1.1 Type of wastewater generated in urban centres

The types of wastewater generated in urban centres/in their locality are as shown in **Error! Reference source not found.**. However, some of the respondents reported more than one type of wastewater generated in their locality.

Table 2: Type of wastewater generated in urban centres

Type of wastewater	N = 20	% Frequency
Domestic wastewater	6	30
Industrial wastewater	5	25
Mining wastewater	1	5
Abattoir wastewater	4	20
Tannery wastewater	2	10
other (storm water)	2	10

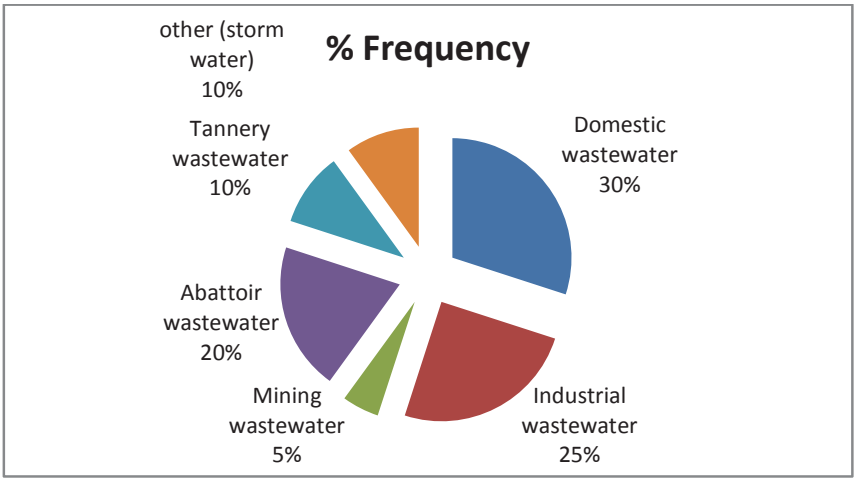

Figure 4: Percentage frequency of wastewater generated in urban centre

3.2.1.2 Technology used to treat wastewater

Most common technology used to treat wastewater reported by all respondents was Waste Stabilizations Pond (WSPs). Two of respondent from Iringa (IRUWASA) and Moshi (MUWSA) reported that they use also Constructed Wetland for final polishing of the effluent from WSPs before discharged to the environment.

3.2.1.3 Basis of selection technologies adopted

In response to the question on how the technology was selected, respondents reported that

- Through studies
- Depending on the treatment required due to component or chemical composition which in turn depend on the production
- Depending on the legal requirements to reach
- Aiming to attain required effluent standard before disposal to the environment
- Nature of town terrain and simplicity of operation and maintenance

3.2.1.4 How the performance is monitored

Most of the respondents indicated that they measure quality of the discharged wastewater through laboratory analysis and compare with standards.

3.2.1.5 Awareness' of TBS standard on wastewater discharge

Most of the respondents (66.7%) are aware of TBS standard on wastewater effluent. 33.3% indicated that they are not aware of TBS standards. However they indicated that they are aware of WHO standards on wastewater discharges.

3.2.1.6 Challenges facing the wastewater management industry in Tanzania

The following are the responses:

- Most of industries have no proper facilities for wastewater treatment some have partial treatment while others discharge untreated wastewater.
- Lack of sufficient knowledge of wastewater disposal on the part of the people producing wastewater
- Mixing of wastewater from different sources which have different characteristics and the different treatment requirements.
- The performance of existing wastewater treatment system mostly (WSP) does not work to the required standard, due to lack of regular inspection and maintenance.

- Absence of standby equipment for measuring wastewater quality to check the quality on site
- High costs of wastewater sample test at the Chief Government Laboratory Chemistry

In response what can be done to the challenges identified, the following are the responses:

- Enforcement of the existing policies and laws is the only weapon for industries to comply
- Educating people producing wastewater on proper ways of wastewater disposal i.e. to pre-treat their wastewater generated before discharging into treatment area
- To improve law enforcement by providing adequate resources
- To conduct regular inspection and maintained of wastewater treatment system should be conducted
- To increase investment on wastewater management
- Availability of equipment to check the quality of wastewater
- Reduce the cost payable for wastewater testing for the better of environmental protection

3.2.2 General Awareness' On Constructed Wetland Technology

3.2.2.1 Awareness of CW

All of respondents were aware of a Constructed Wetlands as wastewater treatment technology and how it works.

A. In response to the question on Advantages of using Constructed Wetland for wastewater treatment, more than (83.3%) of respondents reported that:

i. It provide a high level of treatment

- It improves the performance of WSP by confirmed final effluent of wastewater from WSP by killing pathogens, one of the respondents insisted by saying that test results show that phosphorus, nitrate-nitrites, ammonia, BOD_5 and suspended solids can be reduced to very acceptable levels.

ii. Is inexpensive to operate and construct

- Low cost technology
- Easy to maintain and operate wastewater can flow under gravity

- No mechanical/moving parts needed

iii. Reduces, if not completely eliminates, odour

iv. Is able to handle variable wastewater loadings

v. Reduces the land area needed for application of wastewater

vi. Provide wildlife habitat

B. In response to the question on disadvantage of using CW technology for wastewater treatment, 33.3% of respondents reported that:

- CW technology is a tertiary treatment for concentrated waste it cannot work efficiently and it is a slow process
- Is affected by seasonal weather conditions, which may reduce treatment reliability such as cold and drought reduces the efficacy of the system.

3.2.2.2 General view regarding the appropriateness of CW technology for wastewater treatment

Nearly all respondents agreed that CW is an appropriate technology for wastewater treatment in Tanzania. The following are their responses:

- It is proper to be used for domestic waste but not for heavy industries
- It is a good technology but will need attention to the waste from industries. As its functions depend on biological activities e.g. bacteria, plants, weeds
- The technology is limited to treat wastewater at low scale i.e. from small communities that generate small quantities of wastewater
- Risk of animals to eat plant material which are contaminated and such contaminants may reach human being
- It improves the performance of wastewater stabilization ponds by improving the final effluent.
- Retention period of lagoons to hold wastewater must be observed for better treatment of wastewater plus the size of the lagoons if it fit the quantity of water to be discharged. Because the purification quality depend much on retention period
- Environmentalists have referred to wetlands as nature's kidneys. Much interest has developed in recent years in using constructed wetlands to remove contaminants from water, whether it is effluent from municipal or private waste systems, industrial or agricultural wastewater, or acid mine drainage

3.2.3 Policies and Laws that may be used to promote use of CW

3.2.3.1 Awareness' on policies and laws that govern and enable wastewater management in Tanzania

83.3% of the respondents were aware of the policy or laws specifically governing and enabling wastewater management in Tanzania, some of respondent indicated to be aware of the following polices:

- National water policy (2002)
- Energy policy (2003)
- Environmental policy (1997)
- Water resources management Act No. of 2009
- Environmental Management Act Cap 191
- Mining Act No. 14 of 2010
- Public health Act No. 1 of 2005
- Local government Act No 8 of 1982

3.2.3.2 Existing of policies and laws to guide the selection of technology to be used for treatment of wastewater

The majority of the respondents indicated that thereare no policies or laws that guide the selection of the technology to be used for treatment of wastewater; some indicated that there are policies and laws that guide the selection of technology. They cited the Environmental Policy (1997) and EMA 2004 Cap 191. However, one of respondent was not aware of the presence of policies or laws that guide the selection of the technology to be used for treatment of wastewater; instead he/she reported that, the selection of the technology is based on specific studies for a given application. The results are diverse as shown in

.

Table 3: Existence of policies and laws guiding the selection of wastewater treatment technology to be used

Response	N = 8	% Frequency
There is policy and law	2	25
No policy or law	5	62.5
Not aware	1	12.5

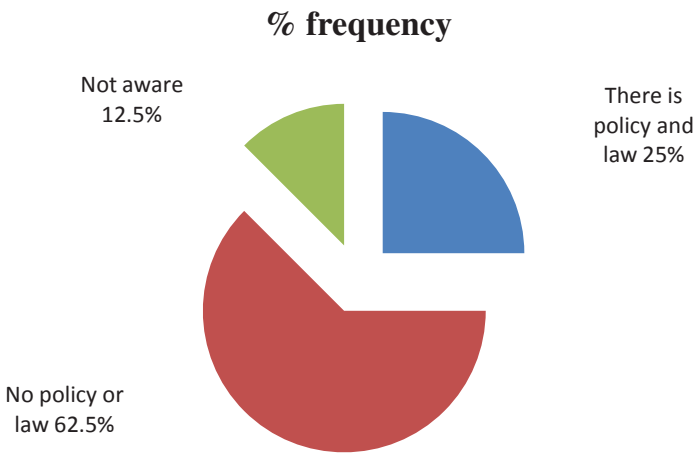

Figure 5: Percentage frequency of existence of any policy or law that guide selection of WWT technology to be use.

3.2.3.3 Responsibility for formalization of new innovative and appropriate technologies for wastewater treatment

About (66.7%) respondentsreported that the following institutions, are responsible were for introducing new technologies.

- Ministry of Health,
- Ministry of Water,
- Vice President Office
- Other ministries related to environmental issue

Other potential stakeholders that can be consulted in order to formalize a new innovative technology, they mention that; Institution and private consultants such as owners of industries, operators and asset owner of wastewater management systems.

3.2.3.4 Presence of structure or procedures for formalization of new innovative technology for wastewater technology for wastewater treatment in Tanzania

In response to this question one of respondent said that for formalization of new innovative and appropriate technologies for wastewater treatment, it has to be approved by COSTECH i.e. Commission for Sciences and Technology.

3.2.3.5 Presence of Relationship between a policy/law that govern wastewater management and formalization of new innovative technologies for wastewater treatment

Half of the respondent (50%) said there is relationship and one of the respondents came from the Ministry of Water and Irrigation, and they explain how the relationship exist

- Laws enforce the implementation of policy and each new technology should be addressed in the policy
- By following Tanzania receiving water bodies standards

3.2.3.6 Possibility of promotion of new innovative technologies for wastewater treatment using existing policies

Most of the responded said it possible to promote the use of new innovative technologies for wastewater treatment using existing policies, see**Error! Reference source not found.**.

Table 4: Possibility of promotion of new technologies for wastewater treatment using existing policies

Response	N = 8	% Frequency
Possible	7	87.5
Impossible	0	0
Not sure	1	12.5

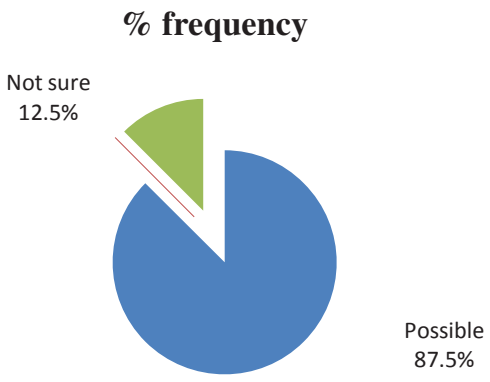

Figure 6: Possibility of promotion of new technologies for WWT using existing policies.

In response to question on influence of existing policies on new innovative technologies for wastewater treatment, the respondents reported that:

- These policies require innovative technologies to meet required disposal of wastewater standards (Before final disposal to the environment).
- The policy guide the procedure to reach the outcome/output of innovative technology

3.2.3.7 General comments on the formalization and uptake of new innovative technologies for sustainable environmental management

In response to the question the respondents observed that:

- Constructed wetland technology is a good approach for wastewater treatment
- Researchers should innovate simple and appropriate technology which is friendly e.g. constructed wetland technology.
- Government should be advised on environmental experts employment in any wastewater generating activity
- Educating people on the best way of using sewerage system if any; and importance of constructing private Constructed Wetland at low density residential areas

CHAPTER4. DISCUSSION, CONCLUSION AND RECOMMENDATION

4.1 Discussion

The survey aimed at assessing the knowledge/understanding of government authorities and other stakeholders on the suitability of Constructed Wetland in the treatment of wastewaters. Also the study assessed procedures that may be used to introduce new technologies in wastewater treatment in Tanzania. From the data analysis it can be seen that majority of the government authorities and other stakeholders are aware and have the general knowledge on wastewater and treatment technologies used in their locality and are able to identify the challenges they face in dealing with wastewater management industry in their area.

One of the most challenges reported was the poor performance of existing and most applicable wastewater treatment system,the WSP. The respondents reported that WSP do not work to the required standard, due to lack of regular inspection and maintenance as well as mixing of wastewater from different sources which have different characteristics and thus

requiring different treatment techniques. This is an area where the CW Research Group may intervene to promote the CW.

On general awareness on the suitability of Constructed Wetland Technology in the wastewater treatment, the survey shows that nearly all respondents are aware of the CW technology and how it works, its advantages and disadvantages. The CW Research Group may capitalise on this knowledge to promote use of CW technology.

The survey also shows that majority of the respondent are aware of the existing policies and laws specifically governing and enabling wastewater management in Tanzania. However Most of the respondents reported that there is no policy or law that guide the selection of the technology to be used in wastewater treatment. It is important to note that without a policy or law that specifically guide the type of technologies to be used, it will take many years for CW to be adopted as appropriate technology. The survey also shows that Ministries are responsible to develop such policies and laws.

Lastly the survey revealed that it is possible to promote the use of new innovative technologies for wastewater treatment by using existing policies and laws.

4.2 Conclusion

Awareness raising on the technology using successful examples the CW Research Group has developed in Tanzania, Kenya, Uganda, Ethiopia, Seychelles could play a big role in the promotion of the CW technology in Tanzania.

4.3 Recommendation

It my therefore recommended that the CW Research Group should develop a communication strategy that will be used as a vehicle to disseminate and raise awareness of all stakeholders on the suitability of CW in wastewater treatment. Particularly drawing attention the impacts of climate change on water resources and hence recirculation and reuse of wastewater is a very important mitigation and adaptation strategy.

APPENDIX 1

ENVIRONMENTAL QUESTIONNAIRE

TO ASSESS KNOWLEDGE / UNDERSTANDING OF GOVERNMENT AUTHORITIES AND OTHER STAKEHOLDERS ON THE SUITABILITY OF CW IN THE TREATMENT OF WASTEWATERS

AND

PROCEDURES THAT MAY BE USED TO INTRODUCE NEW TECHNOLOGIES IN THE RECOMMENDED USE OF WASTEWATER TECHNOLOGIES IN TANZANIA

General information		
1	Date of interview	
2	Name of interviewer	
3	Name of respondent	
4	Name of institution	

5	Position of the respondent	
6	Overall mandate of the institution	
7	Contact details	

General knowledge on wastewater and its treatment

2.1	What are the types of wastewater generated in urban centres / in your locality? (a) Domestic wastewater ( ) (b) Industrial wastewater ( ) (c) Mining wastewater ( ) (d) Abattoir wastewater ( ) (e) Tannery wastewater ( ) (f) Others ( ) (g) I Don't know ( )
2.2	Which technology are using to treat wastewater (a) Domestic wastewater ( ) (b) Industrial wastewater ( ) (c) Mining wastewater ( ) (d) Abattoir wastewater ( ) (e) Tannery wastewater ( ) (f) Others ( ) (g) I Don't know ( )
2.3	How was the technologies selected (how was the technology recommended? …… …… …… ……
2.3	How do you monitor their performance? …… …… ……
2.5	Are you aware of TBS standards on wastewater discharges? .....

	…… …… ……
2.6	What are the challenges facing the wastewater management industry in Tanzania or your area? …… …… …… ……
2.7	What can be done to solve the above challenges? …… …… ……
General Awareness on Constructed Wetland Technology for Wastewater Treatment	
3.1	Are you aware of a Constructed Wetland as wastewater treatment technology? Yes ☐ NO ☐
3.2	If No, are you interested to know what it is and how it works? …… ……
3.3	If YES, what are the advantages and disadvantages of using CW technology for wastewater treatment? …… …… ……
3.4	What are your general views regarding the appropriateness of CW technology for wastewater treatment in Tanzania? …… ……

	…… …… ……
The Policy & Laws Environment	
4.1	Are there any policies and laws specifically governing and enabling wastewater management in Tanzania? Mention them. …… …… …… ……
4.2	Is there any policy or law guiding selection of technology to be used for treatment of wastewater? if yes which policy and how it meet the intended objectives, explain …… …… ……
4.3	What other policies and laws are addressing wastewater management in Tanzania? …… …… ……
4.4	Who is responsible for formalization of new innovative and appropriate technologies for wastewater treatment? What are other potential stakeholders that can be consulted in order to formalize a new innovative technology? …… …… …… ……
4.5	Is there any structured procedure for formalization of new innovative technology for wastewater treatment in Tanzania? What is it? …… …… …… ……

4.6	Is there relationship between a policy / law that govern wastewater management and formalization of new innovative technologies for wastewater treatment? Ifyes,how?…… …… …… If not, from what planning level can the formalization of new technologies be successful intervened? …… …… …… ……
4.7	Is it possible to promote the use of new innovative technologies for wastewater treatment using existing policies? …… …… …… …… ……
4.8	What is the influence of a policy brief on new innovative technologies for wastewater treatment on existing policies? …… …… …… …… ……
4.9	What are your general comments on the formalization and uptake of new innovative technologies for sustainable environmental management?

	…… …… …… ……

Thank you very much for your time and collaboration

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Dissemination of the sustainable wastewater technology of constructed wetlands in Tanzania

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