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Constitution-Making Process in Tanzania (2011-2014): A New Era for Women Political Participation?

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ABSTRACT
Constitution-making as a public policy process requires substantive participation of all citizens in determining the content of the constitution. In Tanzania, unlike the colonial and post-colonial constitution-making legal framework and processes, the 2011-2014 constitution-making process was a critical juncture for it was governed by the Constitutional Review Act, CAP 83 R.E 2012 which for the first time contained provisions allowing citizens including women to participate and influence the content of the 2014 Proposed Constitution. This article examines two interrelated questions notably the extent to which women were involved in the constitution-making process, and how such participation impacted the content of the Proposed Constitution in terms of protection and promotion of women political participation in the country. It is argued that the legal framework facilitated meaningful participation of women in each step of the constitution-making process. Consequently, women managed, for the first time in history, to secure constitutional guarantees of equality and non-discrimination in political life.

Keywords: *Tanzania, constitution, gender, Constitutional Review Commission, Constitutional Review Act, CAP 83 R.E. 2012*

INTRODUCTION

Globally, participation in the constitution-making process is emerging as a legal right. For the constitution to have legitimacy and to fulfil the notion that the government is 'of the people, by the people, and for the people,' all citizens, both men and women, should be substantially in determining the content of the constitution.[1] The United Nations

[1] Hart Vivien 'Democratic constitution-making' (2003)- Module 4_5.1A.pdf. (n.d.), available at http://www.constitutionnet.org/files/Module%204_5.1A.pdf accessed on March 21, 2019.

Human Rights Committee (UNHRC)[2] through General Comment No. 25[3] expounds the meaning of the right to take part in the conduct of public affairs, and confirms participation in constitution-making process as a legal right in line with Article 25 of the International Covenant on Civil and Political Rights (ICCPR).[4] The UNHRC asserts that citizens participate directly in the conduct of public affairs when they choose or change their constitution or decide public issues through a referendum or other electoral processes conducted in accordance with paragraph (b) of Article 25 of ICCPR. Specifically, women's rights advocates infer women the right to participate in constitution-making from Article 7(b) of the Convention on Elimination of All Forms of Discrimination against Women (CEDAW).[5] Article 7 (b) of CEDAW provides rights for women to participate in the formulation of government policy, its implementation, to hold public office and perform all public functions at all levels of a government. Also, the Protocol to the African Charter on Human and Peoples' Rights on the Rights of Women in Africa (Maputo Protocol)[6] requires state parties to take specific measures to ensure women are equal partners with men at all levels of development and implementation of state policies and development programmes. The inclusion of the word participation in the formulation and implementation of public policy provides clear guidance and better inference of constitution-making as a public policy process necessitating public participation including that of women.

[2] The Human Rights Committee is established by Article 28 of the ICCPR 1966.

[3] UN Human Rights Committee (HRC) 'CCPR General Comment No. 25: Article 25 (Participation in Public Affairs and the Right to Vote), The Right to Participate in Public Affairs, Voting Rights and the Right of Equal Access to Public Service' 12 July 1996, CCPR/C/21/Rev.1/Add.7, available at *RefWorld*http://www.refworld.org/docid/453883fc22.html accessed 16th October 2019.

[4] International Covenant on Civil and Political Rights (ICCPR) adopted and opened for signature, ratification, and accession by General Assembly resolution 2200A (XXI) of 16 December 1966, came into force on 23 March 1976. The ICCPR, together with the Universal Declaration of Human Rights and the International Covenant on Economic Social and Cultural Rights, are considered the International Bill of Human Rights. Available at FAQ: The Covenant on Civil & Political Rights, https://www.aclu.org/other/faq-covenant-civil-political-rights-iccpr accessed on 15th October 2019.

[5] CEDAW is often referred to as the 'women's bill of rights.' It is one of the core international human rights treaties of the United Nations treaty system, which requires member states to undertake legal obligations to respect, protect, and fulfil human and women's rights. CEDAW was adopted and opened for signature and accession by the United Nations General Assembly Resolution 34/180 on 18 December 1979. Tanzania ratified CEDAW in 1985, Kenya in 1984, and Rwanda in 1981.

[6] Article 66 of the African Charter on Human and Peoples' Rights provides for the making of special protocols or agreements where necessary to supplement the provisions of the African Charter. This gave power to the Assembly of Heads of State and Government of the Organization of African Unity in its Thirty-First Ordinary Session in Addis Ababa, Ethiopia, in June 1995 to endorse by resolution AHG/Res.240 (XXXI) the recommendation of the African Commission on Human and Peoples' Rights to elaborate a Protocol on the Rights of Women in Africa.

Inspired by CEDAW, the Maputo Protocol and the general world trends some countries have pioneered the incorporation of participation in constitution-making process as a legal right in national constitutions and laws. For instance, the Constitution of the Republic of South Africa[7] specifies under Sections 59(1)(a), 72(1)(a) and 118(1)(a) that the National Assembly should ensure government by the people under the Constitution by facilitating public involvement in the legislative and other processes of the Assembly. The recent constitution-making processes in East Africa exemplified by the process towards the making of the 2010 Kenyan Constitution, was also guided by the Constitution of Kenya Review Act,[8] containing detailed legal framework guaranteeing peoples participation in the constitution-making process. In Tanzania, especially after the long existence of the 1977 Tanzania's Constitution coupled with several ad hoc amendments, and persistence of peoples' demand for the new Constitution, the process of reviewing the constitution occurred from 2011 to 2014. This epoch was the only historic moment that Tanzania as a country endeavoured to engage in a participatory constitution-making process. This article examines two interrelated questions notably the extent to which women were involved in the 2011-2014 constitution-making process, and how such participation impacted the content of the 2014 Proposed Constitution in terms of protection and promotion of women political participation in the country. It is argued that the legal framework facilitated meaningful participation of women in each step of the constitution-making process. Consequently, women managed, for the first time in history, to secure constitutional guarantees of equality and non-discrimination in political life.

Many modern constitutions, including that of Tanzania, were originally written by men at a time when women were systematically denied the right to take part in decision-making spaces.[9] Women were excluded in three tiers, first in identifying constitutional issues, second in the process of defining constitutional priorities, structures and rules, and third as citizens participating in these structures and enjoying the rights at the

[7] Constitution of South Africa, 2014.
[8] The Constitution of Kenya Review Act Chapter 3A Revised Edition 2009 (2008) Published by the National Council for Law Reporting with the Authority of the Attorney General. Lancaster constitutions were negotiated at independence by the British upon handover of state powers to newly independent states. Peter Kasanda, Teresa Parkes and James Pius 'Tanzania Constitution Review – President announces date for referendum' (2014) Clyde & Co LLP.
[9] Hari P. Bhattarai & Jhalak Subedi (ed) 'Democratic constitution making experiences from Nepal, Kenya, South Africa and Sri Lanka' (2007), *International IDEA* ISBN: 978-99933-838-4-0.

same level as men.[10] As large groups of women were not part of the freedom and the independent constitution negotiations, their will and wishes did not feature in the 1961 Independence Constitution.[11] As a result, the Tanzania's Parliament contained only six women by 1965.[12] Yet, the constitutional amendments in Tanzania commenced as the required two-thirds majority of all members of the Assembly to support and pass any alteration of the Constitution was achieved. These legal provisions allowed the Government and the Legislative Assembly to be the main constitution-making organs, and no public consultations were required by law.[13] As a result, a few political elites dominated and spearheaded the onward Constitutional Amendments. For example, soon after independence, Tanganyika African National Union (TANU)[14] nominees formed a Constituent Assembly and revised the 1961 Constitution,[15] which gave birth to the 1962 Republican Constitution and established a strong presidential system.[16] In 1965, the Republican Constitution was modified by a group of a few government officials to cater for the 1964 Union between Tanganyika and Zanzibar.[17] This led to the adoption of the Interim Constitution of the United Republic of

[10] Ibid.

[11] In 1961, the Tanzanian Independence Constitution was based on the traditional Lancaster style, imposed by British colonialists, without a Bill of Rights and public participation.

[12] United Nations Economic Commission for Africa (2005-09) *Tanzania Gender Networking Programme (TGNP): Report on African Gender and Development index (AGDI)-the Tanzania Report* (2005) Addis Ababa © UN. ECA, available at http://hdl.handle.net/10855/3777 accessed on 15 December 2019.

[13] HWO Okoth Ogendo *Constitutions without Constitutionalism: Reflections on an African Political Paradox*. New York American Council of Learned Societies.

[14] Geoffrey Ross Owens 'The secret history of TANU: Rumor, historiography and Muslim unrest in contemporary Dar Es Salaam' History and Anthropology' (2005) 16:4, 441-463, DOI: 10.1080/02757200500399107.

[15] 'Key Historical and Constitutional Developments' available at *http://www.kituochakatiba.org/sites/default/files/legal-resources/Tanzania%20Key%20Historical%20and%20Constitutional%20Developments.pdf* accessed on 9 October 2019. The 71 elected members of the national assembly, all elected members of TANU passed a law that allowed them to convert the national assembly into a constituent assembly with powers to adopt the new constitution.

[16] Ibid. The new President of Tanzania was granted the prerogatives of both former roles, Governor General and First Minister, serving as the head of state as well as commander in chief of the armed forces. He was granted the right to designate the vice president and Ministers, and the right to dismiss the Parliament under certain circumstances. The President also inherited security-related, repressive powers that were formerly of the Governor General, with the addition of new ones; the Preventive Detention Act, for example, gave the President the right to detain any person without trial. Under the 1962 constitution, the president inherited all the powers of the governor by the colonial legislation such as the Deportation Ordinance, the Collective Punishment Ordinance, the Emergency Powers Order in Council to which the independent government added its own repressive laws such as the notorious Preventive Detention Act, which gave the president powers to detain a person without trial. An existing national assembly which converted to a constituent assembly by an Act of parliament passed the new Republican Constitution.

[17] Ibid. In 1964, Tanganyika and Zanzibar merged into the "United Republic of Tanzania" that same year. The Union was constituted by signing of a treaty called the Articles of Union by the respective heads of state Mwalimu Nyerere and Abeid Amani Karume. It was ratified by the respective legislative bodies and became part of the municipal law called the Acts of Union). These agreements had been ratified under the name "Articles of Union", and became part of the new constitution as "Acts of Union."

Tanganyika and Zanzibar.[18] The constitution was again amended in 1965 to abolish the multi-party political system and formalise a one-party state system.[19] The process for enacting the 1965 Tanganyika Interim Constitution was through an ordinary Act of Parliament, without involvement of the people.[20] The 1965 Tanganyika Interim Constitution, under Article 51, provided the procedure for amendment of the Constitution. The procedure required any Bill intending to alter the Constitution to be supported and approved by no less than two-thirds of votes of members of Parliament. Further, after the 1964 Union of Tanganyika and Zanzibar,[21] Articles vii (a) and (b), of the Article of the Union of Tanganyika and Zanzibar[22] provided a procedure for the adoption of a permanent constitution.[23] According to the Articles of the Union, the permanent constitution was to be proposed by a constitutional commission, which would then send it to the constituent assembly for deliberation and adoption. [24] The permanent constitution was supposed to be adopted within a year.[25] After twelve years, the President of the United Republic of Tanzania appointed a 20-person joint party committee to propose a new Constitution.[26] However, within a short time, the committee made and sent proposals to the National Executive Committee (NEC) of the ruling party which adopted them in a day and in camera.[27] In 16 March 1977, the President appointed the Constituent Assembly on the same day as the Committee, to discuss and enact the new constitution.[28] The Bill for the new Constitution was published seven days before the Constituent Assembly met to discuss it and enacted the

[18] The most notable feature of the Acts of Union as incorporated in the Union Constitution was the establishment of the double government structure that is also part of Tanzania's current constitution. This structure included one government for the Union and one largely autonomous independent government for Zanzibar. Zanzibar's government included its own Parliament and President. The President of Zanzibar also served as vice president of the Union. The constitution of 1964 was adopted as *interim*. The Acts of Union themselves included directions on steps to take to elaborate a definitive constitution, to be elaborated by a constituent assembly comprising representatives of both TANU and ASP. This procedure was initiated but was later suspended.

[19] This was coherent to the double government structure defined in 1964; the 1965 Constitution identified two government parties, TANU for the Union and AfroShirazi Party for Zanzibar. The Constitution of TANU was made a schedule to the Constitution thus legally endorsing the emergence of a party state.

[20] 'Key Historical and Constitutional Developments' op cit note 22.

[21] Challa M Future Generation Learning Resources, NGL Resources, available at https://johnchalla.wordpress.com/2017/06/06/the-reasons-of-the-union-between-tanganyika-and-zanzibar/ accessed on 9th October 2017.

[22] 'Key Historical and Constitutional Developments' op cit note 27.

[23] Ibid. First Schedule of the Union of Tanganyika and Zanzibar Act No. 22 964 on 7/01/2019.

[24] Ibid. The Constituent Assembly was supposed to be composed with representatives of both Tanganyika and Zanzibar.

[25] Ibid.

[26] 'Key Historical and Constitutional Developments' op cit note 29. The committee was headed by Thabit Kombo.

[27] Ibid.

[28] Ibid.

Constitution in three hours after it was presented.[29] Both the Constitutional Commission and Constituent Assembly were formed albeit in a fashion that side-lined public participation.[30] In 1977, the fourth and permanent Constitution, namely the 1977 Constitution of United Republic of Tanzania[31] was adopted. Generally, the independent constitution and the subsequent amendments were silent on how marginalized groups, such as women, could participate in decision-making processes. As such, Tanzania was not legally obliged to involve women in decision-making positions, including in the constitution-making activities. This is despite the great role women played during the anti-colonial struggles.[32]

TANU as the supreme organ of the state, co-opted the autonomous associations that participated in the nationalist struggles, including the political party's women's wings namely *Umoja wa Wanawake wa Tanzania* (The Union of Tanzanian Women).[33] The use of parliament as a rubber stamp for new constitutional amendments pushed women away from engaging in the constitution-making processes. It is noted that, a shift from a multiparty to a single-party political system resulted in the number of women in the Tanzania's Parliament dropping from 10 to 8.5 per cent.[34]

It is noted however that, the ratification of ICCPR, CEDAW, and the African Charter on Human and Peoples' Rights (the African Charter)[35] started to influence constitution-making processes especially from the year 1980. For instance, the amendment to the 1977 Permanent

[29] Ibid.
[30] Ibid. The public was never consulted and did not have the opportunity to debate the needs, structure and division of power of the Union and other key governance matters.
[31] (Cap 2 R: E 2002).
[32] Tanganyika had the largest percentage of women in any African parliament in 1960 with 10 percent (six) of the seats held by women. All these seats belonged to the Tanganyika African National Union (TANU), which won the election, and was the dominant party in the post-election legislature. Among African countries, it was believed that TANU had strong belief in gender equality and involvement of women in government structures. See, Aili Mari Tripp 'Women and Politics in Africa Subject' (2017) Women's History DOI:10.1093/acrefore/9780190277734.013.192
[33] Ibid. Women political wings agendas, finances and leaders were controlled by the ruling party. It is noted that sometimes women roles in the ruling parties were reduced to providing entertainment and cooking for visiting party and government dignitaries.
[34] Ibid.
[35] On 27 June 1981, at its 18th General Assembly Meeting in Nairobi, Kenya, the Heads of State and Government of the OAU adopted the African Charter on Human and Peoples' Rights. It came into force on 21 October 1986. The African Charter promotes and protects human rights and basic freedoms in the African continent. A protocol to the Charter was subsequently adopted in 1998.Articles 2 and 3 of the ACHPR provides that the enjoyment of the rights and freedoms recognised in the Charter apply equally without distinction of any kind such as race, ethnic group, colour, sex, language, religion, political or any opinion, national and social origin, fortune, birth or other status.

Constitution in 1984 [36] was an exception particularly on the area of public participation. Despite that, Article 98 of the 1977 Constitution required support and approval from two-thirds of the members of the parliament; several debates were conducted for one year to allow for the collection of public views on the Constitution. The opening of constitution-making process to the public led to the inclusion of the Bill of Rights under part III of the Constitution.[37] Public debates convinced the Party and Government that the constitutional exercise would be incomplete without a Bill of Rights in the Constitution. It was for the first time, the Government agreed to the public demands even with the silence of the 1977 Tanzania Constitution on people's participation in constitution-making process.

It is further noted that, due to the opening of a political space for civil society actors, freedom of press, and greater donor interventions, multiparty system was reintroduced in Tanzania. In 1991, the Nyalali Commission[38] was established with instructions to collect people's views on whether Tanzania should continue with a single party or adopt a multi-party system. The Nyalali Commission's recommendations included the need to amend both the Union and Zanzibar's Constitutions to reflect the will and wishes of the Tanzanian people.[39] Based on recommendations from the Commission, the Eighth Amendment to the 1977 Constitution reinstituted a multiparty political system in May 1992.[40] Alongside the introduction of a multiparty system, change in women's political participation was witnessed in the 1990s, especially after women's temporary measures were provided by Article 4 (1) of CEDAW and the African Charter,[41] and on a larger scale after the 1995 UN Fourth Conference on Women in Beijing.[42] The Beijing Conference adopted a

[36] United Nations Department of Public Information, op cit note 58. The amendments were based on the 1983 proposals which were drawn up by the Executive Committee of ruling party to correct certain anomalies, and shortcomings highlighted in the Party's 1981 guidelines. The National Executive Committee looked at the political situation in Tanzania and the need to provide for democratic safeguards within the context of a one-party democracy and also to guarantee the socialist goals to which Tanzania is committed. There were three main areas which were pointed out for analysis and possible reform, namely-the powers of the Presidency, the supremacy of Parliament, and a participatory democracy.

[37] Ibid. As a result of the debate there demands for more autonomy of Zanzibar which threatened the party and led to announcing a "pollution of political atmosphere" forcing the then leadership of Zanzibar to resign.

[38] The commission constituted of 22 Commissioners, with equal membership, that means ten members each from both TanzaniaMainland and Zanzibar. The Commission was chaired by the late Chief Justice Francis Nyalali.

[39] Ibid. In May 1992 the Eighth Amendment was adopted reinstituting multi-party-political system of governance.

[40] Ibid.

[41] Temporary special measures are provided under Article 2 of African Charter which require state-parties to *"*take corrective and positive action in those areas where discrimination against women in law and fact continues to exist."

[42] To accelerate women participation in decision-making article 4 (1) of CEDAW requires 'adoption by States Parties to practise positive discrimination by adopting temporary special measures to accelerate de facto equality between men and

Plan for Action encouraging member states to ensure women's equal access to and full participation in power structures and decision-making processes.[43] As a result of the Beijing Plan for Action, the Eighth Amendment to the 1977 Tanzania's Constitution introduced a quota of 15 per cent special seats for women in the Parliament. Consequently, the number of women in the Tanzania's Parliament increased to 16.5 per cent after the 1995 election.

In addition, following the *1986 Donald Marshall v Canada*[44] precedent and the UNHRC General Comment no. 25 in 1996, participatory constitution-making was accepted as a legal right falling within the interpretation of the wording 'public affairs' referred to in Article 25 of ICCPR.[45] The UNHRC Comment no. 25 provided for a twenty-year-long awaited clarification on the applicability of Article 25 of ICCPR, requiring states to involve the public when making their constitutions. With the onset of the UNHRC General Comment no 25, changes on how constitutional amendments were undertaken was observed in Tanzania.

In response to demands by members of opposition parties who wanted the Constituent Assembly to be set up and draft the new constitution, the Government issued a White Paper[46] in 1998 that contained a list of demands from stakeholders, including the need for a new constitution.[47] The White Paper also outlined the Government's position on each demand. In response to public demands, the President appointed a 16-member committee to hear the people's views on the future constitution and make necessary recommendations.[48] The committee sought the views of more than half a million Tanzanians from across the country. This was

women. CEDAW requires state parties to take all appropriate measures to eliminate discrimination against women in the political and public life of the country, and to ensure to women, on equal terms with men, the right to vote in all elections and public referenda and to be eligible for election to all publicly elected bodies. United Nations Publication 'Women Rights are Human Rights' (2006) hr/pub/14/2, SALES NO. E.14.xiv.5 ISBN 978-92-1-154206-6 e-ISBN 978-92-1-056789-3.

[43] Ibid. To accelerate the implementation of action in these areas, the Commission on the Status of Women, at its forty-first session in 1997, adopted Agreed Conclusions (1997/2), which emphasized that attaining the goal of equal participation of men and women in decision-making was important for strengthening democracy and achieving the goals of sustainable development. The Commission reaffirmed the need to identify and implement measures that would redress the under-representation of women in decision-making, including through the elimination of discriminatory practices and the introduction of positive action programmes.

[44] U.N. Doc. CCPRC/43/D/ 205/1986 (Dec. 3, 1991), available at http://wwwl.umn.edu/humanrts/undocs/html/dec205. html.

[44] [1994] 3 S.C.R. 627.

[45] U.N. Human Rights Comm., *Marshall v. Canada*, 5.3, U.N. Doc. CCPRC/43/D/ 205/1986 (Dec. 3, 1991), available at *http://wwwl.umn.edu/humanrts/undocs/html/dec205. htm.*

[46] White Paper, No. 1 of 1998.

[47] Key Historical and Constitutional Developments' available at *http://www.kituochakatiba.org/sites/default/files/legal-resources/Tanzania%20Key%20Historical%20and%20Constitutional%20Developments.pdf* accessed on 9 October 2019.

[48] Ibid. The committee was led by Justice Kisanga.

the first time in history where public views were sought to inform the Constitution.[49] One of the committee's recommendations required the Government to open up political spaces for women in line with international conventions.[50] The Tanzania's Government responded to the committee's recommendations with the 13th and 14th Amendments to the 1977 Constitution which among other things, increased the number of special seats for women to 20 per cent in Parliament,[51] and later to 30 per cent in 2000 and 2005 respectively. After the fourteenth amendments were undertaken to the 1977 Constitution, Tanzania began a process to obtain a new Constitution in the year 2011.

METHODOLOGY

This work employed documentary review. Reports, statutes, constitutions as well as previous studies were reviewed in order to ascertain positions of women in the constitution making processes and the actual gains contained in the proposed constitution. This method is useful since the process took place more than five years ago. Retrieving data for the purpose of this study could better be obtained from documents. Moreover, data analysis was done qualitatively to allow in-depth understanding of realities during the constitutional making process in Tanzania.

FINDINGS AND DISCUSSION

The 2011 Constitution-Review Process

As a departure from the colonial and post-colonial constitution-making legal framework, the 2011 was governed by the Constitutional Review Act (CRA) which for the first time contained legal provisions for citizen participation in constitution-making as a legal right. Section 4 of the CRA called for a mechanism to allowing the public to participate widely and freely in expressing and transmitting public opinions on matters relating to the constitution. The key constitution-making organs with roles and responsibilities to guide main steps for constitution-making processes were legally established. The CRA established the Constitutional Review Commission (CRC) as the body responsible for consulting, collecting public opinions and finally providing Tanzanians with a new constitution.[52] As such, the CRA obliged the CRC to regulate

[49] Ibid.
[50] Ibid.
[51] 33.3 percent on local councils. The amendment further, prohibited Sexual discrimination under Paragraph (5) of Article 13 of the 13th and 14th Amendments to the 1977 Constitution of United Republic of Tanzania
[52] The commission was responsible for coordinating and collection of public opinions on the Constitution; to examine and analyse public opinions; to provide for fora for constitutional review; to provide for preparation and submission of report on

constitutional fora, prepare and submit reports on the public opinions, convene the constituent assembly, and conduct a referendum. Section 6 (7) of the CRA required the President to consult widely with the political parties, civil societies and other institutional stakeholders in appointment of the commission's members.[53] After wide consultation, the President appointed thirty members - fifteen from Zanzibar and fifteen from Tanzania Mainland to lead the constitutional review process.[54]

To ensure effective public participation of both men and women, the CRA stipulated several approaches that the commission could use, such as conducting awareness programmes, holding of public meetings, and assemblies.[55] One of the notable weaknesses of the CRA is that it doesn't mention the educational role of the CRC on specific substantive constitutional issues.[56] However, the Commission resolved to undertake sensitisation and awareness-raising while collecting the public views on the new constitution.[57] This was a critical decision since most Tanzanians were not aware of the constitution, let alone understand their role in the constitution-making process.[58] The commission allowed those who were unable to present their views during the public meetings to do so by filling in a special form. These modalities were useful in reaching a significant number of people including women. A minimum of three public meetings were held in each district and a total number of 1,365,337 people attended about 1,942 meetings.[59]

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the public opinions; to provide for the procedure to constitute the Constituent Assembly, the conduct of referendum and to provide for related matters.

[53] They were invited to nominate two candidates from their institutions. It was reported by the Government that there was a total of 550 names proposed by political parties, religious institutions, NGOs and other interested parties. See Jesse James 'The constitution-making process in Tanzania,' (2013) Legal and Human Rights Centre.

[54] As per section 6 (7) the President paid regard to equality of the two parts of Tanzania, namely Tanzania mainland and Zanzibar, experience, gender, age and social groups representation as key factors when the President was appointing the members to the CRC.

[55] According to section 17 (1) (2) (3) and Section 17 (9), the Commission could ask any person willing to appear before it for discussion, orally or by production of document, on any constitutional matter which the Commission considered relevant to the constitutional review process.

[56] Jesse James op cit note 64.

[57] Ibid.

[58] In the first five months, the Commission went around the country to collect views from the people about the new constitution. The first round started from 2nd July 2012 and was completed on 30th July 2012. It marked the beginning of the views collection. The Commission spent almost one month to collect the views from the citizens in this round. The Commission visited eight regions which were marked as the zone. These were Pwani, Dodoma, Manyara, Kagera, Shinyanga, Tanga, Southern Unguja and Southern Pemba. The Commission successfully collected the views in all eight (8) regions. See Speech by the Chairman of the Constitutional Review Commission on launching a Draft Constitution, on 3 June 2013.

[59] See Speech by the Chairman of the Constitutional Review Commission on launching a Draft Constitution, on 3 June 2013.

Women Participation in the 2011-2014 Constitution Review Process

Participatory constitution-making should ensure that the constitution-making legal framework facilitates participation of all marginalized groups such as women, youth, elders, the hard-to-reach population and persons with disabilities.[60] For the purpose of this paper, analysis is based on how the Tanzania's Constitution-making legal framework facilitated meaningful participation by women in each step of the constitution-making process by providing specifically for, a) women's right of participation in constitution-making processes; b) the composition of women in constitution-making structures; c) women's key-constitutional demands; d) participation of women's special constituency assemblies; and lastly e) how women participated in the referendum.

Legal Provisions for Women's Participation in Constitution-Making

Reaching out to all strands of people and collecting their views on the new constitution was one of the key deliverables of the Constitution Review Commission (CRC). In order to ensure effective public participation of both men and women, the Constitution Review Act (CRA) requires the CRC to use several approaches such as conducting awareness programmes and holding of public meetings and assemblies.[61] However the CRA does not contain specific provisions for promoting women participation in constitution-making process but it uses a neutral language allowing all people to participate. Gender is only mentioned as a key criterion for the selection of members of the CRC under Section 6 (3) of CRA. In addition, Section 9(2) obliges the CRC to pay attention to the principle of equality before the law and respect of human rights while drafting the constitution. Further, the CRA requires the CRC to facilitate the full participation of women in the process at different levels.[62] The commission organised women-only opinion collection sessions and encouraged women to organise their own meetings throughout the country to discuss women's key priorities for the new constitution.

[60] Guidance Note of The Secretary-General 'United Nations Assistance to Constitution-making Processes' (2009).
[61] According to section 17 (1) (2) (3) and Section 17 (9), the Commission could ask any person willing to appear before it for discussion, orally or by production of document, on any constitutional matter which the Commission considered relevant to the constitutional review process.
[62]The CKRA included names of the women organizations such *Maendeleo ya Wanawake* Organization (MYWO); National Council of Women of Kenya (NCWK); and Federation of Women Lawyers (FIDA) to be among the organizations to choose representatives to form the Reference Group in providing technical support, researched and factual information on gender and women issues to be covered by the new constitution.

After President Kikwete announced the launch of the new constitution-making process, women organised themselves and formed the *Wanawake na Katiba*[63] Coalition (Women's Coalition on the Constitution) hereinafter referred as the Women Coalition, to streamline priorities, lobby and ensure that the new constitution would be inclusive of women's political, social, and economic rights. Due to strategic positioning of the Women Coalition,[64] the CRC invited the coalition several times to share women's views, priorities, and issues with regard to the new constitution. Members of the CRC were impressed by clear articulation of the women's issues and further requested the women's coalition to engage on issues beyond those affecting women only.[65]

Women's Participation in the Constitutional Review Bodies

The presence of women in constitution-making bodies is important in influencing inclusion of gender specific provisions in the new constitution.[66] The constitution-making legal framework must contain specific provisions that facilitate the presence of women in constitution-making bodies.[67] Section 6(c) of the CRA requires adherence to the principle of gender equality in the appointment of the CRC members.[68] Despite the use of the word equality by section 6(c) of the CRA women in the CRC did not exceed thirty percent. Among 30 members, only ten were women. In addition, the positions of the CRC chairperson, vice chairperson, secretary and vice-secretary were all occupied by men.[69]

[63] Translated as Women and the Constitution Coalition.

[64] This Coalition has 65-women member organizations who are defenders of Human Rights, especially women's and Children's rights, with multiple and variable experiences equitably distributed country-wide. These organisations forming Women and Katiba Coalition are, Tanzania Media Women Association(TAMWA), Women Fund Tanzania (WFT), Tanzania Women Cross Party (TWCP)-ULINGO, Tanzania Gender Networking Programme (TGNP), Tanzania Women Lawyers(TAWLA), Equality for Growth (EfG), Haki za Wanawake (HAWA), Kilimanjaro Women Information Exchange and Consultancy Organization (KWIECO), Shirikisho la Vyama vya Walemavu Tanzania (SHIVYAWATA), Tanzania Union Congress Tanzania (TUCTA), Tumaini Women Development Association (TUWODEA), Women Legal Aid Centre (WLAC), Zanzibar Gender Coalition(ZGC), individual feminists and activists, among others. See Ruth Meena 'Gender analysis of the proposed constitution of the United Republic of Tanzania: Gains and Challenges' (2014) available at *http://womenfundtanzania.nl/wp-content/uploads/2014/12/28Oct14-ENGL.GENDER-ANALYSIS-GAPSCHALLENGES.pdf* accessed on 2nd January 2019.

[65] Ibid.

[66] Guidance Note of the Secretary-General op cit note 72.

[67] Ibid.

[68] Section 6(c) of the CRA.

[69] Among the 15 commissioners nominated from Tanzania mainland 6 were women and 9 men; in Zanzibar among the 15 nominated members 4 were women and 11 men. The former Prime Minister of Tanzania and Attorney General, Hon. Judge Joseph Sinde Warioba was appointed as the Chairperson. The retired Chief Justice of Tanzania, Hon. Augustino Ramadhan was appointed the Vice Chairperson. The President appointed Mr. Assaa Ahmad Rashid (from Zanzibar) as the Commission's Secretary and Mr. Casmir Sumba Kyuki (from Mainland) as Commission's Vice-Secretary.

Women's Demands in the New Constitution

The CRA recognizes and promotes women's participation in constitution-making. However, after several consultative processes among the members of the Women Coalition, twelve key demands were identified.[70] The demands encompassed among other things, the need for the new constitution to provide for equal representation between men and women to engage in all levels of decision-making processes.[71]

Women's Participation in the Constitutional Foras and in Special Constituency Assembly

After collection of public views and issuance of the draft constitutions, the next step was for deliberations of the draft constitutions by the national assembly before the referendum. In February 2013, after collection and analysis of the public opinion, the CRC produced the First Draft Constitution.[72] The draft contained among other things, key gains of the twelve areas of priority identified by women.[73] Relating to matters pertaining to women political participation, the First Draft Constitution suggested significant change in the electoral system by abolishing parliamentary special seats for women and provided that for every constituency, each political party should field a man and a woman as candidates. As such voters will vote for a man and a woman of their choice from any political party as their representatives in that particular constituency. This provision implies that women would be elected democratically, and will be accountable to their voters and their own electoral constituencies, thus addressing challenges associated with the women's special seats arrangement.[74]

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[70] These priorities were: women's rights to be spelt out in the constitution; prohibiting all laws, regulations and practices which discriminate against women; women's rights to dignity to be protected by the constitution; the international instruments and standards to be respected and translated into laws; constitution to guarantee equal rights for women in decision making organs; spelling out the age of the child (to protect girl children against early marriages); women's rights to access, control and benefit from national resources should be spelt out in the constitution; women's rights to maternal health services to be spelt out; women's rights to access and benefit from basic services to be spelt out; the rights of women with disabilities to be spelt out; a commission to monitor and oversee implementation of these rights to be provided as one of the accountability instruments for gender equality; a family court to be provided for in the constitution.

[71] Article 66 (1)(b) of the 1977 Constitution of the United Republic of Tanzania established the Special Seat system which provides for a 30% quota for women which is subject to criticisms.

[72] The Draft Constitution ("titled in Kiswahili— *Rasimu ya Katiba ya Jamhuri ya Muungano wa Tanzania*, 2013") contains 240 Articles. It is long compared to the current Constitution of 1977 which has only 152 Articles.

[73] Ruth Meena 'Gender analysis of the proposed constitution of the United Republic of Tanzania: Gains and Challenges' (2014) available at *http://womenfundtanzania.nl/wp-content/uploads/2014/12/28Oct14-ENGL.GENDER-ANALYSIS-GAPSCHALLENGES.pdf* accessed on 2nd January 2019.

[74] 'Draft Constitution in Tanzania proposes gender equality in electoral system' available at https://demofinland.org/draft-constitution-in-tanzania-proposes-gender-equality-in-electoral-system/?lang=en accessed on 2 January 2018.

It is noted however that, the fact that the First Draft Constitution was only available in English posed a serious challenge, as less than 20 per cent of Tanzanians speak English and it made it difficult for the majority of the population, particularly women, to understand the content of the draft constitution without assistance.[75] The Women Coalition took immediate efforts to translate the draft constitution in Swahili, but financial constraints hindered the dissemination of the translated version to majority Tanzanians especially those in remote areas. Therefore, it affected how the majority people provided feedback to the commission on the content of the draft constitution.

After issuing the first draft constitution, the formation and operation of constitutional fora was the second step for constitution-making.[76] The Commission, in line with section 18 of CRA, allowed reactions from the public through district constitutional fora, direct meetings, letters, petitions, and memoranda.[77] The fora were tasked to review the first draft constitution and make comments with a view to improve it before it went to the Constituent Assembly.[78] There were two types of fora. The first type was managed by the Commission[79] while the second was managed by organisations or institutions.[80] The Women's Coalition made a great effort to influence the first draft by translating, reading, analysing and commenting on how it responded to the women's twelve priorities. The Coalition also identified gaps, provided alternatives on how they could be addressed, and compiled its report and submitted the proposed recommendations to the Commission for further consideration in the Second Draft.[81] The women's coalition and other civil society organisations, such as the Legal and Human Rights Centre, launched a

[75] 'New Constitution: Civil society has taken an active role,' Available at *http://www.kepa.fi/jasensivut/jasenblogi/12992* as accessed on 3 October 2019.
[76]Section 18 of the CRA.
[77]As per section 18 (6), it says for the purpose of this section, the Commission may allow organizations, associations or groups of persons to convene meetings in order to afford opportunity to its members to air their views on the Draft Constitution and forward such views to the Commission.
[78] This phase started officially in June 2013 and was completed on 31st August 2013.
[79] Ibid. These were constituted under the level of District. The Commission was directly responsible to supervise them. Election of members to these fora started from village (in rural area) or mitaa (in urban areas) and then at ward level and finally at district level. People were invited to apply within their village or mitaa to be elected by residents of those areas. Those who were elected in each village or mitaa went to the ward level to compete with others elected from other villages or mitaa. Elections were also done at the ward level and those elected went to the district to constitute the District forum.
[80] Ibid. These were formed by organisations or institutions which wanted to do so. So, political parties, various institutions, religious organizations, professional clubs, civil society organizations and any groups of persons with the same interests formed their own independent fora. These types of fora were not supervised by the Commission. They were self-supervising. They were required to present their views to the Commission after their meetings on or before 31st August 2013.
[81] Ruth Meena op cit note 85.

countrywide campaign through constitutional fora to educate remote populations including women, on the content of the draft constitution and the extent to which women's rights had been catered for and what they could do further to attain progressive gender provisions.[82]

There were issues pertaining to how the constitutional fora were operated, which posed doubts on key areas such as inclusivity, viability and acceptability of the fora's deliberations. At first, the formation of the fora was to be democratic and transparent. People who wanted to be forum members in the villages, streets and ward levels were requested to apply and be elected.[83] However, the elections were marred by violence, and the voting of the members were influenced by political, tribal and religious forces.[84] Members were screened by Ward Development Committees (WDCs) of which the majority of its members were dominated by councillors from ruling party, Chama Cha Mapinduzi (CCM). This led to perception that the views and deliberations from the constitutional fora were unduly influenced by the dominant party, causing challenges in acceptability of the constitutional fora as platforms for gathering views for genuine enrichment of the First Draft Constitution. [85]

After compilation and analysis of the public opinion on the first draft constitution from the constitution fora, the commission prepared and released the Second Draft Constitution.[86] The Women Coalition found the Second Draft Constitution to have systematically incorporated women's key priorities except for a few identified gaps.[87] Just like the First Draft,

[82] Ibid.

[83] Ibid.

[84] A total of 19,378 constitutional fora members were elected all over the country. In Tanzania Mainland, a total of 18,180 members were elected to form the constitutional fora. Zanzibar had 1,198 members of the fora of whom 1,005 were elected from all Shehia. Each shehia was represented by three members. And, all 193 councillors joined the for a as members.

[85] Ibid. Another challenge was on the closer look of section 17 and 21 (3) of the CRA which states that: "Any person or organization wishing to conduct awareness programmes on constitutional review must register under the relevant laws and must disclose sources of his/their funds. Failure to do so constitutes an offence punishable by a fine of not less than Tzs.5, 000,000/= and not exceeding Tzs .15, 000,000/= or imprisonment for a term of not less than three years

[86] Ibid.

[87] Ruth Meena op cit note 93. Further, in its preamble, the proposed draft constitution commits among other things to build a society which is free from all forms of discrimination including gender. In defining discrimination, the draft constitution affirmed that purposeful acts to rectify the historical imbalances in the society shall not be deemed to be discrimination. The draft considered gender equality as one of governance issues, and its overall goal included the principle of equality generally, while specific social, economic and political objectives included gender equality goals. The draft constitution directs that goals and specific objectives spelt out in this draft constitution will guide the interpretation and implementation of the constitutional principles. The draft constitution established the principle of supremacy of the constitution, hence declares all practices, traditions and cultural beliefs which contradict the constitutional principles null and void. The second draft constitution also affirmed respect for all international and regional standards which the country is a party to such standards including CEDAW, CRC, and the Maputo Protocol.

the Second Draft Constitution endorsed the women's demand for the provision of equal representation between men and women in the decision-making processes by providing that each electoral constituency should have one male and one female candidate from each political party.[88] The second draft allowed independent candidates and provided for non-registration of political parties that had not taken gender equality principles into consideration. [89] Allowing independent candidates was a great gain for women in the Second Draft Constitution. It was expected that it would allow women who were not interested to be members of political parties, but have political ambitions to still stand as candidates.[90]

After the issuance of the Second Draft Constitution, the CRA provided for a Constituent Assembly as the third step of the constitution-making process.[91] The President, in agreement with the President of Zanzibar, appointed members and convened the Constituent Assembly. As per the CRA, the President appointed 201 different governmental and non-governmental organisations to join the existing members of parliament and together they formed the Special Constituent Assembly (SCA).[92] The President considered the qualifications and experience of the nominees as well as the gender factor.[93] Before he appointed members of the SCA, the Women's Coalition took the initiative to consult and influence the then President Jakaya Mrisho Kikwete to observe equal representation between men and women when appointing the SCA's members. This was the greatest move by the Women's Coalition and a major success for women, as the President appointed 101 men and 100 women, almost in

[88] Ibid. This is likely going to reduce the financial burden which individual women have to incur when contesting for electoral position. It is also more likely that such modality will reduce electoral corruption and build a more gender responsive electoral culture. In the final analysis, electoral resources will be used in a more equitable manner, reduce corruption and finally the nation will benefit by getting legislatures who are more accountable; who will adhere to ethical standards.

[89] Ibid. This is a first time in the history of this country that demands are made on political parties to address gender equality and non-discriminative practices in decision-making organs. For women movement, this is a great gain, as political parties are gate-keepers in defining and determining who gets in or who is out in political participation in electoral processes.

[90] Ibid.

[91] Ibid. After releasing the second draft constitution, the CRC submitted the report and the Second Draft Constitution to the President who published it in the Gazette and other local newspapers with a statement that the Second Draft Constitution was to be presented to the Constituent Assembly for enactment as the proposed Constitution.

[92] As per section 22.-(1) A Constituent Assembly consisted of the following members: (a) all members of the National Assembly of the United Republic; (b) all members of the House of Representatives of Zanzibar; (c) one hundred and sixty six members drawn from the following: (i) Non-Governmental Organisations; (ii) Faith Based Organisations; (iii) all fully registered political parties; (iv) institutions of higher learning; (v) groups of people with special needs; (vi) Workers Association; (vii) an association representing farmers; (viii) an association representing pastoralists; and (ix) any other group of persons under whatever name having common interest.

[93] The President consulted the interest groups and selected names from their lists of nominees to be members of the SCA. Ruth Meena op cit note 99.

parity. Further, due to the great role of the Women Coalition in the constitution review process, six of its members were appointed to be part of the SCA. In total, there were 620-members in the SCA[94] of whom 256 were women, comprising 41.3 per cent of the entire Assembly.[95] Before the CSA began its work, there were leadership positions that needed to be filled. In the election for the Interim Chairperson of the SCA, only one out of four candidates were a female, and a male candidate won. During the election of the deputy SCA Chairperson, only two candidates were women, and a woman won.[96] The pattern is also reflected at the SCA Committees level, where women chaired four out of fourteen committees, and ten out of fourteen vice chairpersons were female. This suggested that it was easy to accept women as deputies but not at the helm of the assembly or respective committees.[97]

As the CSA began its work, the Women's Coalition also started to empower all members of SCA on the twelve women's priorities for the new constitution.[98] Through the coalition's experts and consultants, the Coalition produced a deeper analysis of the second draft constitution from a gender perspective by comparing it with best practices from other jurisdictions with progressive constitutions such as Rwanda, Kenya, and South Africa.[99] The Women's Coalition provided the female members of the CSA with well-researched, factual and evidence-based recommendations on what should be discarded, retained or added to the second draft constitution. This was in addition to enhancing the coalition's capacity to identify male champions who were willing to support the women's agenda during the whole process.[100] The Women Coalition also intervened through the media in various TV and radio programmes and through the issuance of press releases whenever anything occurred that was likely to be detrimental to obtaining a gender-sensitive constitution.[101] Further, the Coalition conducted a national convention in the capital city, Dodoma, as a parallel or shadow SCA with

[94] Comprising 365 ordinary members of parliament, 54 members from the Zanzibar House of Representatives and 201 presidential appointees from civil society and other non-governmental organisations' members charged with the task of reviewing the second draft constitution. Jesse James op cit note 121.
[95] Ruth Meena op cit note 105.
[96] Ibid.
[97] Ibid.
[98] Ruth Meena op cite note 108.
[99] Ibid.
[100] Ibid.
[101] Ibid. The women coalition lobbied for about 10 different TV spaces to utilise whenever a need arise, they issues various new papers articles and social media press releases.

rural women to enhance their understanding of the constitution-making processes. They were reminded of women's priorities versus the content of the Second Draft Constitution, and jointly, strategies to influence the remainder of the constitution-making process were devised.[102]

Women's Participation in a Referendum

After the Special Constituency Assembly completed its work and produced the 2014 Proposed Constitution, the new constitution was supposed to be put to a referendum. The CRA provided for a referendum to be conducted by the Electoral Commission of the Union, and that of Zanzibar. The Constitution should have been approved by a 'Yes' or 'No' vote.[103] The Women Coalition started preparation for the referendum by strengthening the Coalition and analysing other existing related laws in the new constitution. The Coalition informed women of the gains obtained from the Proposed Constitution, and on why they should vote 'Yes' during the referendum. The referendum was initially announced to take place on 30 April 2015 but was later postponed until further notice.[104]

Women's Achievements in the Proposed New Constitution

In determining the extent that the final content of the Proposed Constitution provides, promotes and protects women's participation in decision-making processes, guidance from criteria deduced from Article 7 (a) and (b) of CEDAW is sought. It provides that: -

> 'States Parties shall take all appropriate measures to eliminate discrimination against women in the political and public life of the country and, in particular, shall ensure to women, on equal terms with men, the right: (a) To vote in all elections and public referenda and to be eligible for election to all publicly elected bodies; (b) To participate in the formulation of government policy and…'

The UNWOMEN and International IDEA Guidance Note on Women's Human Rights and National Constitutions, Leadership and Political

[102] Ibid.
[103] Ibid.
[104] Ibid.

Participation[105] expound Article 7 of CEDAW and require scrutiny of the final content of constitutional provisions in relation to how they provide for i) the general guarantees of equality and non-discrimination; ii) a favourable electoral system and modalities for women's participation in decision-making processes; iii) regulation of political parties; iv) the role of the electoral management body in protection and promoting women participation in elections; v) institutions to safeguard women's rights; vi) procedure for amending the new constitutions, and vii) the new constitutions as a basis for progressive electoral reforms.[106] These criteria are discussed below in understanding the level of women's influence and gains they obtained as a result of their participation in the making of the 2014 Proposed Constitution of Tanzania.

Constitutional General Guarantees of Equality and Non-Discrimination in Political Life

For women to have meaningful participation in decision-making processes, principles of equality and non-discrimination against discriminatory traditions among other things, must be established in the nation's constitution. This is because in countries such as Tanzania, customs, traditions, and public attitudes not only determine how many women are considered and nominated for office, but also they have a direct and indirect influence on how many female candidates win a general election.[107] During the 2011-2014 constitution-making process in Tanzania, women consistently demanded for prohibitions of discriminatory customs and traditions, which for a long time, have placed them on unequal footing with men, particularly in the decision-making arena.

Equality Guarantees

The use of gender-neutral language has been widely recognized as being hugely important in the struggle for gender equality and normalisation of women being equal in social, economic, and political spheres.[108] The use of gender-neutral language, such as 'each person', 'both men and women', 'every person' or 'every citizen' features across the wording of

[105] Ibid.
[106] Ibid.
[107] International Institute for Democracy and Electoral Assistance, Constitution Assessment for Women's Equality, ISBN: 978-91-7671-049-4, (2016), available at *https://www.idea.int/sites/default/files/publications/constitution-assessment-for-womens-equality.pdf* accessed on 5th February 2019.
[108] Suzannah Weiss '7 Gender-neutral terms we should all be using', available at *https://www.bustle.com/p/7-gender-neutral-terms-we-should-all-be-using-9565996* accessed on 15 July 2018.

the 2014 Proposed Constitution. The Proposed Constitution also covers the general principles of equality before the law. Paragraph 1 of the Preamble of the 2014 Proposed Constitution commits the Government to build a nation guided by principles of human dignity, freedom, human rights, equality of persons and gender equality. Gender equality is stated as a governance principle under Article 6 (g)[109] and it runs through the political, economic, and social development sections.

Furthermore, under equality guarantees criteria, the national constitutions are required to include equality as one of the key principles in applying and interpreting the constitution and other laws, and in making or implementing any policy decisions. The 2014 Proposed Constitution stipulates development of the economy to be guided by principles of equity and equal opportunities to all citizens as provided for under Article 8. The use of gender neural language and recognition of equality principles in the 2014 Proposed Tanzania's Constitution is a major constitutional gain for women. Gender equality principles in the constitution help in shifting the mind set about the role of women in the society and provide a strong foundation for women to take a first step to their greater participation in all sectors of life, including in decision-making processes.

Non-discrimination Guarantees

Equality guarantees are often followed by a non-discrimination provision and contain a list of grounds on which discrimination is prohibited, including gender. The Committee on the Elimination of Discrimination against Women[110] has consistently recommended that state parties incorporate the definition of 'discrimination against women' into their constitutions from Article 1 of CEDAW, which provides: -

> "For the purposes of the present Convention, the term 'discrimination against women' shall mean any distinction, exclusion or restriction made on the basis of sex which has the effect or purpose of impairing or nullifying the recognition,

[109] Also, the development of the economy is supposed to be guided by principles of equity & equal opportunities to all citizen as provided for under Article 8 (e & g) of the Proposed Constitution.

[110] The Committee on the Elimination of Discrimination against Women (CEDAW) is the body of independent experts that monitors implementation of the Convention on the Elimination of All Forms of Discrimination against Women. CEDAW Committee consists of 23 experts on women's rights from around the world. 'The Committee on the Elimination of Discrimination against Women (CEDAW)' available at *https://www.ohchr.org/en/hrbodies/cedaw/pages/cedawindex.aspx*, accessed on 10 February 2019.

> enjoyment or exercise by women, irrespective of their marital status, on a basis of equality of men and women, of human rights and fundamental freedoms in the political, economic, social, cultural, civil or any other field."

The 2014 Proposed Constitution includes critical elements of Article 1 of CEDAW in defining discrimination against women as seen in Article 33 (5). Articles 12 (a) and 33 of the 2014 Proposed Constitution of Tanzania prohibit all forms of discrimination including sex. Also, Articles 8 and 14 (b) of the Proposed Constitution require national authorities to provide equal opportunities to both women and men, without discrimination. Hence, the 2014 Proposed Constitution successfully provides and protects the women's rights to political participation, by including non-discrimination provisions that are important to safe-guard women against discriminatory traditions, customs and beliefs that for a long time have kept women away from electoral decision-making spaces. Changing discriminatory practices takes a long time, but the constitutional provisions to that effect are important to kick start the transition within the Tanzanian societies towards freedom from discriminatory practises against women.[111]

Prohibitions of Harmful Customs and Traditions

As noted in the preceding paragraphs, part of the strategy for the attainment of meaningful participation of women in political leadership lies in the explicit prohibition of customary law practices or harmful customs that have been discriminating negatively against women's ability to participate in electoral politics.[112] Article 8 (1) of the 2014 Proposed Constitution obliges the state and its organs to direct their policies and duties to ensure dignity and respect, and all other human rights are preserved and maintained considering regional and international agreements consented to by the United Republic of Tanzania. Customary law has limited women's spaces to participate in decision-making for centuries.[113]

Specific Provision for Women's Rights

[111] As in 2014 percentage of females was measured at 50.09 in Rwanda, 50.03 in Kenya, 50.05 in Tanzania, 50.03 in Uganda according to the World Bank Group, available at *https://data.worldbank.org/indicator/sp.pop.totl.fe.zs* accessed on 13 March 2019.
[112] Kadaga R 'Women's political leadership in East Africa with specific reference to Uganda' Tenth Commonwealth Women's Affairs Ministers Meeting 'Women's Leadership for Enterprise' Dhaka, Bangladesh, 17-19 June 2013.
[113] Ibid.

The women's rights clauses are important tools for advancing gender equality. In equality and non-discrimination guarantees, constitutions should contain provisions dedicated to setting out women's rights only in addition to every right elsewhere in the constitution that also applies to women.[114] Article 54 of the Proposed Constitution guarantees every woman the right to: i) be respected, valued and their dignity recognised; ii) protection against discrimination, harassment, abuse, violence, sexual violence and harmful traditional practices; and iii) participate in elections and all stages of decision-making without discrimination.[115] Specific provisions for women's rights provide for active measures to improve the position of women, which is usually lower in the society; to enable them to achieve gender equality through women's social, economic and political empowerment.

Gender Equality and Constitutional Status of International Law

The advancement of gender equality is more likely to occur if constitutions incorporate international law, including aspects of international human rights standards.[116] The kinds of constitutional provisions that are most favourable to the full enforcement of international human rights law are those which give international law direct effect and make them take precedence over domestic law in case of conflict or where the international law instruments are more rights-protective.[117]

In Tanzania, signing or ratification of any international convention does not automatically place it at the same level as the Constitution or any other national laws. However, Article 14 (1) of the 2014 Proposed Constitution ensures that human dignity is preserved and maintained in accordance with the customs, traditions and regulations of the Universal Declaration of Human Rights and other international conventions adopted by Tanzania. Further, Article 8 (1) of the Proposed Constitution obliges the state and its organs to direct their policies and duties to ensure that dignity, respect and all other human rights are preserved and maintained

[114] The UNWOMEN and International IDEA Guidance Note on Women's Human Rights and National Constitutions, Leadership and Political Participation, (2012), available at http://www.onu.cl/es/wp-content/uploads/2016/06/Womens-Human-Rights-and-National-Consitutions-Guidance-Note.pdf accessed on 6 November 2017.
[115] In women only clause, the 2014 Tanzania Proposed Constitution, continued providing under Article 54: (d) get employment opportunity and be paid the same salary as a man; (e) protection for her employment while she is pregnant and after delivery; (f) get quality medical services including safe reproductive health; and (g) own property.
[116] The UNWOMEN and International IDEA Guidance Note op cit note 132.
[117] Ibid.

considering different agreements to which the United Republic of Tanzania has consented. The Foreign Policy of the United Republic of Tanzania aims to safeguard national interests and full state sovereignty and requires that the policy shall be implemented with transparency in order to respect international laws, observe international and regional treaties which are beneficial to the United Republic, and to resolve international conflicts through dialogue.[118] Article 62 (1) also requires the judiciary or any other agency to observe international laws and human rights in interpreting the provisions of the Constitution regarding human rights. The recognition and consideration of the international conventions in the national jurisdiction depict the great influence these conventions can have on the conduct of state, civil, and political affairs. However, proper respect and implementation of international conventions or covenants call for their automatic application in national jurisdiction. It remains important that, the recognition and application of international law and standards in the 2014 Proposed Constitution will be paramount to counter laws, policies, customs and traditions that have side-lined women's participation in decision-making processes for ages.

Electoral System and Women's Participation in Decision-Making Organs

The Tanzanian women's priorities for the new constitutions include, among other things, the need for specific constitutional stipulations that would facilitate the realisation of equal representation of men and women in all decision-making processes. It was named as the fifty-fifty agenda calling for a constitutionally stipulated process that will lead to equal numbers of men and women in all decision-making processes. In line with women recommendations, the 2014 Proposed Constitution included political rights and civil liberties, specifically providing for voting rights and the right to stand for election. Also, through equality and non-discrimination provisions, the constitution has set a broader context for political gender equality and participation in the parliament. Despite the broad consensus in the literature that the proportional representation electoral system creates less obstacles to women's representation,[119]the 2014 Proposed Constitution provides for the first-past-the post electoral

[118] Article 21 (1) of the 2014 Proposed Constitution.
[119]Ibid. Party list can be either closed, where voters vote only for a particular party, and parties determine who will fill the seats that they have been allocated. Party list can also be open where voters have some degree of choice among individual candidates, in addition to voting for entire parties.

system to govern presidential and parliamentary elections.[120] In a bid to promote more women in the parliament, the Proposed Constitution did away with the parliamentary quota system popularly referred as women special seats, which was introduced in Tanzania in 1985 by the 1977 Constitution of United Republic of Tanzania. As an alternative to a parliamentary quota, the 2014 Proposed Constitution called for equal representation of men and women in determining the composition of the Parliament through Article 124 (4). Astonishingly however, Article 124 (4) limits the intention to realize equal representation of men and women in decision-making processes only in the parliament. Article 124(4) is not applicable to determine the composition of men and women in other decision-making organs or positions. Further, Article 124(4) is silent on which modalities will be used to facilitate the attainment of equal representation of men and women, but obliges the Parliament under Article 124 (6) to enact legislation to classify the procedure of implementation of Article 124.[121]

It is noteworthy that, before rewriting the 2014 Proposed Constitution, the 1977 Constitution had under-gone several amendments, which contributed to an increase in the number of women in the Parliament but did not lead to realisation of equal representation of men and women. For example, the first post-independence Tanzania's Parliament (1962-1965) contained only 7.5 per cent of women, the number was maintained below 10 per cent until 1985.[122] In 1985, constitutional reform introduced a parliamentary quota system comprising of 15 per cent and 25 per cent of seats in the Parliament and local councils respectively.[123] This constitutional amendment increased the percentage of women in parliament to 16.5 after the 1995 election. The Beijing Declaration[124] and

[120] King C 'Electoral Systems' (2000), available at *http://faculty.georgetown.edu/kingch/Electoral_Systems.htm* accessed on 13 November 2019

[121] The explanation from the Constitutional Review Commission entails that each party will have to have both male and female candidates in a constituency, hence once that party wins, both male and female candidate have won. On the other hand, the 1977 Constitution of Tanzania uses the mixture of both first-past-the-post electoral system in the presidential and parliamentary elections and Proportional representation which is used to allocate women seats; the seats for women are distributed among the political parties in proportion to the total number of votes they received as a party. To qualify to offer a special seat candidate, the political party must have at least five per cent of the total parliamentary votes. See Meena R 'Women participation in positions of power and influence in Tanzania' available at *http://www.redet.udsm.ac.tz/documents_storage/2009-8-19-11-34-23_womenparticipationinpositionsofpower.pdf* accessed on14 March 2016.

[122] Ibid.

[123] Ibid.

[124] 'Fourth World Conference on Women in Beijing China' available at *http://www.un.org/womenwatch/daw/beijing/platform/declar.htm* accessed on 27 May 2016.

the Southern African Development Community (SADC) Declaration[125] required a benchmark of 30 per cent female representation in parliaments. To comply with the SADC Declaration, Tanzania amended its constitution to increase the parliamentary percentages of special seats to 20 per cent in 2000 and later to 30 per cent of women in 2005.[126] The 2005 elections increased the percentage of women in the Parliament from 21.5 per cent to 30.3 per cent, which increased to 35 per cent after the 2010 election.[127] The number further increased to 37.18 per cent after the 2015 election, where 30 per cent of women were appointed through special seats while 7.1 per cent were from constituencies after winning competitive elections.[128] Therefore, despite facing some challenges, special seats arrangement has helped Tanzania become a keen promoter of female political participation with more than 37.2 per cent in the current parliament.[129]

Finally, another way an electoral system can promote women's political participation is by allowing independent candidates. In Tanzania, the Women's Coalition pressed strongly for independent candidates given the male dominated nature of Tanzanian political parties.[130] As a departure from the 1977 Constitution, Article 135 of the 2014 Tanzania's Proposed Constitution also allows independent candidates. This is an important gain for women as it opens more doors for candidacy in electoral positions and it diversifies political parties as the only option and gate-keepers in determining electoral candidates.

Responsibility of Political Parties to Advance Gender Equality

Political parties are the 'gatekeepers' for anyone to be elected to office. Therefore, how they function internally and whether women can gain leadership positions within parties is crucial.[131] Although women play

[125] SADC signed the Declaration on Gender and Development on 8th September 1997 at Blantyre, Malawi to promote closer regional cooperation and collective action as a means of fostering gender equality. Available at *https://www.sadc.int/documents-publications/show/Declaration_on_Gender__Development_1997.pdf* accessed on 15 February 2019.

[126] Article 66-1(b) of the 1977 Constitution of United Republic of Tanzania.

[127] Ibid.

[128] 30 per cent came from special seats arrangement and only 7.18 per cent were directly elected. See the United Republic of Tanzania Bunge (National Assembly), available at *http://archive.ipu.org/parline/reports/2337.htm* accessed on 1 May 2019.

[129] 'Women in national parliaments as in December 2018', available at *http://archive.ipu.org/Wmn-e/world.htm* accessed on 5th January 2019.

[130] Meena R op cit note 56.

[131] United Nations Division for the Advancement of Women (DAW), Department of Economic and Social Affairs (DESA), Economic Commission for Africa (ECA), Inter-Parliamentary Union (IPU) 'Equal participation of women and men in decision-making processes, with particular emphasis on political participation and leadership' (2005) Report of the Expert

important roles in campaigning and mobilising support for their parties, they rarely occupy decision-making positions in political party structures.[132] The constitution may regulate political parties through a prohibition on sex discrimination in parties' membership, a requirement to include women in party decision-making structures, and nomination and candidates lists.[133] For parties to fulfil their critical functions of aggregating and expressing the political interests of different public spectrums, women must be able to take part in setting the priorities and agendas of parties.[134]

In Tanzania, for the first time, the 2014 Proposed Constitution requires political parties to adhere to the gender equality principle in leadership positions as a condition for registration.[135] The constitutional regulations for political parties are important in influencing the behaviour of political parties, which in many ways are the gatekeepers of who gets the constituency candidacy. Having women in the top leadership positions of the political parties will have a multiplier effect on how nomination rules facilitate more women as electoral aspirants and candidates.

The Role of Independent and Supportive Electoral Commission

A nation electoral commission should be mandated to oversee compliance regarding guarantees of women's participation in electoral politics. [136] For the electoral commission to facilitate women's participation in electoral politics, it must adopt gender sensitive guidelines and rules to govern the conduct of elections. The composition of the members of a commission and staff must also reflect equality.[137] Article 211 of the 2014 Proposed Constitution establishes the Independent Electoral Commission. However, Article 211 is silent on the promotion of women's participation in terms of composition of the members of the commission and in

Group Meeting Addis-Ababa Ethiopia 24 – 27 October 2005. Available at http://www.un.org/womenwatch/daw/egm/eql-men/FinalReport.pdf accessed on 17 November 2019.

[132] Many parties have women's units (women's wings), and although they can play a role in the party, their influence on party decisions can be limited. Women should also be integrated into party structures, including key decision-making bodies. International Institute for Democracy and Electoral Assistance op cit note 34.

[133] United Nations Division for the Advancement of Women (DAW), Department of Economic and Social Affairs (DESA), Economic Commission for Africa (ECA), Inter-Parliamentary Union (IPU) op cit note 149.

[134] Ibid.

[135] (see Article (224) (2)(e).

[136] For example, Article 91(g) of the Constitution of the Republic of Burundi 2005 requires the independent national electoral Commission to "assure the respect for the provisions of this Constitution relative to multi-ethnicity and to gender and to take cognizance of the claims in this respect." In addition, constitutions may provide for gender balance in the staffing of such commissions.

[137] The UNWOMEN and International IDEA Guidance Note op cit note 134.

elections. In Tanzania, the 2015 elections observed the National Election Commission (NEC) and the Zanzibar Election Commission (ZEC) incorporating gender policies in the election observer guidelines, voter education guidelines, and the code of ethics for political parties.[138] Additionally, it is worth noting that ZEC adopted and committed to implement gender inclusion strategy that was developed in coordination with other promoters of women's participation in electoral politics stakeholders.[139] The political parties guidelines and code of ethics were useful documents for NEC and ZEC to think more systematically about the inclusion of women by political parties in elections.

Institutions to Safeguard Women's Rights

The new constitutions should incorporate additional enforcement mechanisms or bodies tasked to mainstream, promote and enforce women's rights, including political rights.[140] The 2014, Proposed Constitution provides for the duties and functions of the Commission for Human Rights and Good Governance to include the sensitisation of the public about the preservation of human rights. The Constitution further provides for duties to the public to promote, protect, and monitor implementation of gender equality.[141] In some other countries such as Rwanda, there is an independent body to oversee women's rights while in Tanzania, women's rights are promoted through the Human Rights and Good Governance Commission. This commission helps to promote gender equality through promotion of public policy that effectively responds to women's demands and interests.[142] It is noted, however, that while women's rights are human rights, there is a danger for women's rights to be monitored by the body that generally oversees human rights. When this happens, women's rights though may get its share in the planning sessions they may suffer implementation oversight.[143]

CONCLUSION

This article was set out to examine two interrelated questions notably the extent to which women were involved in the 2011-2014 constitution-

[138] With support from the Democratic Empowerment Project, NEC managed to entrench gender provisions in the key election guidelines, 'International Republic Institute, Tanzania National Elections Gender Assessment'(2016) available at *https://www.iri.org/sites/default/files/wysiwyg/tanzania_gender_report.pdfl* accessed on 16 February 2018.
[139] Ibid.
[140] The UNWOMEN and International IDEA Guidance Note op cit note 155.
[141] Article 232 (1) of the 2014 Proposed Constitution.
[142] Chauve C op cit note 37.
[143] The UNWOMEN and International IDEA Guidance Note op cit note 158.

making process, and how such participation impacted the content of the 2014 Proposed Constitution in terms of protection and promotion of women political participation in the country. For the first time in Tanzania, the 2011-2014 constitution-making process allowed citizen participation in the formulation of the 2014 Proposed Constitution. Despite the observed challenges, the constitution-making process depicted satisfactory levels of women's involvement in all stages. The final product of the constitution-making process namely the 2014 Proposed Constitution guarantees participation of men and women in political life. Also, it contains key provisions on the general guarantees of equality and non-discrimination. The turning point on protection and promotion of women political participation is seen under Article 124(4) of the 2014 Proposed Constitution which provides that, 'the basis of composition of the Parliament shall be on equal representation of female and male parliamentarians.' It is noted however that Article 124 (4) limits the intention to realize equal representation of men and women in the parliament only. Article 124(4) is not applicable to determine the composition of men and women in other decision-making organs or positions.

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Assessment of Wildfires in Tanzania Forest Plantations: A Case of Sao Hill in Mufindi District

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ABSTRACT
The study investigated the wildfires in Sao Hill Forest Plantation (SHFP) in Mufindi District with a focus on causes, impacts, and challenges in fire-fighting. The inadequate data and studies on forest fires rationalized the choice of the study area. Mixed approach and a case study design were used. The sample of 45 respondents were purposively selected out of which 15 were key informants as an entrance point and 30 were other respondents snowballed as proposed by key informants. Descriptive and thematic analysis was used for quantitative and qualitative data respectively. Land preparation which involved clearing of forest harvest debris for tree replanting; slash and burning practice that farmers use traditionally for farm preparation was the major cause of wildfire in SHFP. The negative impacts outweighed the positive through the loss of trees which was ecologically and economically destructive. Inadequate facilities and community participation were the frequently mentioned challenges. The study recommended for the prerequisites in controlled burning to be followed, enhanced rational allocation of resources like equitable harvesting permits and farming land to avoid arsonism. More researches on biological means of land preparation are suggested to reduce fuel load through efficient technology and improved recovery.

Keywords: *Wildfires, Arsonism, Forest plantation, controlled burning, Fuel load*

INTRODUCTION

Traditionally, fire has been associated with the history of human development. In ecological sense, fire has been an important factor in the dynamics of the Earth's climate and in the development of biomes since its widespread occurrence began 400–350 million years ago (Doerr and Santı´n, 2016). WWF rates fire to be among the top threats of ecosystems., for example, in April 2020, the number of fires alerts the

globe was up by 13% compared to last year which was already a record year for fires. Persistent hotter and drier weather due to climate change and other change and other human factors such as land conversion change and other human factors such as land conversion for agriculture and poor forest management are the main drivers behind the increase. It is estimated that humans are responsible for around 75% of all wildfires, and much of the increase in fire incidents during 2020 can be directly linked to human actions (WWF, 2020).

Despite the absence of precise figures that reflect the loss of forests, it is well established that broad areas of tropical forests have diminished inspite of conservation efforts over the last 25 years (Keenan *et al*., 2015). Africa is the leading continent, where out of 9,200 million tons of biomass affected by fire in 2000, 42% belonged to Africa which is quantitatively equivalent to 7 billion Tanzania shillings loss (Madoffe *et al*., 2000; Aloo, 2001; FAO, 2003; FAO, 2005 and FAO, 2011). Tanzania is also significantly affected by wildfires when used in land preparation, hunting, control burning and pest control. Wildfires result from a number of interacting factors like ignitions, conditions amenable for fire initiation and spread, and landscapes with vegetation that can support the combustion process (Moreno, 2014).

The current increase of fire incidences is related to global warming and the alarming global deforestation rate of 5.2×10^6 ha per year (Fernandez *et al*, 2017). A study by FAO (2013) showed that Tanzania as a country has been experiencing wildfires throughout the year whereby around 65,000 ha of plantation forests and other wooded areas (FBD, 2002) are destroyed annually. The average forest plantation area burnt annually is 2466 ha and 40% of which is from Sao Hill where the fires are frequent (Malinga, 2011). Fire is identified to be one of the major deforestations causes in Tanzania. Other causes of deforestation include: consumption of forest products, encroachment and clearing for agriculture.

In Tanzania, government plantations are the major supply of wood raw materials, where Sao Hill Forest Plantation (SHFP) alone has been supplying over 85% of raw material consumed by wood industries (Ngaga, 2011). However, fire outbreaks have been one of the major threats to the sustainability of the Sao Hill plantation forest since its establishment in the late 1930s. From 1970 to 2007 the forest

experienced at least ten fire incidents every five years coming from the adjacent villages. Between 1985 and 1987 at Sao Hill Forest Plantations, there were 105 incidences of forest fires destroying 5 665 ha (Lulandala *et al*., 1995). From 1990 to 2000 forest fires in Tanzania plantations (excluding Sao Hill) caused a financial loss of Tshs 8.8 billion (MNRT, 2001). In a period from 1999 and 2001, a total of 7 644 ha of forest plantations were destroyed by forest fires at Sao Hill alone (MNRT, 2001). Between 2000 and 2011 the number of fire incidences increased to 143, and there were 400ha burnt at Sao Hill in 2018. The later occurred in four consecutive days from 25 to 28 September 2018 of which 11 compartments were severely destroyed (TFS, 2018). According to the study by Nyongesa and Vacik (2019) in Kenya; fire records from 1980 to 2017 show that Mount Kenya Forest Reserve and National Park experienced about 210 wildfires. Most of these wildfires occurred in the months of January, February, March, September, and October. The fire records also show that from 1980 to 2017, more than 668 Ha of plantations, 21,276 Ha of bush land and grassland, 267 Ha of bamboo, 6727 Ha of indigenous/natural forests and 11,175 Ha of moorland were burned by wildfires in MKFRNP. According to the KFS and KWS, fire records from 1980 to 2015, the estimated fire fighting cost and the fire damages were $134,759.84 and $4,712,384.96 respectively.

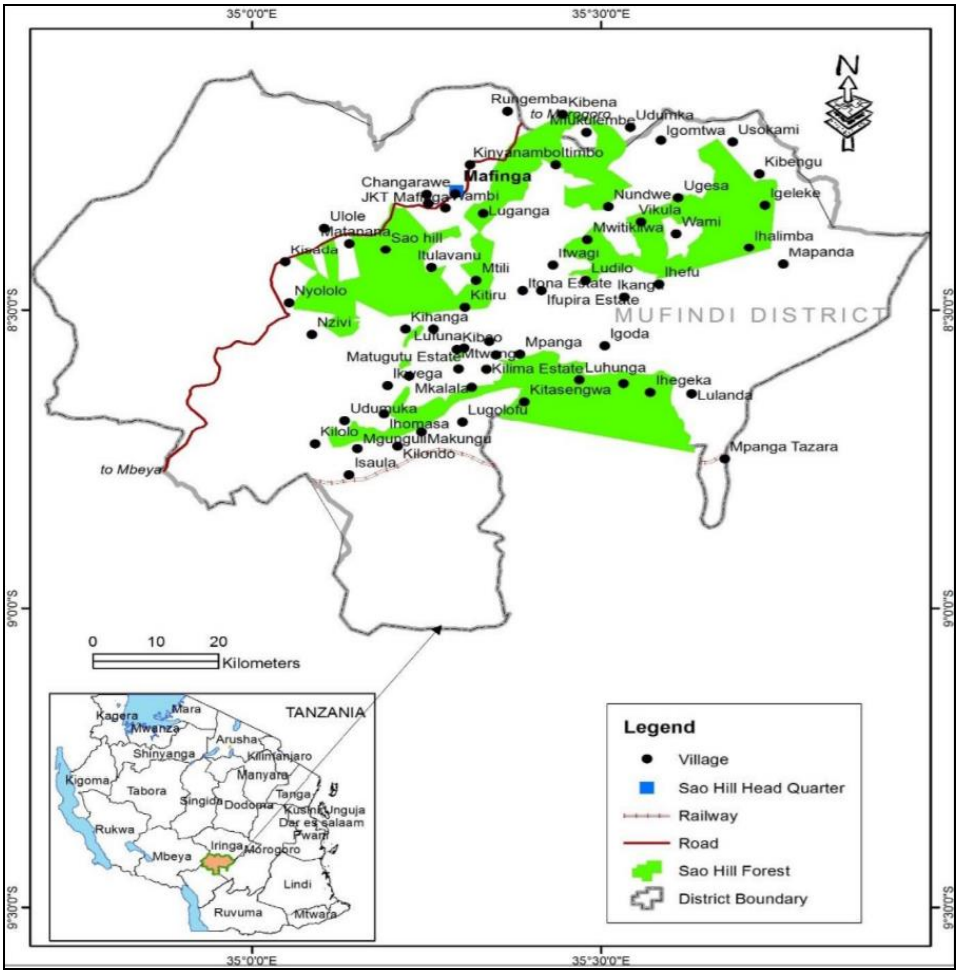
These alarming trends of wildfires called for national and international fire management intervention agenda like the 5th version of the International Wild-land Fire Conference in Sun City, South Africa, 9-13 May 2011. In East African countries like Kenya, the parliament passed the country governments' fire and disaster management bill that prepared the ground for the country to establish and implement integrated fire management approaches in the future in 2014 (Nyongesa and Vacik, 2019). Programmes like Reducing Emissions from Deforestation and Forest Degradation in developing countries (REDD) were introduced with a focus on integrated fire management and community-based fire management approaches (Kilahama, 2005; FAO, 2011). In Tanzania, the related programmes include Participatory Forest Management (PFM) strategies, sustainable agriculture programmes which were adapted to ensure sound fire management and improving livelihoods of rural communities (Yanda *et al*, 2008; URT, 2012). In line with these programmes, the Tanzania National Forest Policy spotted fires as the major threats that have been leading to degradation of forests and woodlands (URT, 1998). However, lack of specific policies and

institutional frameworks to address the problem of fire have compromised the effectiveness of fire management in Tanzania. Despite the strategies devised by responsible authorities, forest fires have been persisting (FAO 2013). FAO (2011) asserts that efforts like establishment of Community Based Forest Management and Joint Forest Management are thought to have reduced the annual net loss of forest, but reliable figures on their impact are not yet available. On the other hand, the data on extent, nature, impacts and sources of wildfires have been inadequate, and most statements on the fire issue are based on anecdote and opinions (Madoffe *et al*., 2000; FAO, 2013). This paper investigated the causes of forest fires focusing on Sao Hill Forest Plantation as a case study. It determined the impacts of wildfires and challenges in fire-fighting hence establishing the measures for combating forest fires.

METHODOLOGY

SHFP is located in Mufindi district, Iringa region. Its altitude ranges between 812 mm and 2,009 mm with heavy rains from November to January and March to April, and short dry spell of approximately two weeks in the first half of February and a long dry spell from May to November. The highest wind velocities occur during May to November, which offer fire risks season (Ngaga, 2011).

The study adapted mixed approach which enriched data, added value and allowed comprehensive understanding of the problem. The case study design was used. The term 'case' contextually implies 'an instance of' and fundamentally it focused on investigating one or more specific 'instances of' something or issues which established the cases in the study. In this context, Sao Hill Forest plantation (SHFP) was a case as an organization (Map 1). Case design allowed multiple sources of data like interviews, direct or indirect observation, and archival document; sometimes the inclusions of the physical environment, in this case the burnt forest area. This triangulation guaranteed the authenticity of the research findings. The study used the face-to-face individual interview to get the qualitative data. This was mainly from the key informants. Interviewing is a great way of learning about attitudes and values. And it is a great way of finding out what people think and what they do. When you want to know what people actually do, there is no substitute for watching them or studying the physical traces their behaviour leaves behind.



Map 1: Map of Mufindi district showing the coverage of Sao Hill Forest Plantation

Source: GIS (Geographical Information Systems), University of Dar es Salaam, June 2016

The study adapted direct observation (watching people and recording their behaviour on the spot) and indirect observation which investigated peoples' attitude, culture and perception on forest protection through the archaeology of human behaviour (Russell, 2011). Ethnographic research offers an orientation to understand the process and structure of a social setting and employs research techniques consistent with this orientation. It is the study of both explicit and tacit cultural knowledge. Observing user in the field is always the best way to determine their usability

requirement. Key informants established the entrance points during data collection. This offered connection for more respondents to be engaged in the study. The interview was adopted due to its tendency to gather voluminous deep information, which can answer the research objectives (Yin, 2009; Creswell, 2009).

The study employed judgmental sampling where a sample of 45 was purposively incorporated. Such a method allows the researcher to decide on units to be involved in the study. Fifteen (15) key informants out of 45 were purposively selected and interviewed due to their knowledge and skills about the problem. They comprised of the general plantation manager, division managers and key stakeholders and heads of departments. The questionnaires were provided to the 30 remaining respondents who were snowballed as directed by the key informants until a saturation point was reached according to Sapsford and Jupp (2006). The snowballed informants included some elders who were familiar with the Sao Hill context, private tree out-growers, timber dealers, fire guards, foresters and heads of villages where fire incidences occur regularly.

The data were analyzed through thematic analysis. Thematic analysis involved disintegrating the recorded discussion into smallest meaningful units or themes to capture types, patterns and sequences of fires (Creswell, 2009). Data were reduced into simpler categories and specific themes. The themes were related to causes of forest fire, forest fire impacts and challenges during fire prevention, fire suppression and controlled use of fire in the communities. Subthemes were developed from the data to capture knowledge of the communities on fire context, practices and customary norms in relation to fire management.

FINDINGS AND DISCUSSION

This section discusses the results guided by study objectives. The causes of forest fires at SHFP were mainly human centred. Table 1 shows the findings on the perceived major causes of forest fire. Majority of the respondents (68.9%) viewed land preparations done by farmers near forest stands, and land prepared before tree replanting in the formerly harvested forest compartments as a major cause of wildfire in the area. 15.6% of the respondents spotted arsonism while the remaining 11.1% emphasized on accidental fires.

Table 1: Causes of Forest fires at SHFP; N=45

Statement	Response	Frequency	Percent
Causes of forest fires``	Accidental fires	5	11.1
	Land preparations	31	68.9
	Arsonism	7	15.6
	Honey harvesting	2	4.4
	Total	45	100.0

Source: Field data (2018)

The interviewed forest officer who was in-charge of fire and road department had these to say:

> "We normally use fire in cleaning the harvested area before replanting trees. This is practically dangerous since the chance of fire escaping to unintended destination is too high. Despite the fact that this act is done on cool/calm days from evening to night, the changing patterns of weather may result into escaping fires which eventually impose risk to the plantation. In some cases, local farms preparation result into escaping fires which find their way into the plantations. We address this by insisting villagers to prepare their fields after seeking permits from authorities including division managers in respective areas. This is permitted after proper assessment of weather trends and after ensuring that the fire crew is stand-by just in case of any fire emergence" (July, 2018).

The findings reflect the World-Wide Fund (2006) report that, fire has been and is still used because it is one of the least expensive methods of clearing and preparing land for agriculture and other land uses. It is a tradition attributed to by poverty, inadequate knowledge, skills and awareness on the appropriate agronomic practices and sustainable environmental management. At Sao Hill Forest, fire is used to prepare land for replanting, after trees harvesting (Figure 1).

Figure 1: Forest Compartment Affected by Escaped Fire during Land Preparations
Source: Field data (2018)

Besides, fire is used when preparing the virgin land for tree planting and communities use fire to prepare land during cultivation. In 2010 the Sao Hill plantation conducted a survey whose results indicated that honey harvesting, farm preparation, hunting, arson, loggers' camps, fishermen, herders and envious people were the main causes of fire outbreaks from the adjacent villages (Kangalawe, 2018).

Although fire resulting from land preparations is a major threat in the area, there are seasons of low and high fire incidences. Land preparations and fire peak seasons are especially the case in months of August and September. It was noted that the rainy season has been experiencing a lesser number of fire incidences. During this season, the weather at Sao Hill area is calm, less windy and there is plenty of moisture. The moisture makes the total amount of combustible material (fuel load) like grasses and debris wet. This reduces the chance of fire occurrence and limits the rapid spreading of fire in case of such incidence.

However, in practice, this is not a relaxation stage; rather it is a transition stage, which invites preparation towards the fire intense dry season. Such observations are in line with the records by World Wide Fund (2006) on their study on bush fires in East Usambara landscapes, where it was noted

that, bush fires are the most common and widespread in the lowlands especially during the dry season (July to November) when people are clearing the land for cultivation. The interview with a member of fire stand- by crew reveals more on the season of likely forest fire incidences:

> "The dry season is normally the peak. It is the peak of hot seasons, the peak of harvesting operations and the peak of land preparation activities before starting tree replanting and farming onsets. In our place it starts from mid July to September, it is normally the most dangerous period" (July, 2018).

As suggested from the quotation above, the dry season is also the peak of harvesting season. Activities like logging and timber processing result into accumulation of wood wastes which could become dangerous during dry season (Figure 2). It has been estimated that in order to produce 45 tons of timber, 55 tons of waste is created in the form of sawdust, treetops and branches, and is left to decay, burnt on site or collected as wood fuel, hence creating a potential danger to the forest plantation if left unmanaged.

Figure 2: Poorly Handled Tree wastes Left after Harvesting Operation

Source: Field data (2018)

Rate of forest fire incidences

The statistics related with the result on the number of fire incidences in the area is shown in Table 2, where 31.1% of the respondents indicated that there were 25 to 35 fire incidences per year.

Table 2: Rate of Fire Incidences N=45

Statement	Response	Frequency	Percent
Fire incidences per year	< 5	3	6.7
	5-15	8	17.8
	15-25	11	24.4
	25-35	14	31.1
	>35	9	20.0
	Total	**45**	**100**

Source: Field data (2018)

The fluctuation of fire incidence was also reflected in the study by Poletti (2016) who noted a constant increase per decades, whereby the number lowered from 2000 to 2009 and gained a bigger mean size from 2010 - 2015. However, critics suggest the rate may not directly convey the seriousness of the problem! Hence suggest that the type of fire can be more crucial than the number of incidences. For example, experience from Europe – Southern France as studied by Ganteaume *et al* (2013) showed that, less than one percent of fire incidences was recorded during this period but accounted for 78 percent of the burned area.

Negligent causes of forest fires have mainly been cigarettes' smokers, honey collectors and timber processors. For example, those who are operating mobile sawmills inside or near the forest stands or burning of wood leftovers like slabs and sawdust during timber processing can cause forest fires (Figure 3).

Figure 3: Burning of slabs near Forest Stand can Facilitate Forest Fire if done without Precautions

Source: Field data (2018)

Negligence causes are characterized by features of frequent repetition; concentration, distribution pattern, and relationship with human seasonal activities hence change with time horizons. Polleti recorded that from 1980 to 1999 negligence sources were dominant, but after 2000s the arsonists and charcoal burners became dominant causes of forest fires (Polleti, 2016). In Sao Hill context, arsonists perceived that they were not acquiring direct benefit from the forest plantation in the form of trees harvesting permits, or farming lands. This concurs with the statement from interviewed forest officer who stated that:

> "We have no recent records of naturally induced fire like thunderstorms at Sao Hill. Most of the fire incidences are human induced either accidentally or purposely" (July, 2018).

This finding also concurs with Garcı ´a-Ortega *et al* (2011) who showed that, natural causes of wildfires are either absent per year or represent only a small percentage of all fires and are mostly explained by lightning, which can be very important in some areas of several European countries.

Arsonism was the next cause of forest fires as mentioned by the respondents (15.6%) in Table 1. Arsonism is facilitated by conflicting interests and opinions among stakeholders in aspects of unfair distribution of farming lands, harvesting permits, temporary employment in terms of man-days which are perceived to be unjustly given hence resulting into revenge among arsonists. Polleti (2016) observed that, the arsonists, followed by the honey collectors played the most relevant role in causing forest fires. Tedim *et al.*, (2016) asserted that arsonists have been causing fires for profit gain where interests are related to setting fire for monetary profit like insurance fraud, or non-monetary profit like setting a fire to maintain seasonal employment. Interview with one of the stakeholders in saw mill industry revealed the following:

> "I am holding the view that fire is purposively caused by arsonists. These are people who think they don't benefit directly from forest products. Arsonists are individuals who couldn't get harvesting permits, licenses or farming lands. They therefore burn the forest as part of revenge" (July, 2018).

This observation invites the need for policy review to advocate the matter. At plantation level, there is a need to incorporate issues related to how communities surrounding the forest plantation could benefit. Such matters need to be reflected in the annual budget and in the management plans. The issues of community support need to be firmly established. Besides, they could also be incorporated into forest policy and regulations for legitimacy purposes. Other strategies could involve allocating tree seedlings to communities in order to establish their own forest stands. This could reduce pressure for tree raw materials from Sao Hill plantation. This can work in line with educating community members to form sawmill groups and get assured of tree raw materials on contractual basis. A part from creating employment, such a strategy would also widen the market for forest produces.

Another view was from the forest officer who had the following observations with regard to arsonism and fire causes:

> "My experience is that the patches of the plantation that are closer to human activities make the area more prone to fire incidences. In some cases, fire emerge as a result of business conspiracies; where the scarcity of raw materials makes arsonists burn the part of the forest on the belief that the forest management will finally allow the

> burnt plots to be harvested by community members. In some cases, arsonists burn the plantation due to being denied access to the harvesting permits. However, it is not easy to detect the true intention of the doers as many are not caught ready handed. Those who are caught are those who caused fire during land preparation" (July, 2018).

The observations above are parallel with the report by World Wide Fund (2006) that forests adjacent to communities that are poor, own small farm sizes insufficient to cater for their annual livelihood demands. This results into such communities becoming involved into other alternative economic activities. This highlights the fact that, the forest stands will be prone to encroachment and other illegal activities like hunting, collecting fuel wood, honey collection, cultivation, charcoal making, collecting non timber products like medicines and fruits. In Sao Hill forest, such activities are the causes of some of the ongoing bush fires in the area.

Accidental causes of forest fires include failure of electric lines, sparks emitted by vehicles. This is especially dangerous in mobile sawmills which operate inside the forest stands in situation whereby the terrain is too difficult to justify pulling the logs out of felling site. During field survey the researchers witnessed the sparks from operating machines, which caused escaping fire by wind force to the nearest forest leftovers (Figure 4).

Figure 4: Fire caused by Sparks from Machines that make Forest Stands Prone to fire Incidences

Source: Field data, (2018)

In forest stands passed by the Tanzania to Zambia highway there are cases where forest fires have been resulting from combustion or ignition from vehicles (Figure 5). This includes combustion from vehicles and other machinery especially those employed in road construction, timber processing and heavy trucks used in loading and unloading of logs.

Figure 5: Combustion from Moving Vehicles can Result into Forest Fires when fire sparks get contact with dry grasses

Source: Field Data (2018)

Interview with timber processor indicated that this situation normally occurs during dry season, where the grasses are dry and the temperature is high, in which ignition from cars could produce sparks which might result into fire. This could further spread fires to the nearby forest stands. Though the SHFP management has tried to conduct silviculture operations like road side grasses slashing, and trees pruning the number of incidences resulting from this cause have been significantly notable.

Impacts of Forest Fires

Findings in Table 3 indicate negative impacts of forest fires on ecology and economic development.

Table 3: Impacts of Forest Fires

Statement	Response	Frequency	Percent
Forest fire impacts	Destruction of assets	6	13.3
	Deaths of animals	1	2.2
	Loss of trees	35	77.8
	Land degradation	3	6.7
	Total	45	100.0

Source: Field Data (2018)

Forest fire is ecologically and economically destructive at SHFP, and the loss of trees was the top ranked impact (77.8% of the respondents) followed by destruction of assets like houses, saw milling machines and vehicles. Forest fires suppress the re-growth of more resistant species and prevent woodland canopy which suppress herbaceous production and reduce fuel loads. Furthermore, fires slow down ecological regeneration capacity and impact the future extension strategies. Forest fires destroy land structure and make the area prone to soil degradation (Thompson *et al* 2013; Sebata, 2017 and Neary & Leonard, 2020). Fires destroy soil, microbes, pollinating insects and wild animals that support biological functioning that finally affect regeneration (Figure 6).

Figure 6: Forest Fires Destroy Planted Trees and General Ecosystem
Source: Field Data (2018*).*

Interview with one of the respondents in timber processing industry recorded that:

> "The impacts are broad; in some cases, impacts like land degradation could not be quantified into monetary significances but eventually result into declining forest quality. The burnt trees are sold at a cheaper price hence reducing the government revenues. Furthermore; fires result into destruction of buildings and other infrastructures, wastage of valuable time and disturbances to people, and they impose stress to the community" (July, 2018).

This finding tally with several literatures which reveal that wildfire affects many hectares of forests and damage biodiversity, human life and infrastructures (Ganteaume and Jappiot, 2013; FAO, 2013; Jhariya & Raj, 2014; Foldi & Kuti, 2016; Jua´rez-Orozco, Siebe & Ferna´ndez, 2017).

Fires threaten budget and jeopardize future investment. One SHF officer had these to say:

> "We constantly replant the burnt areas rather than extending or opening up the new unplanted areas, this slows down our strategies. We invest a lot in forest protection, I doubt if the investment levels relate with the final yield prices. We are also losing benefits accrued from the forest, burning trees before harvest means you are losing from what you invested!! On the other hand, forest fires have created a fear atmosphere among other investors. The alarming rate of fire incidences make people afraid of taking risk into the ventures they are uncertain if the trees will reach the rotation age, or get return on their investment' (July, 2018).

The respondent's view is reflected by records of fire at Sao Hill in September 2018 alone, where 10,034 ha from 1996 to 1999 were affected by 6 fire incidences equivalent to Tshs. 4 billion loss. In 2005/2006, 1450 ha were affected by fire where 600ha were destroyed (TFS, 2018).

This view is supported by Nyongesa and Vacik (2018) in their study on Fire Management in Mount Kenya where it was pointed that commercialization of forest plantations when coupled with the intensification or cultivation of exotic fire-prone tree species like cypress (Cupressus lusitanica Mill.), patula pines (Pinus patula Schiede Ex Schltdl. & Cham), radiata pines (Pinus radiata D. Don), blue gum (Eucalyptus saligna Smith), and rose gum (Eucalyptus grandis W. Hill Ex Maiden) will increase fire hazard in the future. This is based on the fact that; such species are less resistive to fire threats and they do not produce coppices compared to many indigenous trees' species. This could jeopardize future investment in the sector.

Findings in Table 4 indicate that though forest fires are common to a whole plantation, it was severe at Division I and III by a proportion of 33.3 % each.

Table 4: Severe Fire affected Areas at SHFP N=15

Statement	Response	Frequency	Percent
Most fire affected areas	Division one	5	33.3
	Division two	4	26.7
	Division three	5	33.3
	Division four	1	6.7
	Total	15	100.0

Source: Field data (2018)

Observations related to severity of forest fires showed that division I, II and III were close to villages and urban area with wood industries and a highway passing through the forest. The interview with a division manager recorded that:

> "The plantation is divided into four management areas. Division 1, II and III have more interaction with villagers hence they are prone to forest fires; thus, resulting from socio- economic activities like saw milling and farming which may cause escaping fire. There can be 5-15 fire incidences at division two alone" (July, 2018).

The prolonged fires contribute to climate change by the release of green house gases and contribute to massive heat and smoke which might hinder other socio-economic activities (Figure 7).

Figure 7: A Queue of Cars Stopped by Heavy Smoke from Burnt Forest at Sao Hill Forest: Source: Field Data (2018)

Challenges in Forest Fires Fighting

Respondents were asked on the challenges they were facing during forest fire management. From Table 5, inadequate fire fighting equipment had a proportion of 33.3% while inadequate community participation had 28.9%. These were the two top rated challenges.

Table 5: Fire Fighting Challenges

Statement	Response	Frequency	Percent
Challenges	Inadequate fire fighting equipment	15	33.3
	Poor road network to reach the burnt area	8	17.8
	Little skills in combating forest fires	9	20.0
	Inadequate Community participation	13	28.9
	Total	45	100.0

Source: Field Data (2018)

The limited number of vehicles, pumps, and motor bicycle which hindered fire fighting; other tools were pangas, fire beaters and tree branches. During field survey there was no motorized pump that was observed though the fire crew had power saw for clearing felling trees during fire fighting which may obscure the road. There was one bulldozer and vehicles (pick-ups) at the stand-by area (fire assembly point). Interview with key informant under the fire department noted:

> "Fires here are of sky and ground type. They are difficult to suppress due to ground fuel richness resulting from accumulation of leaves, felled branches over years. While the plantation is large nearly over 60,000 ha of planted trees, the facilities are few and centralized. The wide spread nature of the plantation makes risk management more challenging. Imagine with over 60,000 ha there is only one modern and efficient fire rescue truck. Modern fire fighting equipment like protective gears when coupled with proper fire detection methods can enhance rapid fire detection and suppression hence serving the valuable forest from further destruction" (July, 2018).

The reflection above is in line with the findings by Malinga (2011) in a study on management cost in government and private forest plantations in Tanzania: case study of Sao Hill and Mapanda plantations, Mufindi

district, Tanzania. The study established that purchases of fire protective gears are very costly to the extent that affordability becomes difficult, even though prevention is better than cure. It was found that Sao Hill has a good number of fire protective gears more than Mapanda but was bought in the 1980s when World Bank financed the project. It was further revealed that some equipment is running wear and tear and replacement or buying new equipment is becoming difficult due to high prices.

Another challenge was community participation in forest protection (Table 5, 28.9% of the respondents). During survey, forest officer under publicity department claimed that:

> "The major challenge is community awareness and how people conceptualize the forest benefits. The forest is an ocean for the surrounding communities where they need to fish their livelihood. This makes them view it in one perspective of benefiting them in monetary gain alone. I think we need to invest in creating awareness. Value chains should be made from the forestry where people could benefit in various styles rather than benefiting directly from harvesting the forest" (July, 2018).

The problem of participation has not been observed in SHFP alone; the study by World Wide Foundation (2006) noted the same, although traditionally people used to mobilize themselves. This invites awareness creation, enthusiasm and where necessary legal enforcement. Communities should not be overburdened by such arrangements, especially where tangible benefits are unlikely to be realized in the near future.

Despite the difficulties, Participatory Forest Management (PFM) approaches have been practised at SHFP whereby villagers would cultivate maize in the trees harvested areas for one season before planting trees (Figure 8). They collect herb and other non-wood forest products like fruits, vegetables, though critics blame the practice to have been associated with fire incidences in the area. This is in line with the study by Dewan and Vacik (2010) where it was highlighted that agriculture was ranked as the second most relevant objective and thus it is at the heart of community interests. This suggests that most of the communities in developing countries are more concerned with socio-economic activities aimed at achieving their livelihood benefits such as employment, farming

activities, firewood collection, water collection, grazing, honey collection, tourism, herbal medicine, and hunting or timber production. However, such practices had associated impact if not correctly monitored. Interview with an officer in the publicity department commented that:

> "We initially thought that PFM could address the dilemma. However, it is against all odds. Apart from continuing incorporating PFM principles, we are also using the special security guards to protect the forest because there are community members who do not adhere to principles" (July, 2018).

Figure 8: Farmers are allowed to Cultivate Maize in Trees Harvested Areas through Participatory Approach Communities
(*Source: Field data, 2018)*

Infrastructure problem was also noted, there were unsatisfactory access roads, communication networks and water supply as evidenced in interview with key informant:

> "In my management area, water supply is a big challenge in case of fire emergence. We are allocated far from water sources and the water pumps. Infrastructures like bridges, well maintained access roads, feeder roads and fire lines / fire breaks tend to hinder our efforts in suppressing forest fire timely" (July, 2018).

Inadequate coordination of fire fighting planning operations like pruning and sub-standard construction of fire breaks, control burning and road side slashing can have a net effect of spreading forest fire.

The appropriateness of fire fighting measures depends on the type of fire (Sawe, 2008). For example, firebreaks suit ground fire. Thus, fire-based operation requires good plan, organization of resources and coordination of the fire crew. Interview with responsible officers indicated that there were no reliable weather detectors and data. The fewer fire towers which detect fire by observing smokes were in place. This suggests that, climatology data pertaining to temperature, humidity, wind speed and direction were missing which make fire management challenging. Interviewee at fire department commented that:

> "We are lacking reliable data sources. This makes it difficult to establish trends, which would ensure predictability of the incidences depending on the analyzed data and hence enabling future decision making. We need to have facilities for collecting and analyzing data specific to our area. We rely on satellite data from the headquarters (Dar es Salaam). But the satellites we are using just inform that there is fire at Sao Hill without giving specific details on the site location. Remember Sao hill is big plantation!" (July, 2018).

This deficiency was vivid in the study by FAO (2013) on sustainable forest management in a changing climate - A Fire Baseline for Tanzania showed that, the data on extent, nature and impacts of wildfires have not been compiled and analyzed which preclude developing accurate and reliable data for recent and future comparisons. Besides, such findings relate with study by Nyongesa and Vacik (2019) on evaluating management strategies for Mount Kenya Forest Reserve and National Park to reduce fire danger and address interests of various stakeholders. It was noted that, most of the fires are recorded by Kenya Forest Services had unknown causes, making it difficult to estimate their social, economic, cultural and ecological effects. This study, though specific to Sao Hill Plantation has contributed to the few existing knowledge on plantation fires and its fighting challenges for policy interventions.

In summary, the study found that land preparation was the major cause of forest fire at Sao Hill Forest plantation. This included preparing land by local farmers at nearby forest stands and land prepared before replanting of trees in the formerly harvested forest compartments or extension areas. On the other hand, arsonists were the second contributor of forest fire in the area. Loss of trees was the major identified negative impact of forest

fires followed by destruction of assets. Challenges include; inadequate firefighting equipment and inadequate community participation which were impeding the plantation strategies to address the fire problem.

CONCLUSION AND RECOMMENDATIONS

The findings of this study exposed the need for the decision-makers, forest managers, tree growers and policy actors to consider the issue of forest protection. This is critical for conservation purposes, maintaining ecological balance and for social economic benefits. All stakeholders should coordinate harmoniously through a participatory process. Besides, the study findings could also be adapted in management of natural forests. It is critical to practice forests protection evaluation, enhance forests protection records and adopt relevant frameworks that would facilitate forest protection management practices. Enhancing protection records will also bridge the present information or data gap among decision makers and managers or practitioners at grass root level. This will enable to establish relevant policy, regulations and budgets in forest protection.

In addressing proper land preparation, all the prerequisites for successful controlled burning must be thoroughly followed up as per the agreed Community Based Fire Management Plan (CBFM). For example; villagers were to report to the nearby forest station. This would enable the forest in charge at the station to organize appropriate time or man power to monitor the preparation farming land by fire. This is based on the fact that, the use of fire for land preparation is cost feasible which means that it cannot easily be burnt Use of controlled fire, fire lines, fuel breaks, fuel load removal and mapping of fire sensitive areas are key principles to minimize fire risk. In addressing arsonism, the plantation management needs to carefully plan for the just and equitable allocation of resources such as trees harvesting permits, farming land among communities and establishing community relations programmes through participating in social events like supporting health services, funeral services, education, sports and games activities. Farmers must ensure proper land use to reduce competition to the forested land; for example, practising multiple purposes land uses like agro-forestry or mixed cropping with trees for future timber uses. The later can also be sold as poles at the local and urban markets. Furthermore, employing the use of Remote sensing techniques such as Geographical Information Systems (GIS) can facilitate early detection and hence timely suppression of forest fires.

Training of fire fighting crew and ensuring the availability of fire fighting equipment, radio devices like "walkie-talkies" are recommended for communication among fire fighting crews and head quarters at Sao Hill main office. There should be a good network of fire towers for monitoring and detection of possible fire signs, adequate protective gears for crew safety during fire fighting and means of transport like standby vehicles, motorbikes and bicycles for fireguards. This should be in line with good forest road network to enhance immediate access and hence response to fire incidences. Besides, the need to enhance social relationship through supporting adjacent communities in form of materials and services, and joint forest management between plantation management and surrounding villagers is important for forest protection against arsonists.

There is a need to review the management practices. This can be achieved through redefining the mission of the forest plantations. Recently, managers have been putting much emphasis on extension of unplanted areas and some on conservation of biodiversity. However, lesser concentration has been invested on other goals such as improving wood production in terms of recovery, forests and energy, quantification of social economic values of forests, non-timber or non-wood forest products and matters associated with climate change.

Commercial companies and other stakeholders should come up with means to utilize the after harvest remains from timber processing. This will in turn reduce the fuel load left during harvesting operations. Policy makers and the government should enhance the legal legitimacy and budgetary favourable atmosphere. It is crucial to establish new policies, laws, new penalties and sanctions for emerging forest fire related offences. Policy coherence and harmonization should be ensured; for example; wildlife policy, national forest policy, national land policy, water policy, agriculture development policy, energy policy etc. Such policies need to work in harmony as they are all being affected directly or indirectly by forest fire threats.

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Transaction Cost of Sunflower Seed Production in Tanzania: Application of Transaction Cost Economics Theory

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ABSTRACT
This paper analyses the effects of transaction costs of production of the sunflower seeds by small scale farmers in Tanzania. The study utilises cross-sectional farm household data collected from a randomly selected sample of 120 small scale farmers in two central regions of Singida and Tabora in Tanzania. The results showed that transaction cost variables associated with information search and negotiation had negative effect on total output of sunflower seed production while contractual enforcement cost had positive effect on sunflower production. The effects were however not supported statistically (at $p<0.05$). Transaction costs associated with inputs information, access to means of communication and transportation, had significant negative effects on sunflower seed production. We recommend that policies aimed at improving rural road infrastructure, market information systems, small scale asset accumulation, human capital and promotion of farmer association could reduce transaction costs and enhance sunflower production by small scale commercial farmers.

Keywords: *Transaction cost economics, search cost, negotiation cost, enforcement cost, sunflower production, Tanzania*

INTRODUCTION

Transaction costs exist in all production and market exchanges; and high transport costs, which are an element of transaction costs, are a major deterrent for participation of farmers in Africa, and they affect the price farmers receive as well as their production (Hine and Ellis, 2001). This implies that a reduction in transaction costs can encourage small scale farmers to participate efficiently in production and marketing. In Africa, agricultural commercialisation remains to be marginal as it has been observed that 26% of farmers did not sell any of their crops produced and

so they were not connected to market; with only 25% of farmers selling more than half of their total production (World Bank, 2011). From all these observations it is plausible to argue that the output side of agricultural commercialisation is very low for small scale farmers to experience the associated benefits.

Sunflower is one of Tanzania's most important cash crops grown mostly within the central regions of Tanzania. The country ranks eleventh in the world in sunflower seed production and it is the second largest producer in Africa behind South Africa, accounting for 35% of the continent's total production; yet the country imports nearly 50% of edible oil. African countries account for 5.5 per cent of the world's production (FAOSTAT, 2018). Furthermore, statistics show that local production of both factory and home extracted sunflower seed oil in Tanzania contributes about 40% of edible oil requirement of 330,000 tones implying that the 60% supply gap is filled by imports.

Sunflower oil is one of the most popular oils in the world, in Tanzania sunflower production offers multiple livelihood opportunities, as it produces important and valuable vegetable oils and animal feeds that are sold to internal and external markets (Ugulumu E.S.; Inanga E.L., 2014). It is estimated that about 4 million small scale farmers engage in sunflower production (URT, 2013). Sunflower is grown in most regions across Tanzania as the crop is drought resistant and less susceptible to diseases; consequently, the semi-arid areas of the central zone and the southern coast of Tanzania are most favorable for sunflower production (Kajimbwa et al., 2010).

In African tropical countries, Tanzania production stands at 108 000 MT per annum, Sudan (18 000 MT), Kenya (12 000 MT), Angola, Mozambique, and Zambia (each about 11 000 MT). Most of the sunflower oil is consumed in these countries of origin and less than 30% reaches the international markets. Low exports of sunflower oil are attributed to high demand in domestic markets, low quality and standards which restrict entrant to international markets, and low output of most small-scale processors (Berglund, 2015). In Tanzania, agriculture continues to be the main backbone of the economy of most of the rural population. According to URT (2008) over 80% Tanzanians live in rural areas where agriculture and the use of natural resources are crucial to their livelihoods. Sunflower represents one of the key sub-sectors of

agriculture in Tanzania (RLDC 2008). Globally, the leading commercial producers of sunflower seeds includes Russia, Peru, Argentina, Spain, France and China (The George Mateljan Foundation, 2001-2010). Irrespective of its relevance in understanding determinants of transactions in developing countries, the application of Transaction Cost Economics (TCE) theory in thin markets has been minimal especially in agrarian economies. As a result, explanation of what could explain commercialised agricultural production in the country is lacking. The overall objective of this paper therefore, is to apply TCE theory in identifying the different forms of transaction costs and assessing their relative effects on sunflower seed production in Tanzania.

Transaction Cost Economics Theory and its Application

Since Williamson proposed the TCE theory in 1970s, a number of researchers have used it in a variety of relationships. Williamson, focuses on how the characteristics of a transaction affect the costs of handling it through production, markets, bureaucracies, and other forms of organization. A transaction occurs whenever a good or service is transferred across a technologically separable interface (Williamson, 1985). According to Williamson (opt cit), transaction costs can be classified into observable (explicit) and unobservable (implicit) or inhibitive transaction costs. The observable transaction costs, which include production costs such as transport, handling, packaging, and storage, affect the magnitude of output. The unobservable transaction costs, which include cost of information, search, bargaining, screening partners or customers, monitoring, coordination, and enforcement are inhibitive. The other delineation of transaction costs is *ex ante* fixed and proportional transaction costs. Ex ante fixed transaction costs are the same regardless of the magnitude or level of transactions made. An example of ex ante fixed costs is information cost on inputs, which would remain the same regardless of the amount of produce a farmer sells after the market information has been obtained (Yustika, 2008).

From yet a different perspective, Wang and Huo, (2013) and Key et al., (2000) define transactions costs as fixed and proportional (or variable) transaction costs. Here fixed transactions costs include the original search, negotiation and enforcement costs that are invariant to the volume of input as well as output. However, with respect to sunflower production, there is need to use a narrower definition of transaction costs which provides a clear relationship with search, negotiation and enforcement

costs in sunflower production. In this context, the definition by Staal et al, (1997) who classify transaction costs into observable and unobservable transaction costs is used. The observable transaction costs include marketing costs such as transport, handling, packaging, storage, spoilage etc. that are visible when a transaction takes place. Unobservable transaction costs include cost of information search, bargaining, and enforcement of contracts etc. The adopted framework of Transaction Costs underpinnings of why the transaction costs effect sunflower seed production can be found in the transaction costs theory as postulated by Williamson (Siziba et al., 2011).

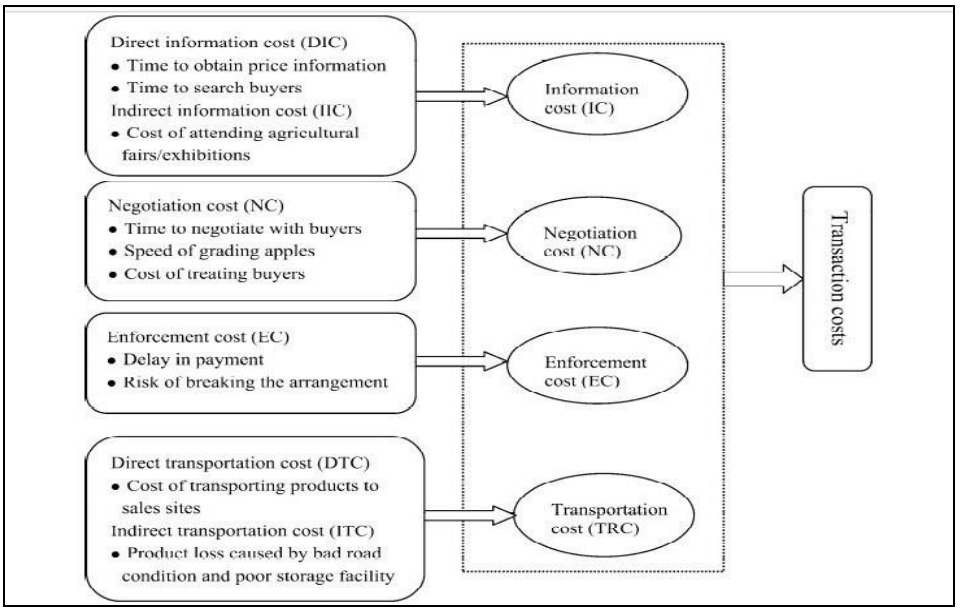


Figure 1: Adoptive Framework of Transaction Costs
Source: Modified from Wang and Huo (2013)

A number of studies, such as Key et al., (2000) and Makhura et al., (2001) have identified high transaction costs as one of the key reasons for small scale farmers to participate in production, though they accorded attention to the global production of oil and seed shows that, sunflower industry is dominated by a few large global players, characterized by large, mechanized farms with easy access to inputs and funding. The study investigated the role of proportional and fixed transaction costs on farmers' market participation and supply volume decisions. Key et al. (2000) show that maize production in Mexico is not only associated with

agricultural mechanization, use of high-yield inputs, and price, but also with selling to official sources and membership of agricultural organizations, implying lower proportional transaction costs. The marketable production threshold was significantly associated with pick-up truck ownership, i.e., higher fixed transaction costs (Key et al., 2000).

A study conducted by Hobbs and Young (2000) stated that product perishability also complicates transaction, and raises transaction cost. Shiferaw et al. (2009) identified low volume as one of the major factors limiting the success of small-scale marketing groups in Kenya. Though numerous studies have accorded attention to the effects of transaction costs on small scale farmers, not many foci on how they affect small scale paddy farmers. In Niger, Aker (2008) has shown that mobile phone use among grain sellers led to significant reductions in grain-price dispersion net of transport costs across production and markets of small-scale farmers in Niger.

Baloyi (2010) conducted a study on analysis of constraints facing small scale farmers in the agribusiness value chain in Tanzania; the study discussed the factors such as lack of human capital, high transaction cost, lack of information on markets, transport problems, technological barriers. The study discovered that many small-scale farmers were illiterate, with poor technological skills, which seemed to be obstacles in accessing useful formal institutions that can disseminate technological knowledge. It shows that majority of emerging producers lack knowledge on financial and marketing skills and it was found that producers were not able to meet the quality standards set by fresh produce markets and food processors. Further, Ugulumu, and Inanga (2014) argue that reducing transaction costs can significantly unlock the limited market participation by small scale farmers.

METHODOLOGY

Data and Sampling Design

Cross section data were collected from a survey of 120 randomly selected small-scale farmers in two districts of Mkalama and Igunga in Singida and Tabora regions of central Tanzania. The study confined in collecting quantifiable transaction cost determinants of Commercialised production of sunflower seeds. A formula for simple determination proposed by Tabachnick and Fidell (2007) was used to come up with a sample size. Tobachnick and Fidel (opt cit) suggest a formula: $N > 50 + 8m$ for

multivariate data analysis where *N* is the number of sunflower producers target population and *m* is the number of independent variables.

Theoretical Model Formulation

The transaction cost economics (TCE) and neo-classical economics (NCE) theories assert that the producer maximises profit subject to some technical and institutional constraints (Meyer, 2006). A farmer will thus, choose level of output and set of inputs in such a way that a maximum profit (π Max) is realized. The production maximization function with consideration of transaction cost as an exogeneous factor is as presented in equation (1).

$$MaxU(C_i, T_i^c) \quad \text{..... 1}$$

Equation (1) is assumed possible subject to income, resource and transaction cost constraints as indicated in equations 2-5. Income Constraints equation is thus as presented in Equation (1), whereas the resource constraints equation is represented in Equations (2) and (3).

$$A + \sum_{i=1}^{N} P_i^c B_i \geq \sum_{i=1}^{N} P_i^c B_i \quad \text{..... 2}$$

$$Q_i + E_i + B_i \geq K_i + C_i + S_i \quad \text{.....3}$$

Equations (4) and (5) present transaction costs of production constraints

$$G(Q_i, K_i, Z^q) = 0 \quad \text{..... 4}$$

$$C_i, Q_i, S_i, B_i, K_i \geq 0 \quad \text{..... 5}$$

Where;

T_i^c = Transaction costs

P_i = Total production of good i

A = Exogenous factors

Z^c = Farmer characteristics

Z^q = Transaction costs characteristics of production

Model Estimation Method

Due to the continuous nature of dependent variable (quantity of sunflower seed produced by small scale producer) an Ordinary Least Square (OLS) method was used to estimate the Multivariate Linear Regression Model of transaction costs sunflower determinants of sunflower seed production. An econometric form is adopted as shown in equation (6) and the estimates β_i for the vector of variables capturing the factors determining L, which include transaction costs related factors (i.e., access to information, negotiation, and law enforcement to loans), are obtained.

$$L_i = \sum_{i=1}^{i=n} (\chi_i \beta) + \mu_{1i}$$

…….. 6

Where,

L_i = the intensity output (the quantity of sunflower production)

χ_i = independent variables (transaction costs) affecting sunflower production

β = coefficient estimates of the independent variables, and

μ_{1i} = the error term for the regression equation

In the current study conceptual framework integrates output and transaction costs in the choice of production channels. For the current study, the functional form of the classical multivariate regression model is represented in equation (7) and its loglinear form in equation (8).

$$Y_i = \beta_0 + \sum_{i=8}^{8} \beta_1 \ln Searchcost + \sum_{i=5}^{5} \beta_2 \ln Negocost + \sum_{i=2}^{2} \beta_3 \ln Enforcost \quad \text{..... 7}$$

$$\ln Y_0 = \beta_0 + \beta_1 \ln Searchcost + \beta_2 \ln Negocost + \beta_3 \ln Enforcost \quad \text{..... 8}$$

Where Y refers to total number of bags of 70kg (TONUBA)

Effect of Search Transaction Cost on Sunflower Production

In this study Search cost (Searchcost) =*f* (seeding, deciding, preparing land and planting, harvesting, packing and storing, selling). Hence holding negotiation cost (Negocost) and enforcement cost (Enforcost)

constant, the effect of search transaction (Searchcost) cost can be rewritten as in equation (9).

$$\ln Y_{1i} = \beta_0 + \beta_1 \ln(Seed\,\text{cost}) + \beta_2 \ln(Decide\,\text{cost}) + \beta_3 \ln(\text{Pr}epLand\,\text{cost}) + \beta_4 \ln(Input\,\text{cost}) + \beta_5 \ln(Harvest\,\text{cost}) + \beta_6 \ln(Pack\,\text{cost}) + \beta_7 \ln(Store\,\text{cost}) + \beta_8 \ln(Sell\,\text{cost}).....eqn_2 \quad \text{..... 9}$$

Where,

Seedcost = transaction cost of finding information about a particular type of seed and cost of traveling to purchase seeds if the seeds were not available.

Decidecost = transaction cost of decision by farmers to phone-call to agricultural officers to find information about the sunflower farming.

Preplandcost = transaction cost of finding labour and cost of finding machines to prepare the land for farming.

Inputcost = transaction cost of finding fertilizer, pesticides, weeds etc. and cost of traveling to purchase fertilizer, pesticides, weeds etc. if those were not available.

Harvestcost = transaction cost of harvesting and finding storage, packing materials.

Packcost = transaction cost of packages and packaging sunflower seeds in the required quantities

Storecost = transaction cost of storing sunflower seeds and associated conditionalities

Sellcost = transaction cost of comparing prices of different traders and costs of finding transport.

Effect of Negotiation Transaction Cost on Sunflower Production

The second component in equation (8) is negotiation transaction costs (Negocost) that are more related costs to access to the right information. In this study Negocost = *f* (Payment for land hiring, transportation of inputs, writing the contract, waiting time at bank for loan receiving, bargaining power of buying inputs). Thus, holding Searchcost and Enforcost constant, then equation (8) can be represented as shown in equation (10).

$$\ln Y_{2i} = \beta_0 + \beta_1 \ln Land\,\text{cost} + \beta_2 \ln Inputs\text{cost} + \beta_3 \ln ContractWriting\,\text{cost} + \beta_4 \ln Bank\,\text{cost} + \beta_5 \ln B\text{arg}aining\,\text{cost} \quad \ldots\ldots 10$$

Effect of Enforcement Transaction Cost on Sunflower Production

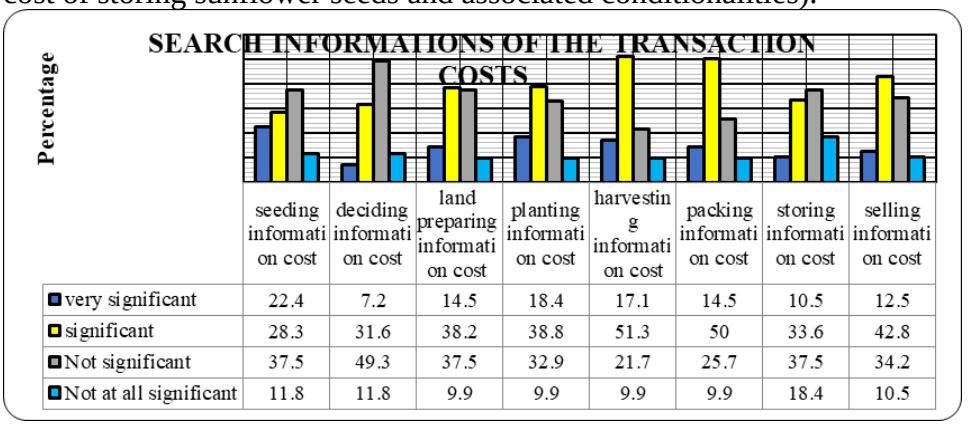
Enforcement transaction costs (Enforcost) include cost of monitoring (contract enforcement) of sunflower seeds production. In this study enforcost is referred to the cost of collecting the payment from buyers in terms of days to receive payment from buyers and from cooperatives. Thus equation (8) is rewritten as shown in equation (11)

$$\ln Y_{3i} = \beta_0 + \beta_1 \ln No.daystorecaivePayment + \beta_2 \ln No.daysfor\text{Re}ceivingPaymentfromCooperative \quad \ldots\ldots\ldots\ldots 11$$

FINDINGS AND DISCUSSION

Description of Transaction Cost Determinants

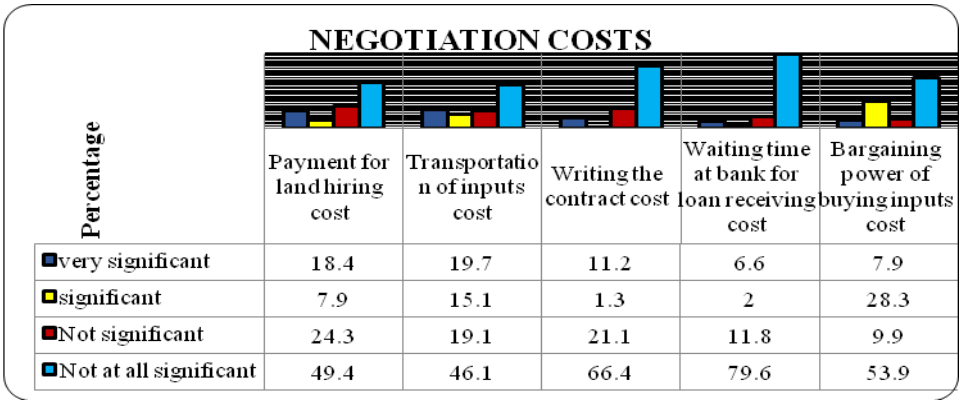
Figures 2-4 summarise small scales farmers' perceptions on significance of various determinants of transaction cost dimensions. It can be learnt from Figure 2 that unlike other search cost determinants, majority of farmers felt that two determinants of search cost were not as significant as other determinants. The two determinants are Decidecost (transaction cost related to the decision by farmers to phone-call agricultural officers to find information about the sunflower farming) and Storecost (transaction cost of storing sunflower seeds and associated conditionalities).



	seeding information cost	deciding information cost	land preparing information cost	planting information cost	harvesting information cost	packing information cost	storing information cost	selling information cost
very significant	22.4	7.2	14.5	18.4	17.1	14.5	10.5	12.5
significant	28.3	31.6	38.2	38.8	51.3	50	33.6	42.8
Not significant	37.5	49.3	37.5	32.9	21.7	25.7	37.5	34.2
Not at all significant	11.8	11.8	9.9	9.9	9.9	9.9	18.4	10.5

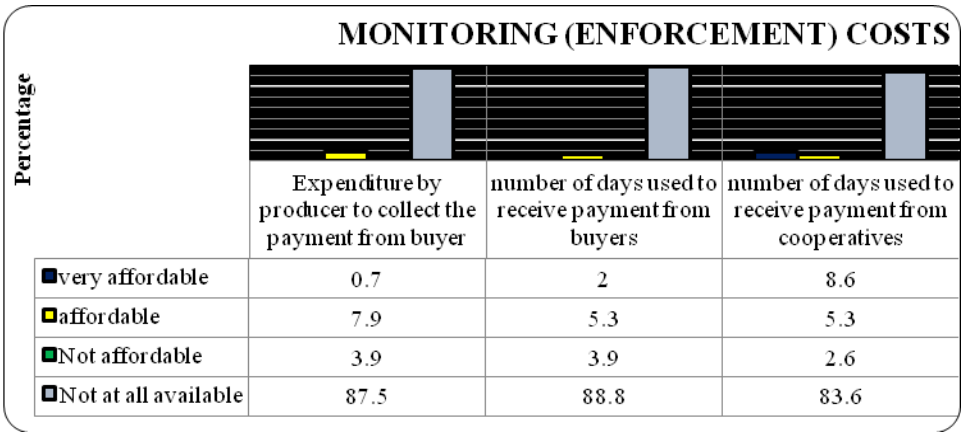
Figure 2: Farmers' perceptions on significance of Search transaction cost determinants

Figure 3 suggests that overwhelming majority of farmers did not perceive any of the negotiation cost determinants significantly affecting their overall negotiation cost hence their resultant effect on sunflower production. On the other hand, Figure 4 shows that all the enforcement cost determinants were found not affordable at all by small scale farmers.



Percentage	Payment for land hiring cost	Transportation of inputs cost	Writing the contract cost	Waiting time at bank for loan receiving cost	Bargaining power of buying inputs cost
very significant	18.4	19.7	11.2	6.6	7.9
significant	7.9	15.1	1.3	2	28.3
Not significant	24.3	19.1	21.1	11.8	9.9
Not at all significant	49.4	46.1	66.4	79.6	53.9

Figure 3: Farmers' perceptions on significance of Negotiation transaction cost determinants



Percentage	Expenditure by producer to collect the payment from buyer	number of days used to receive payment from buyers	number of days used to receive payment from cooperatives
very affordable	0.7	2	8.6
affordable	7.9	5.3	5.3
Not affordable	3.9	3.9	2.6
Not at all available	87.5	88.8	83.6

Figure 4: Farmers' perceptions on significance of Enforcement transaction cost determinants

Multivariate Regression Analysis Results

Regression analysis results which reflect structural equation models (8) – (11) are presented in tables 1-4 respectively. Table 1 shows that of all the three dimensions of transaction costs (search cost, negotiation cost and enforcement cost) were statistically insignificant. Though insignificant, only enforcement transaction cost had positive effect on sunflower seed

production. The effect of search and negotiation transaction cost had negative, though insignificant. These results suggest that sunflower seeds production increases with decrease in search and negotiation transaction costs but with an increase in enforcement cost. These findings are in-line with the transaction cost economics theory. Increase in contract enforcement gives assurance for both farmers and buyers of the successful deals since a farmer may be dealing with more than one supplier of production inputs in advance of harvest. However, as noted earlier, the relative effect of these costs is not only minimal but very insignificant.

Table 1: Overall econometric model (Equation 8) estimation

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
		B	Std. Error	Beta			Tolerance	VIF
1	(Constant)	48.774	15.602		3.126	.002		
	SEACOST	-.663	.396	-.150	-1.672	.097	.803	1.245
	NEGOCOST	-.693	.623	-.103	-1.113	.267	.748	1.337
	ENFCOST	.011	1.287	.001	.009	.993	.923	1.083

Dependent Variable: TONUBA
Significant at P = 0.05

Tables 2-4 presents econometric results for models (9) – (11) respectively which represent decomposed determinants of each of the three dimensions of total transaction cost on sunflower seeds production. Three determinants of Search negotiation cost (SEDCOST DECICOST, PLANTCOST, PACKCOST and STOCOST) had positive effect on sunflower seed production whereas the rest had negative effect. However, none of the search cost determinants had individual significant effect on sunflower seed production. Transaction cost of negotiating for a bank loan (BALOCOST) which was measured as waiting time at bank for loan had negative impact on sunflower seed production and the effect was statistically significant. This could be due to the fact that more time a lender stays with the farmer borrower the less the time a farmer spends in production. Like for Search cost, all the determinants of enforcement

transaction cost had effects on sunflower seeds which were statistically insignificant. Whereas REPACOCOST had positive effects, the other two determinants of enforcement cost had negative effects on sunflower seed production.

Table 2: Econometric Model (9) estimation for search costs

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	39.270	8.162		4.811	.000
	SEDCOST	.053	4.531	.002	.012	.991
	DECICOST	3.176	5.428	.091	.585	.559
	PRELACOST	-9.086	7.054	-.286	-1.288	.200
	PLANTCOST	3.157	6.973	.103	.453	.651
	HARVECOST	-5.808	6.973	-.182	-.833	.406
	PACKCOST	.748	6.961	.023	.107	.915
	STOCOST	3.573	4.702	.118	.760	.449
	SELICOST	-2.659	4.500	-.082	-.591	.556

Dependent Variable: TONUBA
Significant at P = 0.05

Table: 3 Econometric model (10) estimation for negotiation costs

Model		Unstandardized Coefficients		Standardized Coefficients	T	Sig.
		B	Std. Error	Beta		
1	(Constant)	58.127	10.157		5.723	.000
	LAHICOST	.702	2.578	.030	.272	.786
	TRANICOST	2.256	2.430	.098	.929	.355
	WRICOST	-.694	3.730	-.025	-.186	.853
	BALOCOST	-10.446	3.632	-.313	-2.876	.005
	BARPOCOST	-.500	2.464	-.020	-.203	.839

Dependent Variable: TONUBA
Significant at P = 0.05

Table 4: Econometric model (11) estimation for enforcement costs

Model	Unstandardized Coefficients		Standardized Coefficients		
	B	Std. Error	Beta	T	Sig.
1 (Constant)	19.580	15.676		1.249	.214
EXPCOST	4.622	4.353	.103	1.062	.290
REPACOST	.645	5.178	.015	.125	.901
REPACOCOST	-4.062	3.073	-.138	-1.322	.188

Dependent Variable: TONUBA
Significant at P = 0.05

CONCLUSION

It is shown in this study that the coefficients of the search information costs were negative implying that increase in transaction cost due to search information costs causes a decrease in production, though statistically insignificant (P > 0.05). The statistical result in negotiation of transportation of inputs cost (NEGOCOST) implies that an increase in negotiation cost leads to a decrease in sunflower produced. However, this effect is also insignificant statistically (p<0.05). Lastly, regression results show the effect of enforcement cost (ENFCOST) is positive though statistically insignificant (P > 0.05). These results conform to the mainstream TCE theory which postulates among others that increase in transaction costs associated with enforcement cost in thin economies may be necessary for transaction to happen. This suggests that there is need for more enforcement of contracts between upstream suppliers of service providers and farmers on one hand, but also between farmers and downstream input suppliers.

Proportional transaction costs associated with inputs information access and negotiation cost, have negative effects on sunflower production. Similarly, fixed transaction costs associated with inputs information, such as access to communication assets and ownership of transport, have significant effects on output. These findings are in conformity with some of the other research applying TCE (see for example Ngaruko & Lwezaula. 2013; Nguvava & Ngaruko, 2016; Sonda & Ngaruko; and Mutayoba & Ngaruko, 2018). Providing better access to inputs by

improving road infrastructure could be an important policy option to reduce transaction costs and enable the small-scale producers to realise the benefits associated with sunflower production. Improving information and communication services could also enhance production by small scale sunflower farmers. The importance of public assets and services such as farmer association and the availability of credit to financial institutions will also influence sunflower farming participation and marketed surplus. All these initiatives and services call for promotion of institutional innovations and improving credit delivery systems for boosting commercialised sunflower production.

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Metal Contamination in Sediments of Coastal Rivers around Dar es Salaam, Tanzania

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ABSTRACT
Sediments from coastal rivers of Kizinga, Mbezi, Msimbazi, and Mzinga were used to determine contamination levels of Cd, Pb, Cr, Ni, Cu, Al, Mn, Fe, and Zn metals. Sampling and sample preparation were done as appropriate and analysis was done using high resolution inductively coupled plasma–mass spectrometry (HR ICP-MS). Higher levels of Cd, Pb, Cr, Al, Mn, Fe, and Zn were mainly observed in Msimbazi river. Whereas higher levels of Ni and Cu were observed in Kizinga river, higher levels of Mn were observed in Mbezi river. Mzinga river had lowest levels of most metals except Mn. Lowest levels of Mn were observed in Kizinga river. Despite of enrichment factor indicating varied contamination status of metals in rivers, geo-accumulation index, contamination factor, degree of contamination, modified degree of contamination, potential contamination index and environmental toxicity quotient have indicated that sediments from these rivers are polluted, with Msimbazi and Kizinga river sediments being more polluted. Pearson correlation and hierarchical cluster analyses have revealed that Cd, Cu, Pb, and Zn were strongly correlated to each other ($r^2 > 0.7$, $p < 0.05$), indicating that they similar anthropogenic origin, while Fe, Mn, Ni, Cr, and Al were strongly correlated to each other ($r^2 > 0.69$, $p < 0.05$), indicative of similar natural origin. This implies that there might be metal-related anthropogenic activities around or close to rivers that pose environmental and health risks. Urgent river management strategies are needed to minimise the continuous metal pollution of these rivers.

Keywords: *Metal Contamination, Environmental Toxicity Quotient, Mbezi, Msimbazi, Mzinga, Kizinga*

INTRODUCTION

Metals are contaminants because they are permanent additions to a given environment and are not subjected to any biological or chemical degradation (MacFarlane and Burchett 2001, Defew 2005).

In addition, they are persistent, toxic, can bioaccumulate as well as biomagnify in sediments and organisms. Sediments tend to act as a source as well as a depository (sink) of the metals (Chi et al. 2007). The presence of metals in sediments may pose a potential threat to marine and other organisms (Kumar et al. 2008, Zhao et al. 2010). As a result, levels of metals in sediments can be important indicators of toxicological risk, especially when they are substantially above natural levels.

Metals in sediments may originate from either natural or anthropogenic processes. Natural sources of metals may include natural weathering and erosion of parent rocks and dusts coming from the wind. Anthropogenic sources may include effluents, sewage, discarded automobiles, and metallic substances as well as wastes from industrial, municipal, and domestic sources (Chatterjee et al. 2007). Since the number of metals in sediments may also indicate local and regional discharges (Moon et al. 2009), sediments can be used to evaluate historical trends as well as fate processes.

The present anthropogenic contribution of the metals in the marine sediments in Tanzania and the impacts of metal contamination in the coastal ecosystems are alarming (Mihale 2017). Studies done on the marine component of Tanzania have revealed that metal pollution is a problem (Machiwa, 1992, Mremi and Machiwa 2003, Muzuka 2007, Mtanga and Machiwa 2007, Mrutu et al. 2013, Mihale 2017, Minu et al. 2018). Since there is a river-ocean continuum, there is a possibility of rivers being the source of the observed metals. Previous studies in Tanzania have identified the Msimbazi River as highly polluted due to metals (Ak'habuhaya and Lodenius, 1988, Machiwa, 1992; De Wolf et al. 2001). Such a situation may exist in other rivers as well. Due to rapid urbanisation and growth of settlements from the increased human population, the rivers are suspected to carry different wastes (agricultural, residential, municipal, etc) and discharges. Besides, industrialisation and the associated socio-economic activities taking place in the city could contribute to the significant input of pollutants in the rivers. For example, mushrooming of street garages, increase in small-scale industrial activities, and urban agriculture in valleys and near rivers could have a significant input of metals in these rivers. Furthermore, the disposal of wastes (direct or indirect) could lead to a significant increase in metal pollutants in the rivers. In view of this, the current situation regarding metal contamination in these rivers is not known with certainty. This

study was intended to assess the contemporary level of contamination of metals in the sediments of the selected coastal rivers of Kizinga, Mbezi, Msimbazi, and Mzinga.

METHODOLOGY

The Study Area

The study was conducted in four selected coastal rivers: Kizinga, Mbezi, Msimbazi, and Mzinga, which are among the twelve rivers that drain the city of Dar es Salaam. These rivers are presumed to be the major sources of contaminants from different areas of the city (Gaspare et al. 2009) because they receive metals from municipal wastes and discharges, farming (urban agriculture), residential as well as industrial (small and medium scale) sources. The Kizinga River drains the relatively urbanised areas of Keko, Chang'ombe, Kurasini, and Temeke (approximately 400,000 inhabitants; URT, 2013). Mbezi River that originates from the upper Mbezi drains the residential areas of Mbezi Msigani, Mbezi Mwisho, Mbezi Louis, Kimara B, Goba and Ukwamani. The Msimbazi River originates from the Pugu hills and its tributaries (Kinyerezi, Luhanga, Ubungo and Ng'ombe or Sinza) drain the Pugu, Gongo la Mboto, Vingunguti, Kinyerezi, Ubungo, Manzese, Tabata, Mabibo, Mburahati, Kigogo, Tandale, Buguruni, Mchikichini, Magomeni, Mwananyamala and Hananasif areas (Kironde, 2016, Ngassapa et al. 2018, Sawe et al. 2019). The Mzinga River drains the relatively rural areas of Vijibweni, Tuangoma, and Mji Mwema with a population of around 90,000 (URT, 2013). All these rivers flow into the Indian Ocean. Whereas the Kizinga and Mzinga rivers flow on the South of Dar es Salaam, Msimbazi flows onto the central, and Mbezi flows on the North of Dar es Salaam.

Methods

Sampling

Sediment sampling was done during the wet and dry seasons of 2015 and 2019, as described previously (EPA, 2001), using a method described by Mihale et al. (2013). Five sampling stations were selected from each site and were located using a global positioning system (GPS, etrex 10, Garmin Ltd, USA). Sampling of sediments was done in the same locations in both seasons. A corer was used in areas with large sediment deposits while a plastic shovel was used to scoop the river sediments in areas with relatively low deposits like along the river banks. The use of a corer has been described by Mihale et al. (2013). A total of 80 samples

were collected from all the sites in both seasons. All sediment samples were packed in prior-labelled and zipped polyethylene bags, stored in iceboxes, and later frozen to −20 °C. Sediment samples were then air-transported while frozen to the laboratory of the Department of Analytical and Environmental Geochemistry, Vrije Universiteit Brussel (VUB), Belgium for analysis. Prior to metal analysis all samples were lyophilised (Leybold Heraus Lyophiliser).

Determination of Metals in Sediments

Sample Preparation

Sediment samples for the determination of metals were analysed using the method described by Mihale, (2017). Briefly, the lyophilised sediment samples in triplicate were pulverised (Fritsch Pulverisette) and digested using a CEM Microwave Accelerated Reaction System (MARS 5®, Matthews, USA). Prior to digestion, the MARS® HP 500 digestion vessels were cleaned appropriately (Mihale, 2017). For each sample, an analytical amount of sediment sample (≈ 0.20g) was put into the digestion vessel followed with Hydrochloric acid, (Suprapur®, 6 mL, 30% w/w, Merck KGaA, Darmstadt, Germany) and distilled nitric acid (suprapur®, 2 mL, 65% w/w). The MARS was programmed to operate at 150°C temperature, 1200 W (100%) maximum power, 15 min ramp time, 200 psi maximum pressure, and 15 min hold time. After cooling, Milli-Q water (40 mL) was added to each vessel and the contents were transferred into polyethylene bottles ready for metal analysis. Blank samples as well as certified reference material (LGC 6139, River Clay sediment, Middlesex, UK) were included in each digestion session and treated in a similar manner as the samples.

Metal Analysis

Nine metals: two major elements (Al, Fe), two minor elements (Mn, Cr), and five trace elements (Cd, Cu, Ni, Pb, Zn) were analysed in triplicate for each river sediment sample. The concentrations of the metals were determined using high resolution inductively coupled plasma–mass spectrometry, HR-ICP-MS (Thermo Finnigan Element II). Prior to ICP-MS analysis, the samples were diluted tenfold. The metal standards solutions were prepared by serial dilution of stock solutions made from ICM 224 (Radion), SM 70 (Radion), and XIII (Merck). Prepared working standards (1, 2, 5, 10, and 20 ppm) were run before and after every batch of 10 samples. Indium at a concentration of 1 µg/L was used as the

internal standard. A calibration curve drawn from the working standards of each metal was used to determine the concentration of metals in the sediments.

Assessment of Sediment Contamination

Assessment of contamination of metals in river sediments was done using six contamination indices: enrichment factor (EF), geo-accumulation index (Igeo), contamination factor, (CF), degree of contamination (DC), modified degree of contamination (mCd), potential contamination index (PCI) and environmental toxicity quotient (ETQ). Enrichment factor (EF), which is used in evaluating the status of contamination as well as geochemical trends (Feng et al. 2004, Pekey 2006) was determined using the formula:

$$EF = \frac{[X]_{sample}[Fe]_{crust}}{[X]_{crust}[Fe]_{sample}}$$

where *X* is the concentration of a given metal. Iron (Fe) was used as a normalisation (reference) element because its anthropogenic source is relatively not significant (Maftei et al. 2019).

The geoaccumulation index (Igeo), which is used in studying the lithogenic effects in sediments was determined by:

$$Igeo = \log_2\left(\frac{C_n}{1.5B_n}\right)$$

where *C* is the concentration of a given metal, *n*, *B* is the background value of the corresponding metal in the average crust (Nobi et al. 2010) and *1.5* is a factor that takes into account the variations in the background values originating from lithologic differences of the sediments (Abrahim and Parker 2008).

The contamination factor (CF) was determined by:

$$CF = \frac{C_{sample}}{C_{reference}}$$

where C_{sample} is the observed value of the metal in samples and $C_{reference}$is the reference value for the respective metal.

The degree of contamination (DC), which gives the overall contamination of all the analysed elements in the sample (Håkanson 1980), was determined by:

$$DC = \sum_{i=1}^{i=n} CF_i \qquad \text{where } CF = \frac{C_{average}}{C_{reference}}$$

where *CF* is a *CF* of individual metal *i, $C_{average}$* is the average value of the analysed metal obtained from an area and *$C_{reference}$*is background value of the individual metal.

The average crustal abundance (Taylor 1964) and/ or average shale values (Turekian and Wedepohl 1961) were used as reference values during the calculations of EF, Igeo, CF, and DC. The magnitude of the contamination due to metals in the study area was determined by the modified degree of contamination, mCd:

$$mCd = \frac{\sum_{i=i}^{i=n} CF_i}{n}$$

where *CF* is the contamination factor of the metal *i* and *n* is the total number of analysed metals.

The metals in the sedimentary environment exist as complex mixtures that change in space and time. So, contamination can also be determined using the potential contamination index (PCI), which is given by:

$$PCI = \frac{C_{maximum}}{C_{background}}$$

where *$C_{maximum}$* is the maximum level of the metal in the sediment and *$C_{background}$* is the baseline value of a corresponding metal in the average crust.

Furthermore, sediment contamination can be assessed using sediment quality based on toxicity. Here the environmental toxicity quotient (ETQ) is used. To get the elemental toxicity, each metal value multiplied to its total score (TS) was divided by the highest total score obtained from the United States Agency for Toxic Substances and Diseases Registry (ATSDR, 2019). The sum of the metal toxicities divided by the number of metal parameters analysed gives the ETQ as shown in the equation:

$$ETQ = \frac{\sum_{i=1}^{n} \left(C_i \times \frac{TS_i}{TS_x} \right)}{n}$$

where C is the observed concentration of the metal i, TS_i is the total score for each metal (Cd = 1318, Pb = 1531, Cr = 893, Ni = 993, Cu = 805, Al = 685, Mn = 797 and Zn = 913) and TS_x is the highest total score of the metal under consideration based on the ATSDR (ATSDR, 2019).

Quality Control and Quality Assurance

The certified reference material (LGC 6139) and procedural blanks were used to evaluate the accuracy and precision. Analytical procedures were assessed using blanks that were treated as real samples. Whereas instrumental precision was < 5% relative standard deviation (RSD), the limit of detection (LOD) was computed as 3 times the standard deviation of the average signal from the procedural blanks. The LODs of the analysed metals are given in Table 1.

Table 1: Detection limits (mg/kg, n = 3) of the analysed metals

Metal	Detection limit	Metal	Detection limit	Metal	Detection limit
Cd	4.0×10^{-3}	Ni	1.9×10^{-1}	Mn	5.0×10^{-2}
Pb	2.0×10^{-2}	Cu	1.3×10^{-1}	Fe	4.5
Cr	6.0×10^{-2}	Al	3.85	Zn	1.4

The mean recoveries of the measured metals were determined. Compared to the LGC 6139 certified reference material, the percentage recoveries of the analysed metals were 102.6% for Cd, 93.1% for Pb, 117.6% for Cr, 110.8% for Ni, 101.8% for Cu, 76.0% for Al, 106.4% for Mn, 129.9% for Fe and 109.4% for Zn. The ranges of percentage recoveries (93.1% - 129.9%) indicate that the obtained values are acceptable and so no correction was done to the observed levels of all metals.

Data Analysis

Descriptive (range, mean and standard deviation), Pearson correlation, and hierarchical cluster statistical analyses were computed using IBM SPSS version 23. Pearson correlation analysis was determined using the mean values of the metals from each river to assess the relationship of the metals in the rivers. Hierarchical cluster analysis (HCA) was used to group similar metals in the river sediments in the same classes and different metals in different classes. Prior to HCA, the data were normalised by Ward's linkage and the squared Euclidean distance was used as a similarity measure. Graphing was done using SigmaPlot (v.11).

FINDINGS AND DISCUSSION

Sediments Chemistry

Seasonal variation of the analysed metals was not significant ($p > 0.05$) for all metals, indicative of more or less constant input of the metals. The values of metals presented in this study are the average of the values between seasons. The mean values of the determined metals in the river sediments are presented in Figure 1. Levels of Cd levels in the Msimbazi river ranged from 160 mg/kg to 900 mg/kg (mean 359 ± 267 mg/kg) while the levels in the Mzinga river ranged from 30 mg/kg to 100 mg/kg (mean 67 ± 30 mg/kg). The Pb levels were observed to range from 3.2 x 10^4 mg/kg to 1.5 x 10^5 mg/kg (mean 6.5 x 10^4 ± 3.3 x10^4 mg/kg) in the Msimbazi and from 4.8 x10^3 mg/kg to 1.04 x10^4 mg/kg (mean 7.5 x10^3 ± 2.3 x10^3 mg/kg) in the Mzinga river (Figure 1).

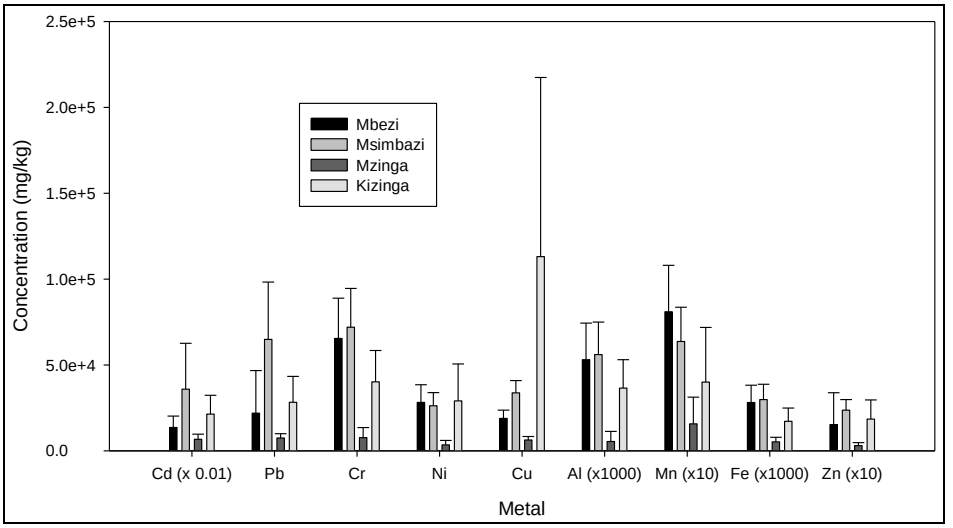

Figure 1: Variation of Metals in the coastal rivers

Similarly, Cr levels ranged from 3.1 x 10^4 mg/kg to 1.2 x 10^5 mg/kg (mean 7.2 x 10^4 ± 2.3 x10^4 mg/kg) in the Msimbazi river and from 3.8 x 10^3 mg/kg to 1.6 x 10^4 mg/kg (mean 7.7 x 10^3 ± 6.0 x10^3 mg/kg) in the Mzinga river. Levels of Al ranged from 1.9 x 10^7 mg/kg to 9.3 x 10^7 mg/kg (mean 5.6 x 10^7 ± 1.9 x10^7 mg/kg) in the Msimbazi river and from 1.3 x 10^6 mg/kg to 1.4 x 10^7 mg/kg (mean 5.4 x 10^6 ± 5.9 x10^6 mg/kg) in the Mzinga river (Figure 1).

Fe levels were observed to range from 1.3 x 10^7 mg/kg to 4.8 x 10^7 mg/kg (mean 3.0 x 10^7 ± 8.9 x10^6 mg/kg) in the Msimbazi river and from 3.6 x

10^6 mg/kg to 9.2 x 10^6 mg/kg (mean 5.2 x 10^6 ± 2.7 x10^6 mg/kg) in the Mzinga river. Levels of Zn were between 1.5 x 10^5 mg/kg and 3. x 10^5 mg/kg (mean 2.4 x 10^5 ± 6.1 x10^4 mg/kg) in the Msimbazi river and between 1.9 x 10^4 mg/kg and 5.6 x 10^4 mg/kg (mean 3.0 x 10^4 ± 1.76 x10^4 mg/kg) in the Mzinga river (Figure 1). The levels of Cd, Pb, Cr, Al, Fe and Zn in Mbezi and Kizinga rivers were between the values observed in the Msimbazi and Mzinga rivers.

Ni levels ranged from 1.2 x 10^4 mg/kg to 8.0 x 10^4 mg/kg (mean 2.9 x 10^4 ± 2.2 x10^4 mg/kg) in the Kizinga river and from 1.7 x 10^3 mg/kg to 7.2 x 10^3 mg/kg (mean 3.5 x 10^3 ± 2.5 x10^3 mg/kg) in the Mzinga river. Cu ranged from 5.5 x 10^3 mg/kg to 4.0 x 10^5 mg/kg (mean 1.1 x 10^5 ± 1.04 x10^5 mg/kg) in the Kizinga river and from 4.9 x 10^3 mg/kg to 9.4 x 10^3 mg/kg (mean 6.3 x 10^3 ± 2.0 x10^3 mg/kg) in the Mzinga river. Mbezi and Msimbazi rivers had Ni and Cu values that were between the values observed for Kizinga and Mzinga rivers (Figure 1). The Mn levels were between 4.4 x 10^5 mg/kg to 1.4 x 10^6 mg/kg (mean 8.1 x 10^5 ± 2.7 x10^5 mg/kg) in the Mbezi River and between 1.9 x 10^4 mg/kg to 9.2 x 10^5 mg/kg (mean 4.0 x 10^5 ± 3.18 x10^5 mg/kg) in the Mzinga River. The levels of Mn in the Msimbazi and Kizinga rivers were in between the values observed in Mbezi and Mzinga rivers.

High levels of Cd, Pb, Cr, Al, Mn, Fe, and Zn were observed in Msimbazi river. Whereas high levels of Ni and Cu were observed in the Kizinga river, high levels of Mn were observed in the Mbezi river. Low levels of most metals were observed in the Mzinga river except Mn where low levels were observed in the Kizinga river (Figure 1). The observed levels of all the metals in the Msimbazi River were higher than those observed by Rumisha et al. (2012) in the same river. This is indicative of the progressive pollution of the river. Similarly, the levels of the metals observed in sediments of all the rivers were higher than those observed in sediments of Cross River Nigeria (Essien et al. 2009) and Ghaghara river, India (Sigh et al. 2017). The levels of metals in the river sediments were higher than the average shale values (Turekian and Wedepohl 1961) as well as the values in the world river systems (Martin and Meybeck 1979).

Contamination Status of River sediments

Metal Enrichment in River Sediments

The determined EF values of the selected metals in sediments of the four rivers are given in Figure 2. The EF values < 2 reflect no enrichment and

EF values > 2 indicate enrichment due to anthropogenic activities (Maftei et al. 2019). Using these criteria, the EF values of the metals ranged from 0.4 to 8.7, indicating minor enrichment to moderate severe enrichment.

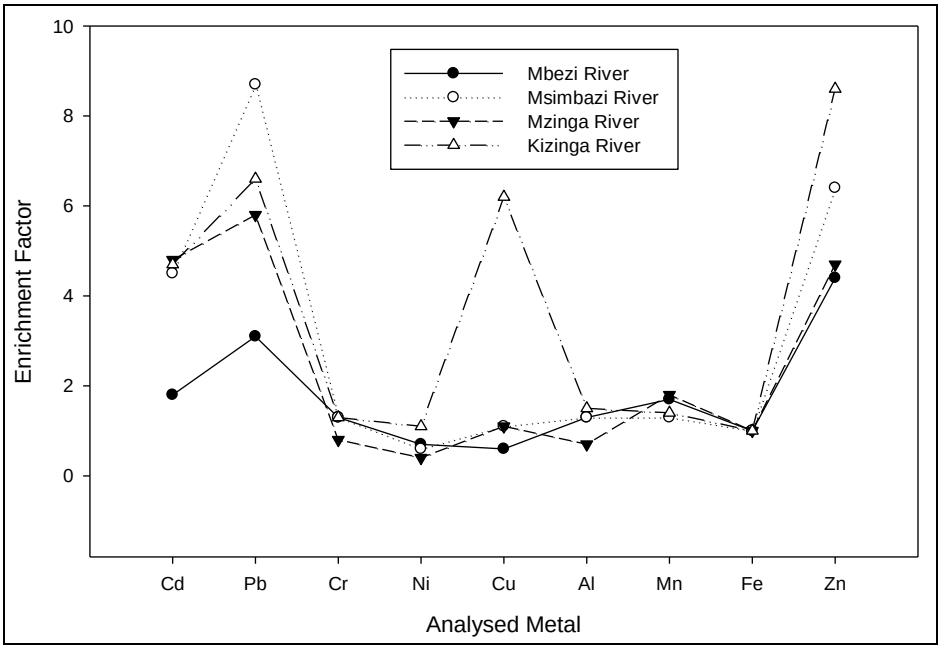

Figure 2: Enrichment Factors of Metals in the Selected Rivers

The findings have indicated that there is no or minor enrichment of Cr, Ni, Al, Mn, and Fe in all rivers (Figure 2). However, there is enrichment of Cr, Pb, and Zn in all rivers and minor enrichment of Cd in the Mbezi River, and moderate enrichment in other rivers. This is an indication that anthropogenic activities have no major consequences of the pollution of the river due to these metals. However, further deposition of the metals in the river sediments could cause enrichment of all the metals.

Geo-contamination Status of River Sediments

The geo-accumulation values of the analysed metals in river sediments are given in Figure 3. The Igeo value > 2 has been set as a criterion of assessment to indicate contamination. The determined Igeo values ranged from 4.8 to 11.6 (Figure 3). All the determined Igeo values in this study were > 2 indicating contamination of the respective metals in all the rivers. Based on this assessment criterion, all the rivers are contaminated with all nine metals.

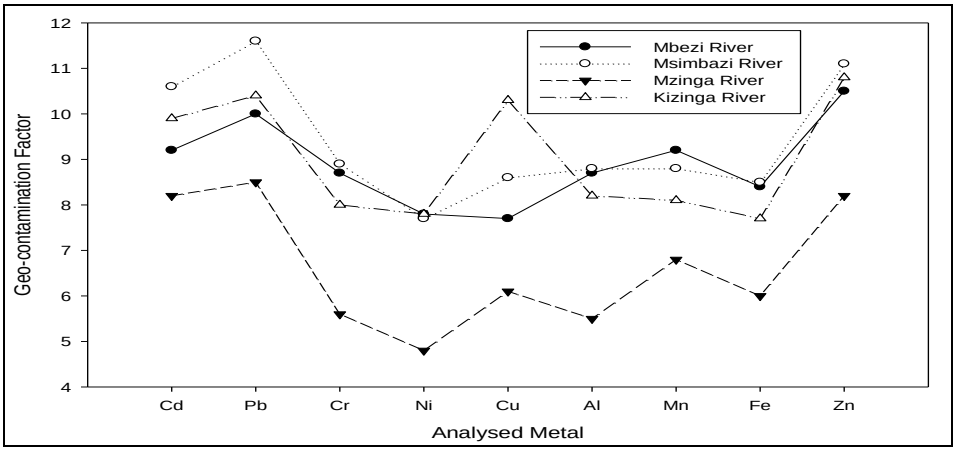

Figure3: Geo-contamination indices of Metals in the Selected Rivers

Contamination status using CF, DC, and mCD

The CF > 6 and DC >24 have been commonly used as evaluation criteria that indicate very high contamination (Håkanson 1980, Maftei et al. 2019), and mCD > 32 has been used to designate ultra-high contamination (Maanan et al. 2015). The determined values of CF, DC, and mCD for the selected metals in the coastal river sediments are given in Table 2. The calculated data for all metals have shown that the CF values are greater than 6, DC values are greater than 24, and mCD values are greater than 32. This is a clear indication that based on these criteria the sediments in the selected rivers are severely contaminated with all the metals.

Table 2: CF, DC, and mCD of Metals in the Selected Rivers

Assessment index		Mbezi River	Msimbazi River	Mzinga River	Kizinga River
	Cd	9.07	23.93	4.48	14.25
	Pb	15.65	46.34	5.36	20.20
	Cr	6.42	7.06	0.75	3.94
	Ni	3.36	3.13	0.42	3.46
	Cu	3.15	5.62	1.06	18.84
	Al	6.45	6.81	0.66	4.43
	Mn	8.52	6.70	1.66	4.22
	Fe	5.00	5.30	0.93	3.05
CF ($\times 10^2$)	Zn	21.76	33.83	4.33	26.38
DC ($\times 10^2$)		79.37	138.73	19.63	98.77
mCD ($\times 10^2$)		7.94	13.87	1.96	9.88
ETQ ($\times 10^5$)		30.42	32.12	3.17	20.97

Environmental Toxicity Quotient

Sediment quality based on toxicity were classified based on the toxicity range (pollution level) such that ETQ < 10 indicates low toxicity, 10 <

ETQ < 50 indicates moderate toxicity, 50 < ETQ < 100 indicates high toxicity, 100 < ETQ < 300 indicates very high toxicity, and ETQ > 300 indicates extremely high toxicity (ATSDR, 2019). Table 2 has indicated that the ETQs of all rivers were in the extremely high toxicity range. The average contribution of the analysed metals to the ETQ varied between rivers. The contribution of Al to the ETQ was more than 95%, which implies that Al metal is the major contributor to metal pollution in all rivers. This could be supported by the fact the metal has gained use in the building industry. The contribution of other metals to ETQ followed the trend Mn > Zn > Cr > Pb > Ni > Cu > Cd in the Mbezi river and Mn > Zn > Pb > Cr > Cu > Ni > Cd in the remaining rivers.

Potential Contamination Indices

The potential contamination indices of the analysed metals in sediments of the coastal rivers are given in Table 3. The determined PCI values in the study area were all greater than the set value of greater than 3. This is indicative of the severe contamination of all the metals in the four coastal river sediments.

The sediment contamination indices used in this study have all presented various contamination levels. While the EF has displayed a slightly different contamination status, other contamination indices have similar status for all the metals in the river sediments. This variation can be explained by the fact that EF uses a terrestrially derived element as a normaliser (Fe in this study), which is not the case with other indices. Mihale (2019) observed that EF values for the same metal may vary even by varying the normalization metal.

Table 3: Potential Contamination Indices of Metals in the Selected Rivers

Metal	Mbezi River	Msimbazi River	Mzinga River	Kizinga River
Al	1154.4	1123.7	168.9	1069.1
Cr	1066.0	1147.4	160.8	875.0
Mn	1473.3	1011.6	394.7	972.6
Fe	837.4	857.6	163.4	605.1
Ni	562.4	485.7	86.1	952.4
Cu	422.2	787.3	155.8	6666.7
Zn	9642.9	5206.0	805.7	6239.9
Cd	1466.7	6000.0	666.7	3000.0
Pb	6457.1	10652.1	742.9	5193.6

Correlation of Metals in River Sediments

In order to assess the relationship of the metals in the coastal river sediments, Pearson correlation coefficients were determined. The metals in coastal river sediments indicated varying levels of correlation at $p < 0.05$ (Table 4). A significant correlation is an indication that the correlated metals have similar behaviour and common source. Suresh et al. (2011) indicated that metals that have good correlations have characteristic similar transport behaviours as well as common sources and vice versa. Table 4 has shown that Cd, Cu, and Pb were strongly correlated to each other by $r^2 > 0.78$, with Cd correlating with Pb at $r^2 = 0.82$ and Cd correlating with Cu at $r^2 = 0.83$. In addition, Cu had strong correlation with Zn ($r^2 > 0.7$, $p < 0.05$). A strong correlation between Cd, Cu, and Pb with each other is indicative of a common source. Similarly, Fe, Mn, Ni, Cr, and Al were strongly correlated to each other by $r^2 > 0.69$, with Cr correlating with Al, Fe, Ni, and Mn at $r^2 > 0.76$. The highest correlations were shown between Cr and Ni as well as between Cr and Al ($r^2 = 0.96$), followed by Ni and Fe ($r^2 = 0.92$). Strong correlations between Fe, Mn, Ni, Cr, and Al with each other clearly indicate a characteristic common source or behaviour.

Table 4: Correlation matrix of the analysed metals in the selected rivers

	Cd	Pb	Cr	Ni	Cu	Al	Mn	Fe	Zn
Cd	1								
Pb	**0.817**	1							
Cr	0.368	0.418	1						
Ni	0.444	0.429	**0.960**	1					
Cu	**0.832**	**0.784**	0.529	**0.599**	1				
Al	0.247	0.310	**0.956**	**0.876**	0.406	1			
Mn	0.503	0.453	**0.757**	**0.841**	**0.711**	**0.691**	1		
Fe	**0.665**	**0.592**	**0.841**	**0.917**	**0.815**	**0.709**	**0.824**	1	
Zn	0.571	0.567	0.482	0.459	**0.699**	0.485	**0.681**	0.505	1

Bold values indicate significant correlations at the $\alpha = 0.01$ (2-tailed).

Principal Component Analysis

Principal component analysis (PCA) after varimax rotation with Kaiser normalisation, as a multivariate analysis, was used to check for similarities and differences between metals in the coastal river sediments. A varifactor or principal component (PC) was considered significant when its eigenvalue was > 1.5 (Shrestha and Kazama, 2007). Prior to PCA, the suitability of the data was checked by performing Kaiser–Meyer–Olkin (KMO) and Bartlett's sphericity tests. The KMO value

obtained was 0.774 and Bartlett's test of sphericity was 0.000, (χ = 216.775, df = 36), indicating the usefulness of such a statistic (Varol, 2011; Li et al. 2013). The measured metals were used as variables (total 9), with the concentrations of the metals in the different sampling sites of each river as objects (total 180).

The PCA computations have indicated that the 9 variables from different stations of the rivers can be represented by 2 new varifactors that accounted for 85.53% of the total variance in the original data sets (Table 5).

Table 5 Rotated Principal Component Matrix

Parameter	1st PC	2nd PC
Cr	**0.953**	0.228
Al	**0.944**	0.107
Ni	**0.934**	0.297
Mn	**0.760**	0.472
Fe	**0.758**	0.560
Cd	0.149	**0.924**
Pb	0.168	**0.884**
Cu	0.366	**0.881**
Zn	0.376	**0.670**
Eigenvalue	6.107	1.590
Contribution Rate (%)	46.104	39.422
Accumulated contribution rate (%)	46.104	85.526

The PCA loading distribution of metals has indicated that Cr, Al, Ni, Mn, and Fe have strong loadings in the first PC, which accounted for 46.1% of the total variance. Furthermore, Cd, Pb, Cu, and Zn have strong loadings in the second PC that accounted for 39.4% of the total variance (Table 5). This coincides with the computed correlation coefficients (Table 4) and a two-dimensional scatter plot (Figure 4).

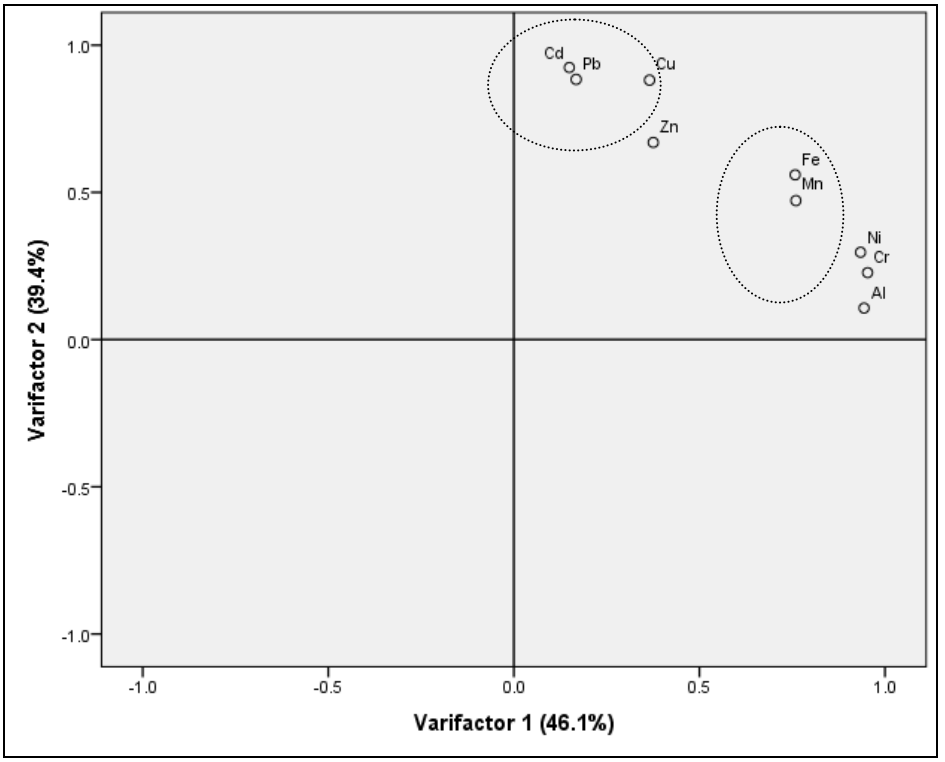

Figure 4: Two-dimensional score plot of metals in the selected rivers

The PCA loading distribution of metals has indicated that Cr, Al, Ni, Mn, and Fe have strong loadings in the first PC, which accounted for 46.1% of the total variance. Furthermore, Cd, Pb, Cu, and Zn have strong loadings in the second PC that accounted for 39.4% of the total variance (Table 5). This corresponds with the computed correlation coefficients (Table 4) and a two-dimensional scatter plot (Figure 4). The findings indicate that probably Cd, Cu, Pb, and Zn have a common source or origin in all river sediments, which is different from that of Mn, Al, Fe, Cr, and Ni. The Cd, Cu, Pb, and Zn could have an anthropogenic related source while Mn, Al, Fe, Cr, and Ni could have a natural related source. This is an indication that there might be metal-related anthropogenic activities around or close to these rivers. As a consequence, the anthropogenic metals could be stored in the sediments and then transferred to other environmental matrices (e.g., water) through physical, chemical, or biological means such as sedimentation, hydrodynamic, and mineralisation processes. Table 4 has also shown that Cu is strongly correlated with Fe and Zn by r^2

> 0.70, indicating that Cu metal could have both anthropogenic and natural origins.

Hierarchical Cluster Analysis

Hierarchical cluster analysis was applied to classify more related metals within the same class and less related metals into different classes. The HCA has further illustrated the interconnectivity of the metal contaminants in the selected rivers. A dendrogram of the metals (Figure 5) has shown that two clusters are evident. One cluster constitutes metals from the natural source (Al and Fe) and another cluster constitutes the metals from the anthropogenic source.

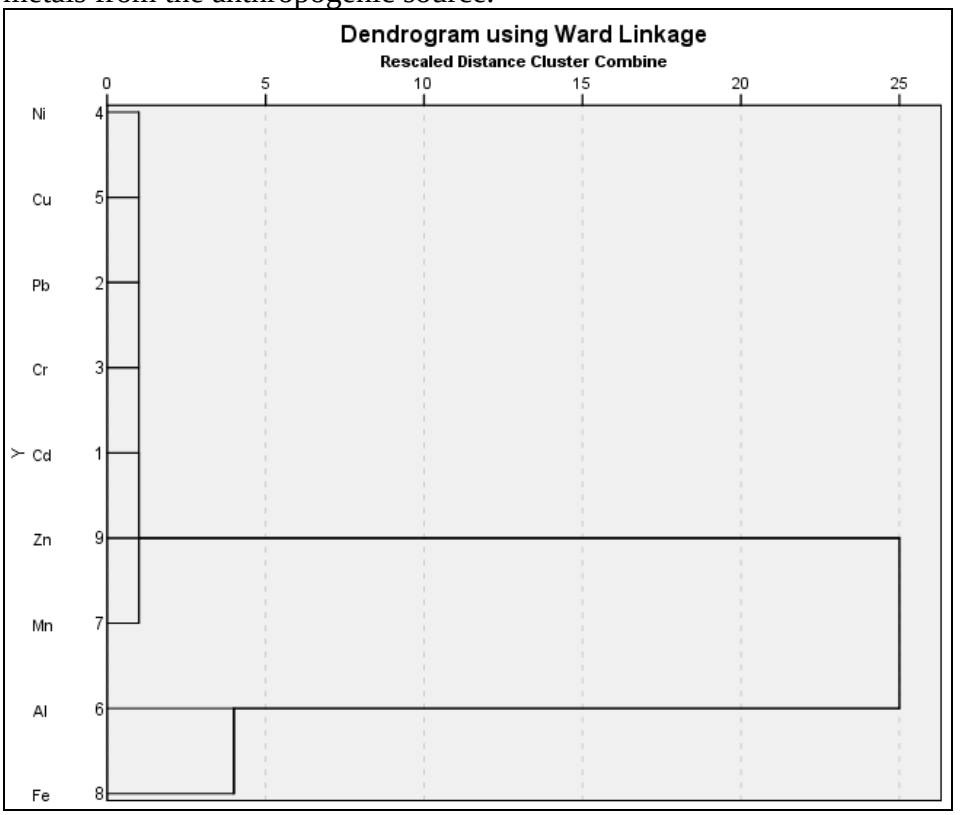

Figure 5: Dendrogram showing Clusters of Analysed Metals based on Selected Rivers

CONCLUSION

The pollution status of the selected metals in sediments of coastal rivers has been established. While high levels of most metals were observed in the Msimbazi river, low levels were observed in the Mzinga river.

Pearson correlation coefficients, PCA, and HCA have indicated significant associations of Mn, Al, Fe, Cr, and Ni on one hand and Cd, Zn, Cu, and Pb on the other, indicating the natural and anthropogenic origin, respectively. The anthropogenic source could be due to the metal-related activities around the rivers. Continuous deposition of such metals could pose environmental and health risks. Though the EF contamination index has indicated varied contamination status of the metals in the rivers, Igeo, CF, DC, mCD, and PCI contamination indices, as well as ETQ, have indicated that sediments from these coastal rivers are more polluted, with the Msimbazi and Kizinga River sediments being the most polluted of all the rivers. There is an urgent need to instituting river management strategies along the coast in order to minimise the continuous release of metals from their sources.

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Implication Analysis of Pre and Post-Harvest Losses of Maize to Household Food Security in Kongwa and Kondoa Districts-Tanzania

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ABSTRACT

The contribution of food losses occurring in the food system to reduced household food security is undoubted. This study therefore investigated the status of the pre- and post-harvest losses in maize and their implication on household food availability, utilization and access in Kongwa and Kondoa districts. The study sites were selected because of their potential in maize production and losses. A mixed method approach was used to collect data for the study including secondary and primary data. Secondary data collection was achieved through literature review of published papers, reports, proceeding, policy documents and strategies relevant to agriculture. Primary data collection was achieved through discussion with key informants (14 people), focus group discussion (6 groups from each village comprising of 4 males and 4 females). A total of 376 (5.9%) households were surveyed and Transect Walk was also done to verify information obtained. Qualitative data was analyzed thematically using NVIVO software whereas quantitative data was descriptively analyzed using Statistical Package for Social Sciences (SPSS) software. The cumulative pre and post-harvest losses estimates were compared against provided pre and post-harvest losses threshold values. The comparison between pre and post-harvest losses was confirmed by two ways ANOVA analysis using Levene test. Findings showed that status of maize pre and post-harvest losses are below the thresholds of 31.2% and 40% whereby maize post-harvest losses are significantly ($p = 0.015$) higher than pre harvest losses. Pre harvest losses in maize were also significantly ($p < 0.011$) associated with reduced food availability while post-harvest losses are significantly ($p < 0.000$) associated with reduced food utilization. The study recommends increased awareness among farmers on the implication of food losses to household food security through trainings and seminars from agriculture extension officers.

Keywords: *Pre- and post-harvest losses, household food security*

INTRODUCTION

Food systems comprises of pre harvest system and a post-harvest system. A pre-harvest system is defined as a system that is concerned with food production while post-harvest system refers to a series of interconnected activities from the time of harvest through crop processing, marketing and food preparation to the final decision by the consumer whether to eat or discard the food (de Lucia and Assenato, 1994) and thus play an important role in providing stability in the food supply chain.The outcome of sustainable food system is food security (Ingram, 2011), while the lack of sustainability of the food system led to food insecurity condition (FAO et al., 2017).Food system can operate in a linear sequence or cyclic and is influenced by many factors including social, political, cultural, technological, economic and natural environment (HLPE, 2014; UNEP, 2016). Occurrence of food losses within the pre and post-harvest system impairs the sustainability of food system. The management of pre and post-harvest systems has grown more complex (Mrema and Rolle, 2002). This is because of increased dynamics of the food systems, limited knowledge of food loss estimates and consideration that losses are often economical rather than physical and yet the economic value of food losses are unknown (Sheahan and Christopher, 2017).

Attempts to estimate the magnitude of the value of losses before time and resources are spent on trying to reduce them are of paramount importance. Despite efforts made over the years to develop acceptable techniques for measuring food losses in grain, it has remained an imperfect science (Greeley, 1982). This is because the food system lacks uniform sequence from producer to consumer (Stevenson and Pirog, 2008). Hence given the lack of a consistent chain, care must be taken to avoid generalizing from particular measurements. Moreover, there are two basic approaches currently adopted to estimate losses either to actually measure what has been lost or use questionnaire to collect subjective loss estimates from those who experience the losses. (Hodges *et al*., 2010). In Africa, the African Post -Harvest Losses Information System (APHLIS) established in 2009 attempts also to address the lost estimates problem by providing cumulative weight losses in specific cereal crops, climate and scale of farming using algorithm of many sub-Saharan African countries. The data used by APHLIS are the averages of

all the data available in the scientific literatures for that particular crop. However, Tyler (1982) warns that it is important to not only rely on the provided estimates as they keep changing in real environment with time. Hence new food loss status and comparison are needed since situation is dynamic.

Estimates of food losses varies greatly among countries, commodities, production areas and seasons (Kader, 2017). Although pre harvest losses estimations are difficult, global estimates of pre harvest losses on different crops according to Oerke (2007) indicates that losses occurring in rice, maize, wheat and soybeans are 37.4%, 31.2%, 28.2% and 26.3% respectively while 1.3 billion tons of food lost are wasted annually due to post harvest losses (FAO, 2011). Total quantitative food loss in sub-Saharan Africa has been estimated at 100 million metric tons per year. It is further estimated that in sub-Saharan Africa 50% of fruits and vegetables, 40% of roots and tubers and 20% of cereals are loss before reaching the market (Daminger*et al*., 2016). On the other hand, a total quantitative food loss in sub-Saharan Africa has been estimated at 100 million metric tons per year. These estimates provide a global perspective of food losses regardless of the causal factor.

In Tanzania, it is estimated that post-harvest losses in cereal crops are high and may range from 30-40% annually. Since the post-harvest system comprises of different stages hence the losses occurring at each stage also differ significantly. According to ICIPE (2013), 1 - 4.5% losses occur during harvesting while 2.8 -17% occur during storage in the maize post-harvest system. Moreover, Abass*et al*. (2013) further added that in semi–arid areas important quantitative losses in maize post-harvest system occur in the field is by 15%, during processing by 13 -20% and during storage by 15 -25%. The annual average losses of cereals crop in Tanzania during and between the years 2014 to 2018 were reported to be 775,768 tons in maize, 115,818 tons in rice, 62,246 tons in sorghum, 193,223 tons in wheat, 138,302 tons in cassava, 135,158 tons in banana and 105,936 tons in pulses (FEWS NET, 2014). In the semi-arid areas, it has been estimated that losses occurring in maize, sunflower and pigeon peas are 32%, 16% and 12% (Abass*et al*., 2013). It has been reported thatmonetary loss in cereal grains due to post-harvest losses in Tanzania is approximately to US$265,000 out of the US$1.7 million used to produce maize annually (FAO *et al*., 2017).

The contribution of food losses to foodinsecurity is undoubted; however, studies have not yet provided the actual implication of the current status of the pre- and post-harvest losses to the prevailing rural household food insecurity. Although Oerke (2007) hinted global estimates of maize pre harvest losses to be 31.2%, there is no current status of the maize pre harvest losses at the household level in semi-arid of Tanzania. Conversely, studies on food losses have only indicated that maize losses in the semi-arid occur by 40% (Suleiman and Rosentrater, 2015; Abass *et al*., 2013). It is not clear on how the food losses affect household food security. Since the food security pillars operates in a hierarchy nature as indicated by Webb and Rogers (2003) then lack of food availability not only affects utilization but also limits access and stability in the long run. It is on this ground that this study specifically seeks to establish the current status of food losses occurring in the pre and post-harvest system and then assess their actual implication on rural household food security. This is important for effective food loss reduction interventions within the pre and post-harvest system for improved rural household food security.

METHODOLOGY

Location and characteristic features of the study area

This study was conducted in Kongwa and Kondoa districts in Dodoma Region (Figure 1). Dodoma Region is the capital city and centrally positioned in Tanzania mainland, lying between latitude 4º and 7º south and longitude 35º-37º east. A total of six sample villages were selected that is Bumbuta, Bukulu and Salanka in Kondoa District, while Mb'ande, Njoge and Pandambili were selected in Kongwa District respectively. Selection of the study area was based on the presence of maize crop growers and proven experiences of food losses across the pre and post-harvest system. A total of 45,098 and 81,069 households grow maize in Kongwa and Kondoa districts respectively (URT, 2003). The population of Dodoma Region is ranked 8th of the 21 regions in Tanzania while total population in Kondoa and Kongwa districts are 269,704 and 309,973 people respectively (URT, 2013). Dodoma region has a local steppe climate which is semi-arid due to low and erratic rainfall which falls seasonally between November/December to April/May (MAFSC, 2006). The region receives an annual average rainfall between 500mm to 800mm with high geographical, seasonal and annual variation, but some parts in Mpwapwa and Kondoa districts experience higher rainfall amount (URT, 2003). The region is comprised of three agro-ecological zones namely;

maasai steppe, rainy and maize zone (URT, 2019). Its major economic activities and source of incomes are earned from selling food crops, cash crops and livestock with relatively sale of forest products.

Figure 1: Location of studied villages in Kongwa and Kondoa Districts

Source: GIS LAB –UDSM (2019)

Data Collection

Both primary and secondary data were collected. Primary data included individual food loss estimates, size of land cultivated, amount of produced obtained and consumed. These data were collected through participatory rural appraisal technique that is key informant interview and focus group discussion while the information provided was cross check through household survey. A total of 12 key informants were interviewed using key informant checklist including; 2 district agriculture officers at Kongwa and Kondoa districts, 1 market manager at Kibaigwa Maize

International Market in Kongwa District, 3 department managers at Post-Harvest Management Department, Crop Management Department, Crop Monitoring and Early Warning Department from Ministry of Agriculture Food Security and Cooperatives, and 6 elderly persons from the sampled villages. Six focus group discussions were conducted using key informant checklist from each village, they comprised of 8 long experienced maize smallholder farmers (4 males and 4 females). A total of 376 households that is 5.9% were sampled from the village household registry using Yamene (1976) sample formula (see formula below and Table 1). A semi-structured questionnaire was used administered to the sampled households. Secondary data on the other hand was collected through relevant literature review.

$$n = \frac{N}{1 + N(e)^2}$$

Whereby;
n = total sample size
N = total household number (from the six villages that is 6370)
e = precision level of 5%

The sample size for each village was calculated;

$$\textit{Sample size for each village} = \frac{\textit{total household in each village x 376}}{6370}$$

While the percentage of the sample size was calculated;

$$\textit{\% of the sample size} = \frac{\textit{sampled size in each village x 100\%}}{376}$$

Table 1: Total household sampled and surveyed

Districts	*Wards*	*Village Name*	*No. of HH*	*Sample Size*	*% of the Sample size*
Kondoa	Bumbuta	Bumbuta	0292	17	0.27
	Salanka	Salanka	1500	88	1.38
	Soera	Bukulu	0851	50	0.78
Kongwa	Njoge	Njoge	1452	86	1.35
	Sejeli	M'bande	1400	83	1.30
	Pandambili	Pandambili	0875	52	0.78
TOTAL			**6370**	**376**	**05.9**

Source: Field Work, (June, 2018)

Data Analysis

Since, there were no established time series pre and post-harvest losses data on maize crop at the village, district, and ministry level. The recognizable data was the percentage estimate of 31.2% for maize pre harvest losses and 40% for maize post-harvest losses provided in the literatures. During the data collection process households were at different stages across the pre and post-harvest system. According to Hodges *et al*. (2010), there are basically two approaches adopted to estimate food losses either to actually measure what has been lost or to use a questionnaire to collect subjective losses estimates from those who have experienced them.

Therefore, quantification of the pre harvest losses for each household in the studied villages was derived as a difference between the capacities of land to produce versus amount obtained whereby for one acre of farm land it was approximated to produce 60 bags which is equivalent to 100 kg of maize. Households who obtained an equally amount of yield as per expected capacity of land were regarded not to experience pre-harvest losses. Data for households who experienced pre harvest losses were converted into percentage for easier comparison with the 31.2% estimate provided by Oerke (2007). Conversely, although the post-harvest system in the studied area comprised of five stages that is harvesting, transporting, drying, and threshing/shelling and storage, the quantification of food losses across the stages involved percentage estimates depending on what households obtained after harvesting versus amount remaining during storage. The percentage loss estimates where then compared against the 40% estimates provided by Abass *et al*. (2013) for easier assessment of the current status of maize post-harvest losses in the studied areas.

Thereafter, two ways ANOVA test was used to make a comparison between pre harvest losses status and post-harvest losses status occurring in Kongwa and Kondoa Districts so as to detect which area experiences greater food losses than the other. The correlation between pre harvest losses and post-harvest losses affecting household food security parameters that is availability, utilization, accessibility and stability was confirmed by the Pearson Product-Moment Correlation Coefficient.

The study considered three aspect of food security that is food availability, food accessibility and food utilization as major facet that determine household food security as indicated by Chijioke*et al*. (2011). The influence of pre-harvest losses towards household food security was reflected more on limitation to food availability aspect, whereby the amount of crop losses as result of pre harvest losses was calculated as a difference between capacities of land to produce versus the actual amount obtained in kilogram. The estimation used during this process was that on average 1 acre produces 60 bags and 1 bag of maize equals to 100 kg as indicated by district agriculture officers at Kongwa and Kondoa districts. Conversely, the influence of post-harvest losses on household food security was reflected more on limited food utilization aspect. This was obtained as a difference between actual amounts of yield obtained in kilogram versus the capacity or amount in kilogram a household consumes per year at a satisfactory level. The difference was terms as consumption deficit which implies that loss food that was to be consumed. Lastly, the study also analyzed the limitation in terms of financial losses households incur after pre and post-harvest losses. The study argued that the amount of finances losses deprives capacity of household to purchase food from the market. This was obtained after converting the total amount of food losses incurs from both pre and post-harvest losses into Tanzanian Shillings whereby 1 kg of maize is sold at 390.07 Tanzanian Shillings. The correlation between pre-harvest losses influences on yield that is food availability and post-harvest losses influence on food utilization was confirmed by the Pearson Product-Moment Correlation Coefficient.

Conceptual Framework

The conceptual framework guiding this study was adopted and modified from the work of Harris-Fry *et al*. (2015) on socio-economic determinants of household food security and women dietary diversity in rural Bangladesh. According to Harris-Fry *et al*. (2015), food availability, access and utilization are the three major pillars that determine food security at the household. However, presence of influencing determinants within the food system environment affects household food security. This study modifies the framework by arguing that household food security is impaired by food losses occurring across the food system. That is presence of sustainable food system with zero food losses and wastes assures improved household food security. The food system comprises of

pre-harvest system and post-harvest system whereby the pre-harvest system produces crop while the post-harvest system performs the delivery of food through supply across different stages. Both the pre and post-harvest system functions to generate the household food security. Presence of food losses across the pre and post-harvest system limits and hinder achievement of household food security. Moreover, the continued food losses household experiences when compounded by other factors such as size of land a household cultivate, household size that is composition and age, financial resources and household consumption pattern further aggravates household food insecurity condition. Webb and Roger (2003) further highlight that since the food security pillars operates in a hierarchy nature then lack of food availability not only affects utilization but also limits access and stability in the long run. Therefore, understanding of the losses occurring across the pre and post-harvest system and their actual implication on household food security are important for improved household food security.

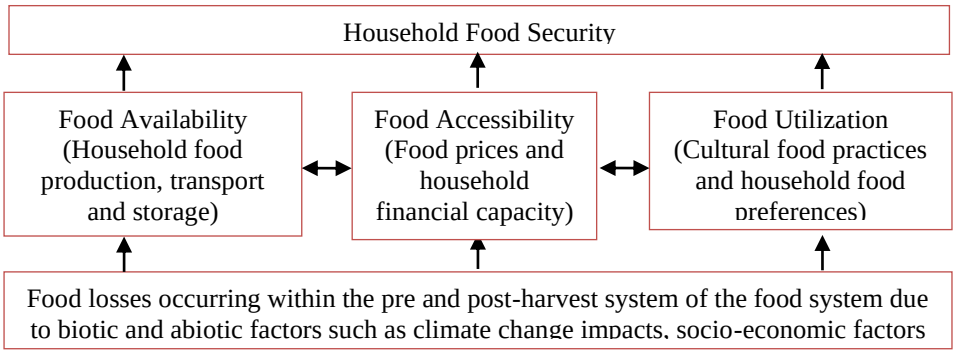

Figure 2: A conceptual framework for pre and post-harvest losses impacts on household food security

Source: Adopted and modified from Harris –Fryet al. (2015)

FINDINGS AND DISCUSSION

Status of maize pre harvest losses in Kongwa and Kondoa Districts

Table 4.1 presents the status of compiled maize pre harvest losses obtained for each individual household surveyed then compared against the global estimate of 31.2% of maize pre harvest losses provided by Oerke (2017). The aim was to establish the current status of maize in the study against the provided estimates done by previous studies. Results show that the majority of the households in the study area in both Kongwa and Kondoa districts are experiencing maize pre-harvest losses

at a status below 31.2% while relatively few households in Salanka and Bukulu experienced pre-harvest losses at a status above the 31.2%.

Table 2: Status of maize pre harvest losses at the household level in (%)

Responses	Kondoa District			Kongwa District		
	Salanka	Bumbuta	Bukulu	M'bande	Pandambili	Njoge
Below 31.2%	49	65	48	65	63	58
Above 31.2%	51	35	52	35	37	42
Total	**100**	**100**	**100**	**100**	**100**	**100**

Source: Fieldwork (2018)

This study argues that presence of majority of households experiencing maize pre harvest losses below 31.2% in Kongwa District is driven from the fact that in Kongwa District lies in the maize agro-ecological zone whereby maize crop is highly commercialized. Thus, farmers are motivated towards increased maize crop production with little pre-harvest losses. Conversely, this study argues that although Salanka and Bukulu villages in Kondoa District lies in the rainy agro-ecological zone, it experiences maize pre-harvest losses above 31.2% due to non-climatic factors. According to URT (2019), farming system in rainy agro-ecological zone is characterized by the shortage of land for extensive crop production with little use of improved seeds, fertilizers and pesticides. Shortage of land to cultivate attributes to land exhaustion and reduced soil fertility following repeated cultivation and lack of financial capacity to acquire fertilizers while cultivation of large land size causes difficulty in management as indicated by Conant (2010) and Pretty and Hine (2001).

Status of maize post-harvest losses in Kondoa and Kongwa Districts

Table 3 and 4 presents the results of complied percentage of individual household's status of maize post-harvest losses experienced during harvesting and storage against the provided status of 40% provided by Abass*et al*., (2013). The aim was to establish the status of maize post-harvest losses in the studied area against the provided estimates. Results in Table 3 indicate that majority of households in the studied areas are experiencing maize post-harvest losses during harvesting were below the 40% threshold. Conversely, results in Table 4 indicate that majority of the households in the studied areas are experiencing maize post-harvest losses below the threshold of 40% as compared to those experiencing losses above the 40% threshold.

Table 3: Status of maize harvesting losses at household level in (%)

Responses	Kondoa District			Kongwa District		
	Salanka	Bumbuta	Bukulu	M'bande	Pandambili	Njoge
Harvesting loss below 40%	96	94	97	94	88	82
Harvesting loss above 40%	04	06	03	06	12	18
Total	**100**	**100**	**100**	**100**	**100**	**100**

Source: Fieldwork (2018)

Table 4: Status of maize storage losses at household level in (%)

Responses	Kondoa District			Kongwa District		
	Salanka	Bumbuta	Bukulu	M'bande	Pandambili	Njoge
Storage loss below 40%	85	88	95	91	81	72
Storage loss above 40%	15	12	05	09	19	28
Total	**100**	**100**	**100**	**100**	**100**	**100**

Source: Fieldwork (2018)

Comparison of maize pre- and post-harvest losses status in Kondoa and Kongwa Districts

Although the variation on household percentage estimates on pre- and post-harvest losses in maize are shown in tables2, 3 and 4 above; it was important for the study to provide the statistically significant variation between pre and post-harvest losses of maize occurring in the study area. Table 5, below presents the results for the statistical significance difference between maize pre and post-harvest losses occurring in Kongwa and Kondoa district according to the two ways ANOVA analysis. It should be noted that prior to conducting the analysis, the homogeneity of variance was investigated using Levene test where the assumption of equality of variance was satisfied as shown in Table 5.

Table 5: Levene Test on Pre and Post-Harvest Losses Variability

Variables	Df	Sum of squares	Mean squares	F value	p-value
Districts	1	29078	29078	21.336	0.000
Type of Loss status	1	8142	8142	5.974	0.015
District: Type of Loss status	1	20554	20554	15.082	0.000
Residuals	583	794547	1363		

Source: Fieldwork (2018)

Findings indicate that there was a statistically significant main effect for district [F (1, 750) =21.336, p=0.000] such that the percentage of maize losses perceived by the farmers' household is statistically different between Kondoa and Kongwa Districts. The difference is denoted through mean percentage whereby Kondoa District has a mean percentage loss of 37.65 while Kongwa District has mean percentage loss of 51.76. This finding suggests that households in Kongwa District are experiencing higher percentage overall losses in both pre and post-harvest system than households in Kondoa District. This study argues that thepresence of significant high pre and post-harvest losses in Kongwa District than in Kondoa District is not only from lack of effective loss reduction but also continued loss influenced by climate change and variability. The ongoing ncreasing temperature trend in the semi-arid areas of Tanzania facilitates food losses through soil moisture reduction, drying of crops, and eruption of pest and diseases which further increases the susceptibility of maize contamination with aflatoxins (Suleiman and Rosentrater, 2015).

Results also indicate that there was a statistically significant main effect for the loss status [F(1,750) =5.974,p=0.015] such that the average percent of pre harvest loss is statistically significantly different from the average percent of post-harvest loss. This also implies that maize post-harvest losses had a higher mean percentage loss of 48.77% than maize pre harvest losses which had a mean percentage loss of 39.39%. This finding suggests that on average farmer's households in both Kongwa and Kondoa Districts experience more maize post-harvest loss than the pre harvest loss. This study argues that presence of high post- harvest losses in the study area is due to the fact that farmer's efforts are channeled on promoting resilient production system than resilient post-harvest system. This was also attested by Kader (2005) and WFLO (2010) that over the past decade's significant focus and resources have been allocated to increased food production than reducing food losses. Cooper et al. (2008) further indicated that most of the semi-arid are characterized by reduced rainfall and severe drought and as a result, farmers in these areas give more priority only to reduce crop risks during production (Cooper et al.2008). However, resilient production system alone without resilient post-harvest system cannot effectively address the prevailing rural household food insecurity conditions. Hence reducing post-harvest losses

remains the critical component in ensuring food security (Aulakh and Regmi, 2013).

Conversely, results also indicate that the interaction factor between district and type of loss was found to be statistically significant [F (1, 750) = 15.082, p=0.000]. This finding suggests that on average the percentage loss variability across different Districts (Kongwa and Kondoa) depends on whether the loss is pre harvest or post-harvest. This means that one cannot explicitly explain the variability of average percentage loss across different district without acknowledging which type of loss is being explained. Therefore, the status of pre and post-harvest losses variability depends on the District that is being explained.

Contribution of pre- and post-harvest losses to household food insecurity

This study argues that food availability, utilization, access and stability at the household level are reduced by pre- and post-harvest losses. However, in most cases, the three facet of food system that is; food availability, food access and food utilization are most needed in order for household food security to be realized (Chijioke*et al*. 2011). According to respondents in the study areas, a household is food secured when it consumes three meals a day comprising of maize meal. This study argues that food availability in the household is first determined by crop yield obtained. Pre harvest losses influences limited food availability in the household through reduced amount of crop production. It was revealed during discussion that a size of farm cultivated is proportional with the household size, so that obtained yield is able to cater for the household needs in terms of food availability.

Figures 3 and 4 present the proportion of the amount of maize household obtained after pre-harvest losses in relation to capacity of land to produce in tons in Kondoa and Kongwa Districts. Resultsin both Kondoa and Kongwa districts indicate that the amount of yield loss during production is comparable to the capacity of land to produce. This implies that households in the study areas obtained low maize yield compared to amount that is lost. The difference existing among villages in the two studied Districts is derived from the variation of the size of household sampled and the total size of land cultivated in each village. However, in general, the maize pre-harvest losses ranged from 428.2 tons in Bumbuta

village to 4925 tons in Njoge village. Therefore, a pre-harvest loss limit and hinders physical access to food through reduced crop yield.

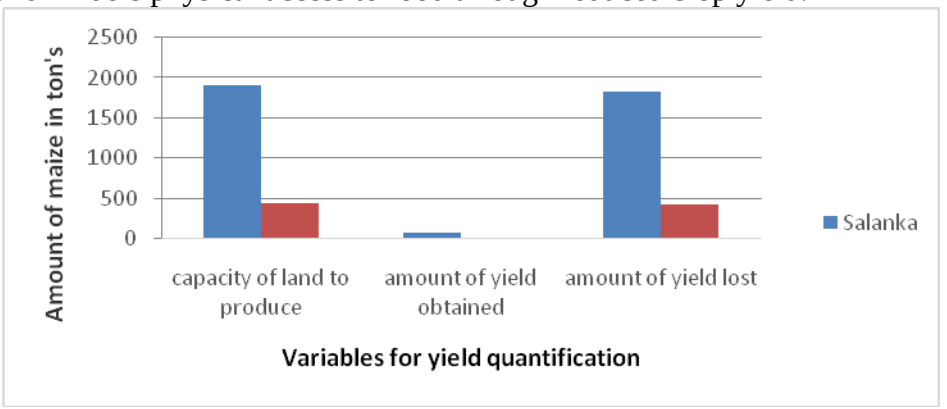

Figure 3: Amount of maize lost by tones in Kondoa District
Source: Fieldwork (2018)

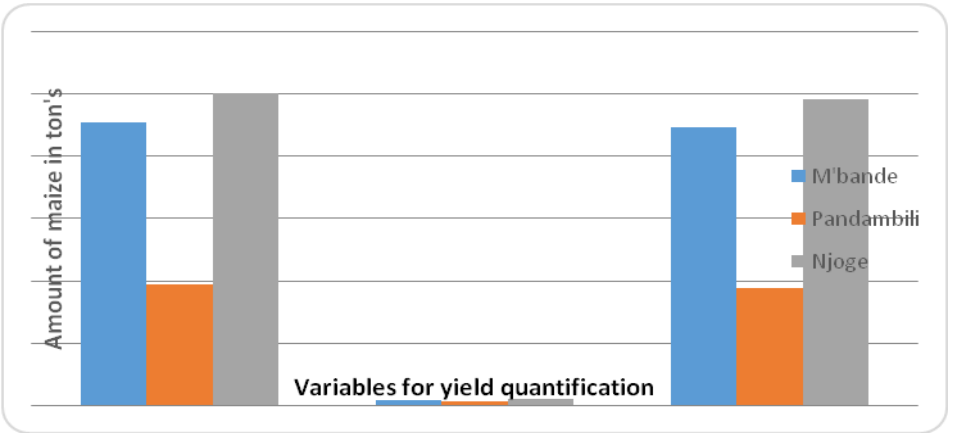

Figure 4: Amount of maize lost in Kongwa District
Source: Fieldwork (2018)

Conversely, the amount of food lost during pre-harvest system affects also the post-harvest system and hence limits household food utilization. However, food utilization in the household is not only determined by availability of food but also consumption amount and pattern at the households. It was revealed that food utilization was also proportional to household size. Parfitt*et al*. (2010) further indicated that household food utilization also depends on household composition, income, demographics and culture. Presence of large household size with high pre and post-harvest losses experiences exacerbates reduced household food

utilization. This may lead to skipping of meals or provision of meals to family members basing on priority needs such as the children and elderly. Figures 5 and 6 present the household maize consumption deficit in relation to amount of maize obtained from the farm and the amount of maize a household consume yearly. Result indicates that households in both Kongwa and Kondoa districts are experiencing household consumption deficit due to post-harvest losses. Comparison among the district show that Kongwa District is experiencing more household consumption deficit than Kondoa District. Finding further suggests and concur with previous findings that presence of high post-harvest losses in Kongwa District contributes to reduced household food utilization.

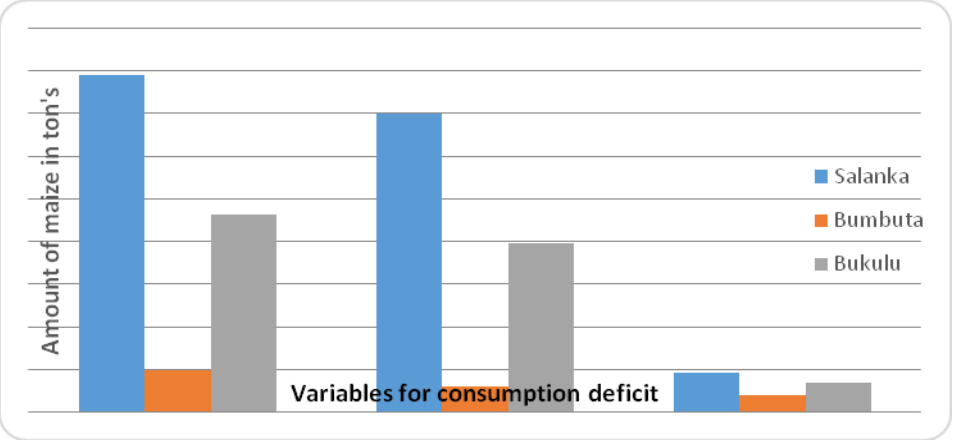

Figure 5: Household maize consumption deficit inKondoa District
Source: Fieldwork (2018)

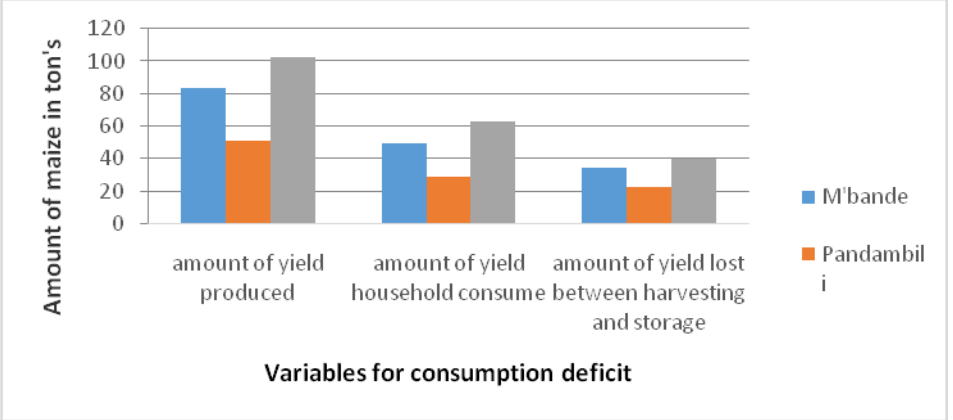

Figure 6: Household maize consumption deficit inKongwa District
Source**:** Fieldwork (2018)

This relationship between pre-harvest losses contribution to reduced household food availability and post-harvest losses contribution to reduced household food utilization or consumption was confirmed through Pearson Product-Moment Correlation Coefficient as indicated in Table 6. Preliminary analyses were performed to ensure no violation of the assumptions of normality, linearity and homoscedasticity.

Table 6: Pearson Product-Moment Correlation Coefficient

Variables	Crop production loss		Consumption deficit	
	correlation	p-value	correlation	p-value
Pre-harvest loss	0.23	0.011		
Post-harvest loss			0.56	0.000

Source: Fieldwork (2018)

Findings indicate that there was a small but positive correlation between the two variables which was also statistically significant at [r=0.23, n=360, p<0.011], with high percentage of pre harvest losses associated with high levels of crop production loss. This finding implies that increase in pre harvest losses also increases crop production losses. Conversely, findings also indicate that there was a large, positive correlation between the two variables which was also statistically significant at [r=0.56, n=360, p<0.000] with high percentage of post-harvest losses associated with high levels of consumption deficit. This finding also implies that increase in post-harvest losses also increases consumption deficit at the household by limiting physical access to food. Therefore, this study asserted that the implication of pre harvest losses are more reflected in the limitation of food access through reduced food availability due to reduced crop yield while post-harvest losses limits food access through reduced food utilization due to consumption deficit.

Apart from hindering physical access to food through availability and utilization, it was also revealed during discussion that pre harvest and post-harvest losses also contribute to limited food access through financial losses household incur from pre and post-harvest losses. Figures 7 and 8 present the financial losses in Tanzanian Shillings households incurred or suffered due to pre and post-harvest losses. Findings indicate that majority of households in both Kongwa and Kondoa Districts experience financial losses from pre and post-harvest losses. Comparison between the districts indicates that cumulatively Kongwa District experience more financial losses than Kondoa District. This study argues

that presence of high pre and post-harvest losses in Kongwa District are associated with more financial losses. Presence of high financial losses hinders household's power to purchase food from the market. This is because increased pre and post-harvest losses influenced by climate change reduces food commodity availability in the market which causes increased food prices which are not affordable by the rural households. This also corroborates to Webb et al. (2006) that the purchasing power varies with market integration, price policies and temporal market condition.

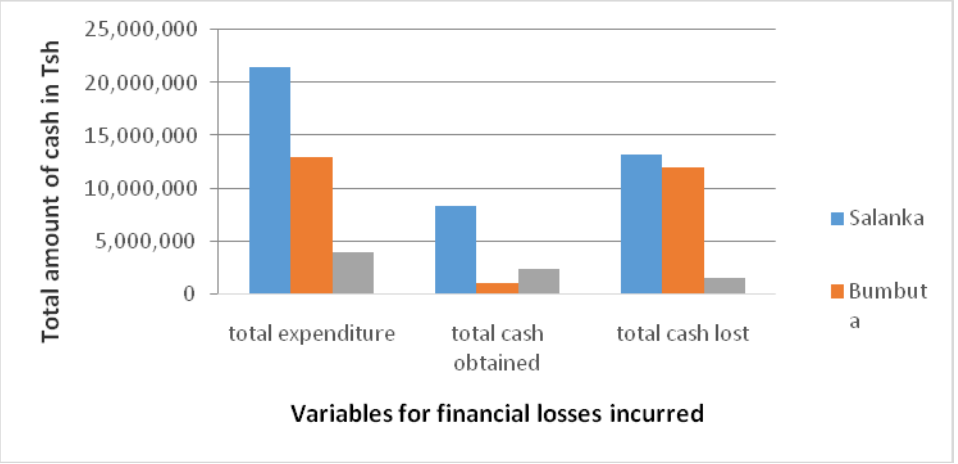

Figure 7: Financial losses incurred by households in Kondoa District
Source: Fieldwork (2018)

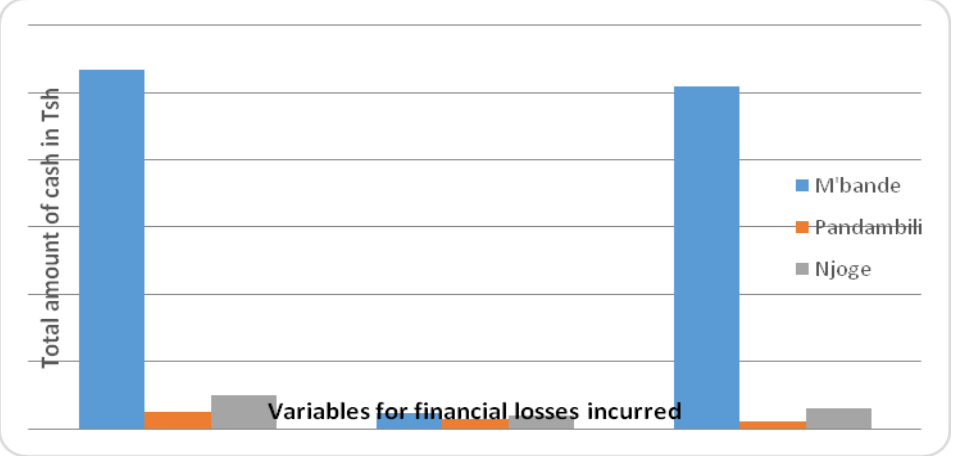

Figure 8: Financial losses incurred by households in Kongwa District
Source: Fieldwork (2018)

Most of households in the studied areas do not purchase foods from the market; they depend entirely on their farm produce and stored food. Therefore, presence of pre and post-harvest losses not only limits food availability but also causes households to incur financial losses which would have been used to purchase food from the market. The financial losses that households incur from pre and post-harvest losses results from the cost of renting of land for those who do not own land, purchase of seeds, hiring of labor for planting, weeding, harvesting, transportation, threshing and shelling and purchase of facilities used during storage. Limitation of access to food through purchase also limits consumption status in terms of amount and pattern (Ericksen*et al*., 2011). Although this study argues that there is relationship between amounts of finances lost through pre and post-harvest losses towards food access restriction in the market, Chakona and Shackleton (2017), report that there is no correlation between food losses occurring through pre and post-harvest with household wealth or food expenditure.

Conclusion and Recommendation

The status of both maize pre and post- harvest losses occurring in the studied area are relative low when compared against the threshold however they are huge to those who experiences losses above the threshold. The comparison between statuses of pre and post-harvest losses showed that post-harvest losses are higher than pre harvest losses, whereby Kongwa district is experiencing high pre and post-harvest losses than Kondoa district. The influences of pre and post-harvest losses on household food security are more reflected through food availability, utilization and accessibility. Pre harvest losses limit physical food access by reducing food availability which occurs as result of reduced food yield. Conversely, post-harvest losses limit physical food access hence reduces household food utilization. Moreover, occurrence of pre and post-harvest losses causes financial losses which also limit physical access of food in the market. Therefore, pre and post-harvest losses have a significant negative implication on household food security conditions by limiting access to food availability and utilization. The study recommends increased awareness on the food losses occurring across the pre and post-harvest system to household farmers and their associated implication on household food security through seminars and trainings on effective food loss reduction methods.

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Factoring the Trust in the Regulatory Relationships: A Reflection from Tanzania's Mining Sector

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ABSTRACT
This paper argues on the complementarities between regulatory structures and relationships which stems upon the reciprocated trust between the mining regulators and operators. One key question addressed by this paper is how can trust relationships better complement the regulatory structures towards improving the natural resource governance for socio-economic development and transformation? Drawing mainly on the case of Tanzania, the paper indicates the trust gaps and offers some perspectives on the role of trust in the regulation of mining activities in a resource-rich lower-middle-income economy. The paper looks at both the cause and effects of trust relationships within a regulatory system in the mining sector of Tanzania and sheds light on the practical challenges and opportunities of building the trust. In the light of the increasing allure of collaborative regulation, the paper also takes a brief navigation into the manner in which trust relationships are established or destroyed by various regulatory stakeholders. Conclusions are drawn by underlining the importance of trust relationships for effective regulation in less developed resource-endowed countries like Tanzania

Keywords: *Trust, regulation, trustworthy, distrust regulation, trust demonstration*

INTRODUCTION

Tanzania is one among the resource-endowed countries with various minerals reserve in Africa. The country has been mining the stockpile of gold and other precious minerals but it is yet to realize a significant improvement in socio-economic life of its populace (LHRC, 2018; Rutenge, 2016; Curtis, 2012; Lugoe, 2012; Curtis & Lissu, 2008). This undermines the prolonged efforts since 1960s in which the Government of Tanzania (GoT) has been adopting some rigorous laws and regulations for mining and minerals production (URT, 1969; URT 1979; URT, 1997; URT, 1998; URT 2010a; URT, 2010b; URT, 2017a, 2017b, 2017c; URT,

2018a, 2018b, 2018c, 2018d, 2018e, 2018f, 2018g). As more socio-economic challenges continue to suffocate the Tanzanians, the author of the current paper suspected that the existing methods of regulatory response which are largely based on policy intervention are certainly insufficient and might be lacking backups of trust phenomenon. It was assumed that the government regulators might have been concentrating much on structural aspect of regulatory regime while putting less emphasis on trust-relationships hence remained ineffective on achieving regulatory objectives. The same assumption was stemmed on a thesis that regulatory relationships which are based on reciprocated trust, if tactically combined with rules and regulations, would have guaranteed regulatory effectiveness. In this regard, trust was considered to be a key factor which can potentially help to foster cooperation and dialogue between the regulators and the regulated entities especially in the context of mining activities. This pre-conceived assumption drove the author of this paper to conduct a small study which was aimed to confirm and establish the appropriate means to forge the trust relationships among the government regulators from various agencies and between them and the mining operators.

METHODOLOGY

The argument in the current paper is based on a six months' qualitative inquiry of the situation of regulatory relationships between the government regulators from different agencies and between them and operators in the large-scale mines in three popular mine-sites in Tanzania. The study was conducted at Bulyanhulu Gold Mine (Kahama) which was owned by Barrick Gold Corporation (BGC), Geita Gold Mine (Geita) which was owned by AngloGold Ashanti (AGA), and North Mara Gold Mine (Tarime) which was also owned by Barrick Gold Corporation (BGC). The investigation was carried out between March and September 2019 and the data was obtained from both the primary and secondary sources. The first-hand information was obtained from field survey and in-depth interviews with various people including the mine inspectors from government regulatory agencies, namely the Occupational Health and Safety Authority (OSHA), National Environmental Management Council (NEMC), Mining Commission and Tanzania Revenue Authority (TRA). Other category of interviewees included the large-scale mining operators who were reached through informal consultations due to their being restricted by their employers from talking to the researcher despite

his formal presentation of personal identification and research permits from government authorities. The last category comprised of key informants from local communities in the studied areas. The researcher supplemented the field data by conducting an extensive review of several documents including the research reports and journal articles.

FINDINGS AD DISCUSSION

Key Regulatory Challenges Revealed in the Study Areas

There were four key regulatory challenges revealed in the study areas, namely inter-institutional distrust, inadequate capacity of some regulators, political interference, and failure to balance the interests in dealing with large-scale mining multinationals. With regard to inter-institutional distrust, the data indicated the prevalence of incongruity among the regulators from various government agencies which had, in some cases, led to undue delays and bureaucracy in monitoring, inspection and auditing activities. This has partly been caused by role confusion like the case in which the Inspectorate Division of the Mining Commission and the NEMC play the similar role of monitoring environmental compliance. Since the same task has not been performed simultaneously by the two agencies, the inspection by the last performer has been wrongly perceived by some observers including some precede inspectors as "follow-up verification" or "the monitoring of the monitor". It has also created concerns among the mining operators who were subject to multiple check-ups. The same incident was generally seen as creating unnecessary layers of bureaucracy and institutional tensions.

The second challenge, inadequate capacity of some regulators entails their lowered potentiality in terms of their personal worth and contribution towards the regulatory outputs. The Mining Commission, for example, had acute shortage of technical staff with solid academic backgrounds. The academic profiles of some of them indicated mostly the first-Degree holders with insignificant industry experience. Yet, there were seemingly less efforts to subject them to the capacity building institutions and the programs of formal trainings which would guarantee their transformation to becoming the relatively good-quality human resources. Besides that, the volume of monitoring, inspections, and extension work made it difficult for the limited number of staff to fully and effectively accomplish all the tasks. The inadequacy of staff meant insufficient inspection and monitoring of mining operations hence the existence of loopholes for noncompliance by some unfaithful operators. This, in turns,

extended their being distrusted. For example, there was a case in which the local residents at Bulyanhulu Gold Mine blamed the MC's staff on a failure of the Inspectorate Division to effectively monitor the development of the mine such that their several houses were drastically damaged by constant tremors (Field Data, 22nd May, 2019).

Political interference along the licensing, mining and minerals production processes is another challenge. For example, the law confers the minister responsible for minerals with the ultimate power to grant or terminate the mining titles. Yet, the same law does not detail the consequences of the arbitrariness or of the minister's power. Despite the fact that the minister can seek the advice of the Mining Commission and that some of his decisions can base on the advice of the Mining Commission, there has been some chances for making some solely subjective decisions. Similarly, there were some evidences especially in North Mara and Geita where some individual politicians have used their influence to intervene in some decisions affecting the mining operations especially at regulatory design and implementation stages. Even though this practice is not common to all the mine sites in the country it seemed to have produced some multiplier effects. The collision between political appointees and regulators were signified in some cases in which the processes of recruitment by the Mining Commission have been directly or indirectly influenced by the sector minister (Field Data, 16 May, 2019).

Another challenge is failure to balance the interests in dealing with large-scale mining by multinational corporations like BGC and AGA and the artisanal and small-scale miners (ASM). Regulation of the large-scale mining (LSM) operations has been formal but somehow complex. On the other hand, some of LSM activities have reflected their defiance of the law despite the existence of various rules and regulations to guide their operations. The reasons for this occurrence include the problem of having long and complex bureaucratic procedures, lack of regulatory capacity to enforce compliance and failure to balance the interests when dealing with the foreign operators. Conflict of interests has been seen in dilemmas in the setting of priorities by the GoT to the extent of becoming unable to balance between attracting and protecting FDI in the country and ensuring the availability of opportunities for local citizens. In this case, some government officials and politicians have tended to support the operations by small-scale miners (some of whom appeared to operate informally) while at the same time wish for foreign investors to keep up their formal

operations. This tendency has caused several incidents of invasion in the concessions of some large-scale mining companies especially in the case of North Mara (Field Data, 18th June 2019). Such events have caused the extension of distrusts of the government regulators.

Indicators and Evidences of Trust Deficit among the Mining Regulators and Operators

The data revealed inadequate collaboration among the regulators from different regulatory authorities due to trust deficits (Field Data, June 2019). For instance, some officers from the Mining Commission could not easily share the information of regulatory relevance with those from OSHA, NEMC and TRA partly due to lack of faith. This was true even between the co-workers in the same institutions. One Mine Resident Officer (MRO) worked for Mining Commission in North Mara Gold Mine explained:

> "Several undesirable incidents taught me not to trust anybody even the co-worker. For example, one of my sad memories of my previous unwarranted trust happened when some confidential information from my personal files leaked to the inspector from OSHA who used the same info to serve his purposes while left me in blames. This created unnecessary tension and dismay especially against those who shared with me the office premises (Field Data, June 2019)."

The above quotation indicates that some regulators do not trust each other especially when dealing with confidential matters. The fear of leakages of confidential information and the failure to perform professionally by some regulators like the one who unduly accessed and utilised the leaked info are some of the reasons for distrusts among the regulators.

With regard to regulator-operator relationship, the government regulators faced some structural and situational challenges most of which lowered their performance and thereof their trustworthiness. For instance, some of them confronted the problem of information scarcity or misinformation from mining operators particularly those worked for AGA and BGC. This was especially in the case in which the two companies were trusted to pursue management-based regulation through the internal rulemaking and monitoring (Field Data, June 2019). Delegation of authority to the firms created some loophole for opportunistic behaviour that was sustained by information scarcity or misinformation. This trend has made some

government regulators remain unable to exercise their discretionary authority in a manner that would enhance their trustworthiness (Field Data, June 2019).

Moreover, government regulators are expected to be mannered with values of honesty and integrity and effectively discharge their obligations but there were incidents in which these expectations were not met hence the drop of their trustworthiness. For instance, some government regulators happened to be inconsistent and unpredictable in their field performance, the manners which lowered their trustworthy (Field Data, June 2019). Furthermore, there was a tendency in which some regulators could not professionally spend their ample time in clarifying regulatory policy intent, rather, they largely focused on administering and enforcing the regulatory policy and behave like 'fault finders'. This trend was explained differently by various operators. For instance, one operator from Bulanhulu Gold Mine revealed that the TRA officials were relatively 'open minded' when addressing certain regulatory issues as compared to other regulators like those from OSHA and NEMC who were said to have tended to behave like the 'fault finders' (Field Data, Kahama, 23rd May, 2019).

One operator at Bulyanhulu Gold Mine explained:

> "The issues of monitoring and enforcement raise questions of trust. If there is a lack of trust between regulators and the regulated entities or, between the government regulators themselves, the efficacy of regulation is weakened. This is especially serious in the situation in which the operator appears nervous on fearing that any breach can lead to the imposition of a strong penalty (Interview with mining operator at Bulyanhulu, 23 May, 2019)".

The above quotation suggests the need for regulators to remain trustworthy in monitoring, guiding and supporting the regulated entities to enhancing compliance. This substantiates the role of trust in the regulatory relationships.

The Role of Trust in the Regulatory Relationships

Trust has been defined differently in different academic disciplines including philosophy, sociology and political science. The synthesis of insights from various scholars including Stern & Coleman (2015)

suggests that the same concept can generally be defined as an individual's (interpersonal) or group's (organisational) expression of positive expectation and willingness to accept vulnerability in the face of uncertainty. In this paper, trust refers to as guts of accepting vulnerability in the face of uncertainty with an expectation that the one who owe will certainly reciprocate. Trust formation, therefore, involves an object which is trustee and a subject which is trustor. In the process, the trustee is expected to be trustworthy or to have attributes of trustworthiness for the trustor to coincide trust. The attributes of trustworthiness in the context of regulatory relations usually include the qualities of being honesty, competent committed and cooperative (Geoghegan & Renard, 2002; O'Neill 2014, 2018).

According to Stern & Coleman (2015) there are four distinct types of trust relevant to regulatory practices: dispositional, rational, affinitive, and systems-based trust. Dispositional trust is based on individuals' pre-dispositions to trust or distrust in a given situation. Personal experiences, historical memories and tales about particular situation may set precedents on which an individual develops trust or distrust. Rational trust, on the other hand, is based on the truster's estimation or calculation about outcomes from the initiatives of the potential trustee. In this sense, if the estimates are pointed to the negative outcomes, then the rational trust was low and the vice-versa of the same incident might be true. Rational trust is therefore influenced by knowledge/information and logical calculations.

Affinitive trust is based on personal relationships and social interactions between participants in the group settings. It is centred on affinity for the potential trustee as manifested into social affiliation, intimacy, shared experiences, perceptions of shared identities and social values (Stern & Coleman, 2015). The other one, systems-based trust is specifically centred on the meanings attached to the set of procedures or rules, rather than trust in an individual or organizational profile. In the contexts of Co-regulation, system-based trust is realised when all actors in the given setting perceive the rule formulation and regulatory procedures as fair (Stern & Baird, 2015; Moffat, Zhang, & Boughen, 2014). In this regard, when procedures in the rule formulation, for example, are jointly agreed upon as being fair by majority actors, participants can place the greater faith and voluntarily comply with the same (Moffat et al., 2014). To that end, the effectiveness of Co- regulation is attained. Considering this

assumption therefore the trust in Co- regulatory environment is considered to be most important of all.

From above insights, trust is hereby considered to be the glue that holds regulatory relationships together and it is also the lubricant that smoothes regulatory process. Trust is essential in regulatory environment since it guarantees stable relationships that are vital for the maintenance of cooperation among various regulators and between the regulators and the operators (Field Data, 2019). A certain amount of trust is therefore integral to the functioning of regulatory system, whether of the local, national or international domains. In that regard, breakdowns in trust often result from regulatory uncertainty which may result from errors by either regulators or by operators. Regulatory uncertainty and a resulting loss of trust may affect all or section of players in the regulatory field including direct financial losses out of, either, investigation, litigation or dissolution, or all of them. The most frequent outcomes of regulatory uncertainty on part of business operators is increases in cost, lost revenue, cancelled or postponed investments while regulators tend to carry political or administrative burden.

The scholars agree that a certain amount of trust can trigger reciprocity in the context of regulatory governance and this is based on one's belief about the other party's trustworthiness (Heemskerk, Gomiam & Pinas, 2015; Stern & Coleman, 2015; Stern & Baird, 2015). In this regard, the business operator may comfortably comply with certain regulations on believing that the regulator will reciprocate the trust by acting in a manner that doesn't cause harm to the operator's interests. In light of the above, a working definition of trust in the context of regulatory governance is based on 'the belief that the operator will not be harmed when her interests are placed in the hands of the regulator'. When this happens there is a chance for arousal of expectation that 'since there is no harm caused thereof, the operator will positively reciprocate by voluntarily complying with regulatory mechanism that pleases the regulator and which ultimately promotes public interests. This analogy insists the importance of reciprocity in the regulatory relations. Reciprocated trust in the regulatory relations means that the regulator is akin not only to the operator's interests per se, but also to how her character influences the formation or maintenance of the operator's interests, and how her capacity to reciprocate trust is affected by external constraints. Similarly, in the context with several regulatory agencies, one agency may

comfortably cooperate with the other on the expectation that the fellow regulator will put their shared interest's paramount.

Different scholars have variedly studied the causes and effects of trust in contexts ranging from interpersonal interactions and small groups to large-scale networks and governments (Karen & Jessica, 2017; Kuwabara, 2015; Schilke & Cook, 2015; Kim, et.al, 2004). Among the sources of trust are individual-level factors, such as those which allow for assessments of others' incentives and trustworthiness (Karen & Jessica, 2017), as well as organizational and institutional factors that facilitate trust (Connelly, et al., 2018; Janowicz-Panjaitan & Krishnan, 2009). Generally, the key factors which have been considered to be potential in influencing the trust include rationality, competency and integrity. Rationality refers to cognitive process through which a person processes information in a way to become certain about cost and/or benefit of the specific decision or action. Some rationality thinkers including Connelly and his colleagues (2018) think that human psyche is capable of developing the cognitions that form the basis of judgments of trustworthiness and decisions to place trust in another. According to Connelly, et al. (2018) the formulation of human psyche can amplify into trust relations in networks, groups, and institutions. This implies that the trust which prevails in society is based on reasoned assessments of the evidence at hand that led one to evaluate others as trustworthy given past performance, reputational information, and the incentives at play. The rationality perspective is divided into thinking about unbounded versus bounded rationality. The 'unbounded rationality' perspective is based on thinking that human cognitive process is unlimitedly precise and typically perfect. On contrast the 'bounded rationality' perspective is based on believing that human cognitive capacity is not purely perfected considering the fact that there are several barriers against the cognitive function. These barriers include limited information and other environmental, social and psychological uncertainties.

The second factor, competency, entails the knowledge, skills, values and experience necessary for maintaining or increasing productivity. The competent regulatory oversight agencies can effectively preserve public safety and order. Considering the influence of competency upon the trust, a number of authors have described government competency as being an important determinant of government trustworthiness (Connelly, et al., 2018). Indeed, the incompetent government agents are proven to

undermine public trust (Kuwabara, 2015). Competency is therefore considered to be an important factor that can enhance or damage trust and the same can be measured at either institutional or personal level.

The third factor, integrity entails virtues like impartiality, honesty and professionalism of a person or the group of persons. The integrity of public officials may influence public trust upon the government. In our case for example, the integrity of government regulators which is manifested into moral and professional conduct can make them be regarded as trustworthy. A number of scholars have linked between the honesty of public officials and the citizens' trust upon the government (Rose-Ackerman, 2001). In order to measure integrity, it is necessary to look at how the citizens perceive the regulators in terms of impartiality, honesty, or corruption. For example, the citizens can be asked if the government regulators lack impartiality.

The major consequence of trust which originated from rationality, competency or integrity in the regulatory relationships is willingness to cooperate (Connelly, et al., 2018). For instance, when the mining operators perceive the government regulators as trustworthy, their trust is transformed into the behavioural response known as "cooperation" which stimulates compliance.

Regulator-Operator Interactions and the Essentiality of Trust

The government regulators in the mining sector, firstly, perform the task of providing education to the mining operators on various topics including the appropriate means to comply with social and environmental obligations. They also deliver information on regulatory requirements. This task requires them to be faithful, honesty, committed and observe integrity. In this regard, mining operators are also expected to honestly support the regulators in their dealing with education provision. This is important especially when seeking advice and guidance which is necessary for the fulfilment of their responsibilities. In this regard, the operators are certainly expected to provide sincere feedback to the regulators in a way to improve the regulatory practice and achieve regulatory objectives.

Another task performed by regulators is licencing and approvals in which they practically assess the application documents before embarking on issuing the lisences. They also grant the registration and accreditation.

After having registered or formally engaging the mining operators, the regulators impose and collect tax, fees, royalties and other amenable dues. The performance of this task requires the virtue of justice and the performer needs to be faithful, honesty, committed and the person of integrity. On the other side, the operators are expected to supply truthful information when applying for lisences, registrations and accreditations. They are also expected to be honest in paying the fees and other charges and in providing the requested information regarding their daily undertakings.

Compliance and risk monitoring is another task which has been performed by government regulators in which they are expected to systematically assess the risks, collect data and conduct inspections and audits. The performance of this task also requires the virtue of justice and the performer needs to be faithful, honesty, committed and the person of integrity. On the other side, operators are expected to honestly support the compliance and risk monitoring by fulfilling their regulatory obligations, facilitating the inspections and audits, and providing some evidence-based information on their compliance. Government regulators also perform enforcement tasks which may involve some measures like rewarding the good compliance practice or imposing the pecuniary or non-pecuniary penalties. The performance of this task requires, as well, the virtue of justice and the performer needs to be faithful, honesty, committed and the person of integrity. On the same regard, operators are particularly expected to honestly support the enforcement practice by implementing the required policy changes or changes of regulatory practice, and by complying with penalties imposed.

The above explanation indicates that the achievement of regulatory objectives depends entirely on the roles played by both – regulators and operators who need to be faithful, honesty, committed and persons of integrity. This is to assert that both of the two groups of actors are required to demonstrate their trustworthy and sincerely reciprocate to each other in the logic of interdependence, short of which may lead into regulatory ineffectiveness.

Essentiality of Trust in the Regulatory Relations

Trust is considered to be an essential factor for effective regulatory relations (Stern & Baird, 2015; Chaffin, Gosnell & Cosens, 2014; Moffat, et al., 2014). The essentiality of trust is based on the fact that it

guarantees, among others, better performance (Klijn, et al., 2010), better compliance (Vasalou, Bonhard, Adams, & Riegelsberger, 2006) and, reliable exchange of information (Beccerra, Lunnan & Huemer 2008). Again, inter-organisational trust is a central factor for the success or failure of various collaborative endeavours between various regulatory agencies (Vangen & Huxham, 2003). The aforesaid viewpoints can be summarised to have a general agreement that trust guarantees reciprocity (Ostrom, 1998) and willingness to cooperate (der Voort, 2017) and therefore allows the smooth regulation. Considering the essentiality of trust in regulatory relations, the Government of Ontario had highlighted it firstly in the list of "Ontario Public Service Organizational Values" which were set forth to guide the conduct of the regulators. In this respect, the Government of Ontario's regulators pledge to act honestly in all their relationships with the people they serve, work with and who rely on them (Government of Ontario, 2017). Trust is therefore highlighted as essential element of the best practice for regulatory compliance. In that respect, all members of the regulatory agencies in Ontario are required to remain trustworthy in promoting compliance with the laws that protect the public interest (Government of Ontario, 2017).

In light of the above, the trustful regulators are expected to cooperate with operators to enhancing the level of compliance while remain mindful that the regulated entity may have difficulty in complying with law and regulations probably due to errors of interpretation or lack of resources. Likewise, the trustworthy operators are expected to behave sincerely by restricting themselves from breaching the rules and principles which specify the standards of conduct. In this view, trust is widely seen as essential ingredient in the context of co-regulation. Yet, despite the centrality of trust, still some regulatory stakeholders in various regulatory agencies have been either unable to forge or incapable to maintain it (UONGOZI Institute, 2016; Morgan & De Urioste-Stone, 2017). This is due to inadequate trustworthiness or lack of knowledge about 'trustworthy demonstration' and 'distrust regulation' (Gillespie & Dietz, 2009).

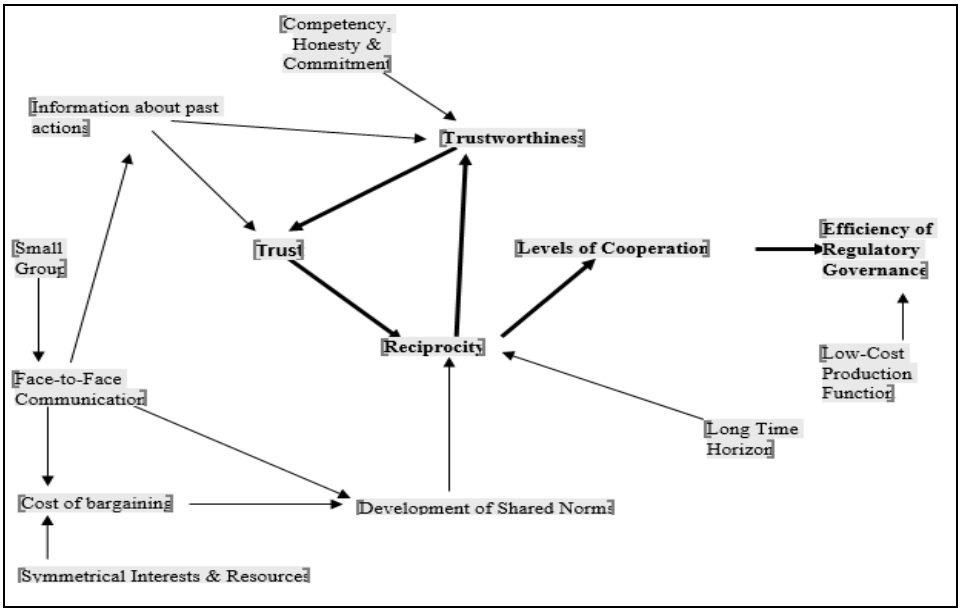

Diagram 1: The Causal Mechanism of Trust-Relationship in the Regulatory Regime
Source: Adopted and slightly modified from Ostrom (1998

Diagram 1 above indicates the interconnection of variables in the regulatory context. It shows the trustworthiness can be determined either by personal attributes including competency, honesty, and commitment, or by information about past action (which is based on face-to-face communication in case of small group of actors), or by personal sentiments, or by combination of aforementioned. Trust is conditioned by trustworthiness and it can determine reciprocity which, in turns, concretizes trustworthiness. Reciprocity which is conditioned by trust levels and shared norms normally stimulates more cooperation in the long run which is necessary for regulatory governance.

Empirical Cases of Trust Utility

There are several cases of trust utility and the following are exemplary ones from different contexts. In foremost, trust has enabled the establishment of the Atlantic Energy Roundtable (AER) as a forum for dialogue between governments, offshore operators, supply and service companies, regulators and labour in Canada (EMMRPIWG, 2008). This forum was meant to facilitate exchange of knowledge on common issues for further development of the Atlantic offshore oil and gas industry. The

AER organized dialogue which involved several stakeholders for the identification of issues and potential solutions related to regulatory efficiency. Despite being challenged by issues including multi-agency responses and its accompanied complexity in coordination the AER helped to foster cooperation between the key government department and agencies, to increase certainty and predictability for participants involved, and to set out principles and approaches to ensure the effective, coordinated and concurrent regulatory performance.

The dialogue between regulators and the regulatory stakeholders including the operators served to improve the overall quality of the project implementation and, as such, it enhanced coordination and exchange of information. Trust relationship paved a way for drafting and signing of Memorandum of Understanding that helped to minimize regulatory uncertainties. The MOU specifically committed the parties to a collaborative regulatory review and environmental assessment process (EMMRPIWG, 2008). This helped to address some regulatory issues including role confusion which cropped up in the past when the regulatory processes were established on a case-by-case basis rather than being based on collaboration. Inter-organizational trust has allowed exchange of information and cooperation among the parties responsible for administering the various processes that applied to the same project. On February 18, 2005, nearly a dozen federal and provincial agencies started to pursue the coordinated and integrated regulatory approval and environmental assessment process for offshore petroleum development projects in the Nova Scotia and Newfoundland and Labrador offshore areas (EMMRPIWG, 2008).

CONCLUSION

The establishment of effective regulatory institutions with technical and other capacities, and relative efficiency of the regulatory policies and instruments are key to how well regulatory regimes can foster transformation and economic development catalysed by mineral extraction. However, cooperation among individual regulators and between regulatory agencies as well as regulated entities is utmost imperative for the efficiency and effectiveness of regulation. The regulation by cooperation and mutual exchange of regulatory facilities require trust among the involved actors. The forge of trust-relationships may guarantee smooth communication and coordination of regulatory activities. If preconditioned by integrity, credible commitment,

competency and constant interactions, it may end-up enhance regulatory compliance. This lays on sincerity and sharing of critical regulatory information among the regulatory agencies and between them and operators. Trust is a key factor which can potentially help to foster collaborative relationships between the regulators and the regulated entities and it may actuate the strategic management of the complex regulatory relationships in the mining sector.

RECOMMENDATIONS

It should generally be agreed that trust is hard to construct and easy to destroy. Considering this fact therefore, both actors - the government regulators and the mining operators must endeavour towards gaining and demonstrating their trustworthiness. It is important to combine various mechanisms of 'trustworthiness demonstration' and 'distrust regulation' towards building and restoring the trust. 'Trustworthy demonstration' entails the actual display of the qualities of trustworthiness including integrity and competence. This can be done by designing the forums for constant exposures through regular interactions between the trustors and potential trustees. This may base on personal relationships and social interactions between regulators and operators to allowing the potential trustee to demonstrate his/her trustworthiness of certain forms like honesty and/or integrity of which the trustor can assess and make the trust decisions.

On the other hand, 'distrust regulation' incorporates both affinitive elements like expressions of regret, acknowledgement of responsibility and offers of reparations for regulatory failure and, rational elements like redesigning of the enforceable rules for the future effective regulation can be pursued to boost trust-relations. In this sense, for instance, regulatory failure may be best addressed by the regulatory agencies through trustworthiness demonstration, whereas distrust regulation may be pursued by the same agencies in the incident of integrity breaches or the inconsistency between professed regulatory values and actions. The government regulators should pursue distrust regulation which entails preventing future disgrace by rectifying the faults that contributed to the prior regulatory failure. For example, the regulatory agency can deliberately substitute the imperfect regulations, rules, contracts, and monitoring processes which caused disgrace upon the operators. The government regulators may pursue 'distrust regulation' to build, for example, affinitive trust through expressing regrets, acknowledging

responsibility, and offering reparations on certain regulatory action that caused harm. Distrust regulation may also base on building rational trust through, for example, redesigning the enforceable rules for the future regulation. Individual regulators and their respective institutions should endeavour to build personal and organization culture which must be interwoven in the generally acceptable value standards. This is based on an assumption that every action by an individual actor has an impact on personal and organisation's trustworthiness.

Mining operators should particularly improve their reputation which is equivalent to their trustworthiness. This is possible by ensuring that the voluntary initiatives of self-monitoring which have been adopted by the same operators are properly implemented. For example, the operators should specifically reduce information asymmetries and establish mechanisms for dialogue and participation which is necessary and sufficient to build trust-relationships. The general idea is that trust deficit would be addressed by tabling an issue for negotiation and mutual understanding. Operators may decide to make, for instance, environmental data comprehensible and release it publicly.

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Investigation on The Level of Insecticide Resistance to Malaria Vectors in Ruangwa District Lindi Region Tanzania

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ABSTRACT
High malaria prevalence remains a major problem in Ruangwa District, despite the high coverage rates of malaria control interventions. The objective of this study was to assess the level of insecticide resistance in malaria vectors in southern, Tanzania. The study was conducted in three villages of Likangara, Nandagara and Chienjere. Resistance level to insecticides in An. gambiae s.l was evaluated using a standard WHO Susceptibility Test Kit. These mosquitoes were reared from larvae collected in varoius breeding sites in a major rice, vegetable and leguminous plant cultivation area in which pesticides use is intensive. Each test was run in four replicates of 25 adult non-blood fed female Anopheles gambiae s.l mosquitoes per tube. In total, 100 specimens were exposed for standard concentration of 1% fenitrothion, 0.1% bendiocarb, 0.75% permethrin and 0.05% deltamethrin using WHO susceptibility test kit. The number of knocked down mosquitoes were recorded at 10,15,20,30,50 and 60 min and mortality rates were determined after 24 hours and results were classified according to WHO guidelines, as susceptible (97-100%), possible resistance (90%-98%) and resistance (<90%). The results indicate suggestive levels of mosquitoes resistance to Bendiocarb at (75%), possible resitance levels of Deltamethrin at (95%), Permethrin at (97%) and Fenitrothion at (96%) ($p < 0.05$). This implies that there is reduced effectiveness of insecticides used in vector control interventions in the district. Superior insecticides should made available and introduced in order to promote the sustainable management of malaria vectors and elimination malaria transmission in the district.

Keywords: *Malaria vectors, Insecticide Resistance, Susceptibility, Ruangwa district, Tanzania*

INTRODUCTION

In spite of intense national and international efforts, malaria remains one of the major tropical challenges in the world today (WHO, 2019). Malaria is one of the main public health problems in Africa, causing more than one million deaths per year and placing a strong burden on developing African countries (WHO, 2018). Vector control remains an important component of malaria prevention. In sub-sahara Africa, the primary tools for malaria vector control are long-lasting insecticidal nets (LLIN) and indoor residual spraying (IRS). However, insecticide resistance development in vector populations could impede the success of malaria control programmes in endemic areas (Riveron, *et al.*, 2018).

Currently, major classes of insecticides such as organochlorines, carbamates, organophosphates and pyrethroids which are being used in malaria control, are increasingly less effective at killing malaria mosquitoes (WHO, 2010; Kabula, 2018; Hancock e*t al.*, 2020).The intensive use of this class of insecticides at large scale both in agriculture and public health in malaria vector control activities has led to its reduced efficacy in sub Saharan Africa (Reid, 2016; Elenora, 2018; Philbert *et al*., 2019). For example in Tanzania, some regions especially, in the southern and north western parts of the country, malaria has remained persistently high 11.7% to 24.7% despite wide coverage with LLINs, IRS and case management using Artmether-Lumephantrine (TMIS, 2017). In Lindi region the average regional malaria prevalence remains high at 11.7% (TMIS, 2017), but with great village variations. For example, in the Ruangwa District, Malaria prevalence rate of 17.7%, 18.3% and 85% were recorded from the villages of Likangara, Nandagara and Chienjere respectively (DHIS, 2017).

Tanzania's national health strategies aspire reducing malaria to 1% by the year 2020 by using malaria vector control tools such as Long-lasting Insecticidal Nets (LLINs), Artemisinin-based Combination therapy (ACT) and indoor residual spraying (IRS) (MoHSW, 2015). Despite wide LLINs distribution by 95% to most vulnerable groups such as pregnant women, school going pupils and infants from 2014 to 2017 malaria prevalence is still high at 17.7% in Ruangwa district (DHIS, 2017).

However, the main contributing factors for this persitence in malaria transmission despite widespread use of the current core vector control intervention measures are not well known. In addition. Factors such as; lack of studies to epidemiological consequences of resistance on malaria vector control (Philbert,2014) and rapid expansion of insecticide resistance to malaria vectors could be playing an important role in malaria transmission(Nkya, *et al.,* 2013; Toe, *et al.,* 2014; Kisinza, *et al.,* 2017). Furthermore, the emergence of antimalaria drug-resistant to strains of malaria parasites (WHO, 2015), resistance mechanisms to different insecticides have been documented (Kisinza *et al.,* 2017). However, substantial collective research evidences on the dynamics of insecticide resistance in mailand Tanzania specifically in Lind Region is still limited (Govella *et al.,* 2013; Protopopoff, 2013; Killeen, 2014).

Therefore, this study aimed to monitor the status of insecticedes resistance in sourthern Tanzania were malaria transmision and is still high. The information obtained could be used as a benchmark for comprehensive approach of new tool and strategies to control insecticedes resistance in Tanzania.

METHODOLOGY

The study area

The study was conducted in Ruangwa district, populated with 131,080 people. It's a flat land with hilly landascape, the altitude is 313 - 549 meters above sea level. It has 707 hectares of the total irrigated area planted with annual and permenent crops. Pesticides such as insecticides, fungicides and herbcides are chemicals used for controlling insects, diseases and weeds, but insecticides were the most common pesticide used in planted area, followed by fungicides and the least was herbicides which could be threatened the present achivement of residual malaria transmission control.There's one rainy season (November – May), averaging 800 mm of rainfall per year. The daily temperature ranges from 24 to 35 degrees Celsius with very high humid air; the source of malaria prevalence rate. The three study villages (Likangara, Nandagara and Chienjere) have rural- urban and para-rural settings with low malaria prevalence of 17.7%), moderate 54.3% and high 85.7% respectively. (DMIS, 2016). The villages are located in low savannah area covered with grasses, bushes and scattered trees, narrow slow running streams with marginal vegetation and pad fields, shallow wells, bored wells and

ponds which are seasonal breeding habitats. Many villagers are agriculturalists, few are petty traders.

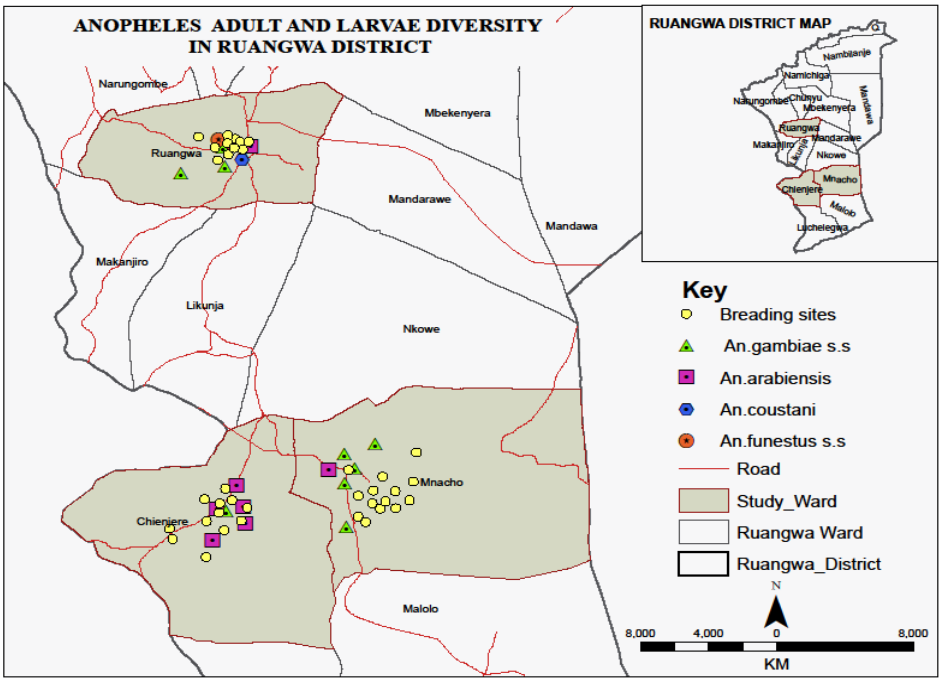

Figure 1: Maps showing the region, district, three wards/ villages and breeding sites where malaria vectors collected in agricultural areas with intensive use of insecticides

Larval sampling (Immature stages of mosquitoes)

Weekly cross-sectional larval surveys in a variety of naturnal breeding sites were carried out between March and September, 2017. All samples were collected at least one km around agricultural area where most of breeding sites were found. The collected larvae were transferred into small bowl labelled with date, site of collection and type of habitat. The larvae specimen was packed in cool-box and transported to the insectary reared to adult under the following conditions: temperature 27±2°C and relative humidity at 70-90%. A 10% glucose solution was supplied in the cages for the emergent adults and maintained photoperiod 12: 12 light/dark period from 0600 hours to 1800 hours –"light period" and 1800hrs to 0600 " dark period". They were fed on King Fish food 2-3 times per day until pupation to reduce variation in larval growth rate and mosquito size at ermegence. The pupae were immediately transferred to

a bowl that contained water and placed in a cage until the adults emerged. Upon emergence from pupa; the adults were fed on glucose 10% sugar solution soaked in cotton wool and maintained in the cages.

Testing for adult susceptibility mosquitoes

Insecticide susceptibility tests were carried out using susceptibility test kits and WHO standard procedures (WHO, 2012). Each test was run in four with replicates of 25 adult non-bloods fed female *Anopheles gambiae* s.l mosquitoes per tube, totally 100 specimens for each insecticide. Tests for mosquitoes were exposed to papers impregnated with WHO recommended discriminating concentration dose of 1% Fenitrothion, 0.1% Bendiocarb, 0.75% Permethrin and 0.05% Deltamethrin (WHO, 2013). The controls were exposed to papers without insecticides coated with specified oil, two replicates per test, totally 50 specimen for similar period. During exposure period, the number of knocked down mosquitoes were recorded at 10,15,20,30,50 and 60 min. After 60 min, tested mosquitoes were then transferred into holding tube and supplied with glucose 10% sugar solution and the mortality rates were also determined after 24 hours. Mortality was compared with the percentage of dead mosquitoes. The mosquito's population resistance results was classified according to WHO guidelines, as susceptible (98-100%), acquiring possible resistance (90%-98%) and resistance (<90%).

FINDINGS AND DISCUSSION

The results showed that *An. gambaie s.l* mosquitoes was resistant to Bendiocarb as compared to Deltamethrin, Permethrin and Fenitrothion insecticides (χ^2 = 2.65, df 2, p>0.05). In addition, significant difference in the levels of resistance was observed among Bendiocarb, Permethrin, Fenitrothion and deltamethrin insecticides tested. (χ^2 =25, df =3, p <0.01).

Table 1 *An. gambaie s.l.* Resistance profile in Ruangwa District

SN.	Insecticides	Concentration	No. Tested	Mortality	Percentage	P Value
1.	Permethrin	0.75%	100	97	97%	0.01
2.	Deltamethrin	0.05%	100	95	95	0.01
3.	Fenitrothion	1%	100	96	96%	0.01
4.	Bendiocarb	0.1%)	100	75	75%	0.01

The levels of resistance are also well illustrated in Figure 2. Red line indicates cut off efficacy of insecticides tested (98%-100%-

susceptibility; 90%-97- possible resistance; < 90- resistance) and black dots illustrate replicates conducted in ratio (Figure 2 and Figure 3).

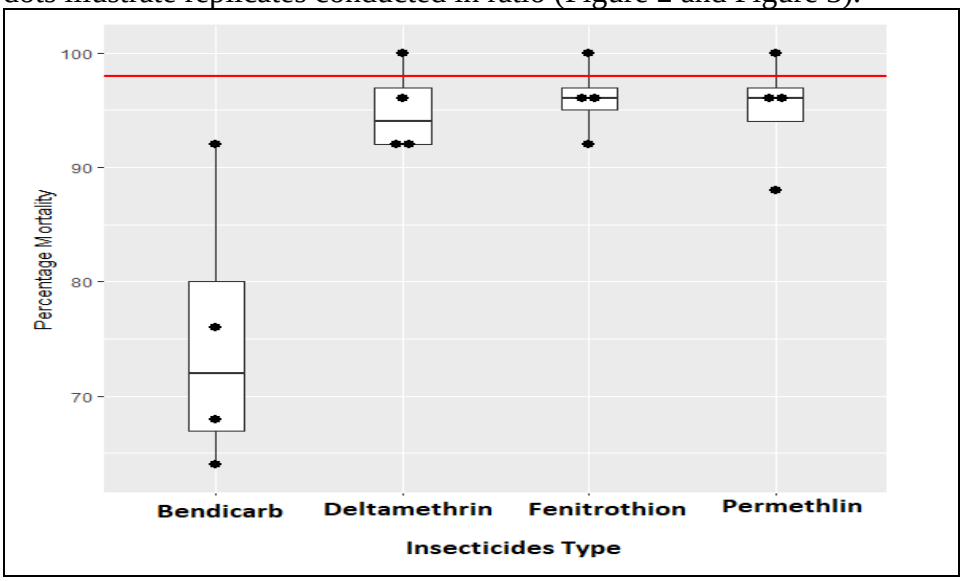

Figure 2: Results for An. gambiae s.l susceptibility tests indicate the four replicates per insecticide tested. Black dots indicate the mortality rate of mosquitoes in percentage

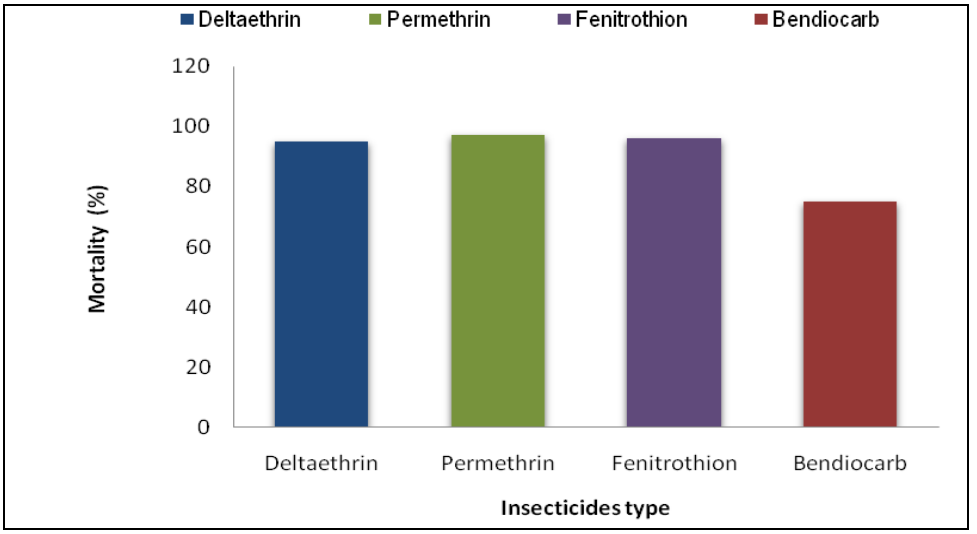

Figure 3: Results of World Health Organization (WHO) Susceptibility tests for *An. gambiae* s.l mosquitoes collected in Ruangwa district

The present study was designed to evaluate under field conditions the efficacy of a carbamate (bendiocarb) pyrethroids (deltamethrin, and permethrin) and organophosphate (fenitrothion) resistance level against malaria vectors in Ruangwa district, southern part of Tanzania. The results showed that *An. gambaie s.l* mosquitoes were resistant to Bendiocarb as compared to Deltamethrin, Permethrin and Fenitrothion insecticides. The resistance level of bendiocarb to malaria vectors reported in the present study concurs with the one reported by Kisinza (2017), in Ngara and Mbozi districts, Tanzania which accounted for 58% in mortality rates of *Anopheles* species tested. The results also concur with (Antonio-Nkondijio, 2016) in a study conducted in Younde, Cameroon in which he reported *An. gambiae* s.s resistance to Bendiocarb insecticides. Besides, Wanjala (2018) also confirmed Bendiocarb resistance to malaria vectors in in Iguhu and Kabula areas of Western Kenya.

In the present study, Deltamethrin showed a possible resistance level at (0.05%) in all wards. Similar results have been reported by (Matowo *et al.*, 2010; PMI, 2016) in several districts in northern and western Tanzania. Similarly, Wanjala (2018) and Kweka (2018) have reported possible resistance to Deltamethrin in Kenya. Another Pyrethroid, Permethrin has been reported to have possible resistance level of 3% in Musoma rural district (PMI, 2016).

Nonetheless, (Akogbeto, 2006; Ochomo *et al.*, 2013; Massebo *et al.*, 2013; Matananga *et al.*, 2015) in Kenya and Malawi respectively, observed that, even in the presence of possible pyrethroid resistance, LLINs perform better than untreated nets in terms of protection against mosquito biting in endemic countries.

The efficacy shown by the organophosphate (fenitrothion) in the present study is supported by studies by Maharaj and Sharp (2005) in KwaZulu Natal South Africa, in which DDT was re-introduced after the failure of pyrethoids to control *Anopheles funestus*. Furthermore, a study by Abilio *et al*., (2011) in Mozambique reported that both *An. gambiae* s.s. and *An. funestus* were controlled effectively with the DDT-based IRS programme in Zambezia, an excercise that led to reduction of disease transmission and burden. However, *Anopheles gambiae* s.l . is becoming resistant to pyrethoids and DDT in several parts of Tanzania (Kabula *et al*., 2014 ; Matowo *et al.,* 2014; Matiya, *et al*., 2019). The discovery of potential

resistance to carbamates and pyrethroid in in Ruangwa district may threatens the gains made here and may impair the effectiveness of these interventions in place and therefore demand close monitoring and the adoption of a resistance management strategy (Kabula *et al*., 2014).

In the present study, *Anopheles mosquitoes* were collected in lowland areas in which; rice, fruits, maize, cashew nuts and vegetable cultivation was being practiced and there is an extensive application of pesticides. The possible resistance levels could emanate from the above practices. Nkya *et al.,* (2013) observed that resistance and possible resistance of insecticides to malaria vectors were due to cross contamination from cumulative pesticide compounds used to control pests in agriculture and livestock as well as weed control. This supports the findings by Philbert (2014) in Dar Es Salaam while assessing the role of agriculture pesticide use on the development of to insecticides resistance to in malaria vectors and the potential impact on control activities. In addition, these observations, coincide with those reported in Cote d' Ivory, Kenya, Cameroon and Benin, which reported that, resistance in *Anopheles* mosquitoes was originating from rice farms, tomatoes and vegetable growing areas (Bigoga *et al*., 2007; Menze *et al.,* 2008; Djegbe *et al.,* 2011; Edi *et al.,* 2012; Antonio-Nkondijio, 2015).

The present study confirms the resistance of Bendiocarb, possible resistance to Deltamethrin and Permethrin. Moreover, the results indicate that Fenitrothion is still highly effective in malaria control in the study area. Moreover, the findings of the present study have shown that mosquito populations in the study area remain susceptible to the organophosphates which indicates that these can be used to good effect in Indoor Residual Spraying as part of a resistance management strategy in the study area.

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Author's contributions

Clement Godfrida was the principal investigator of the study and led collection of data, designed the sampling technique, conducted data analysis, and interpreted results. Prof. Emmanuel S. Kigadye and Dr. Nicodem J. Govella and Dr B. Kabula provided technical support guidance. All authors read and the Open University of Tanzania approved the manuscript.

Ethical clearance: This received an ethical approval from the Medical Research Coordination Committee of the National Institute of Medical Research in Tanzania Reference no NIMRI/HQ/R.8a/Vol. XI /3232. I collected mosquito larvae from various productive breeding sites of Likangara, Nandagara and Chienjere villages. Permission to collect mosquito larvae in the breeding sites in their area was obtained from Lindi region, Ruangwa district, ward, village officials and landlords after explaining the objective and benefit of the study.

Nutritional Prospects and Phyto-Therapeutical Potentials of the Selected Indigenous Green Leafy Vegetables Commonly Used in Tanzania

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ABSTRACT
A purposive interview and laboratory analysis of green leafy vegetables commonly used in Tanzania was carried out to determine nutritive prospects as well as therapeutic value. Nine (9) common green leafy vegetables believed to have therapeutical potential on: dietary, anemia, stomach pain, blood pressure, diabetics and peptic ulcers were selected for this study. The micronutrients Ca, Mg, K and P contents were determined using extracts of fresh ALVs, where the effects of cooking were taken into consideration. Calcium level ranged from 496.0 to 1763.5 mg/kg, phosphorus ranged from 309.8 to 572.3 mg/kg, sodium ranged from 72.4 to 187.3 mg/kg and potassium ranged from 309.8 to 595.3 mg/kg. The ratio between Ca and P was 1.30:1 in Ipomoea sp while in Solanum sp was 3.14:1. These values are within the acceptable ratio for the people who are diabetic. The ratio of Na/K in all green leafy vegetables is less than one, hence consumption of these vegetables is beneficial to people with high blood pressure as they tend to reduce their blood pressure. It is recommended that future studies should consider other aspects of green leafy vegetables such as the biological evaluation of the nutrient content in order to determine the bioavailability of the nutrients. Also, it is important to determine the effects of food processing such as cooking on the chemical components and nutritive value of the green leafy vegetables.

Keywords: *Leafy vegetables, Figiri, Cucurbita maxima, minerals, ipomoea, Tanzania*

INTRODUCTION

Indigenous and or traditional leafy vegetables are concepts used mostly to describe leafy vegetables that have been part of the local food systems in Sub-Saharan Africa (SSA) for generations. The term indigenous leafy vegetables are those that have their natural habitat on sub-Saharan Africa while the traditional leafy vegetables were introduced over a century ago

and due to long use, have become part of the food culture in the sub-continent (Smith and Eyzaguirre, 2007). Previously, production of leafy vegetables was mainly on a subsistence basis; and confined to the rural areas. However, these days in the fast-growing city like Dar es Salaam, production of leafy vegetables is the fast-growing activity and offers a significant opportunity for the poorest people to earn a living as producers and/or traders without requiring large capital investments. These vegetables provide an economic pillar upon which women's livelihood is supported (Opiyo, *et al.,* 2015).

African green leafy vegetables have long been part of traditional diets in communities in the continent, yet many of these crops are underutilized and their nutritional value is unknown (Dalziel, 1937). Their utilization could improve the cassava and maize based staple diet and thus reduce the chronic nutrient deficiencies, although their adverse effects are reported among the populations. Despite official statistics indicating a low consumption level of vegetables in Sub-Saharan Africa, it appears that traditional vegetables are usually consumed with the staple food in various forms (Johns, 2004).

For many years, quite a very good number of African indigenous leafy vegetables have long been known and reported to have health protecting properties and uses (Okeno, *et al.,* 2003; Dalziel, 1937). Some of these African indigenous leafy vegetables maintain to be used for prophylactic and therapeutic purposes by rural communities (Getinet, *et al.,* 1997). This indigenous knowledge of the health promoting and protecting attributes of ALVs is clearly linked to their nutritional and non-nutrient bioactive properties (Okon, *et al.,* 2014). Example is kwashiorkor, which is a form of severe acute malnutrition in children for many years especially in Sub-Saharan Africa and Tanzania is not exceptional. Studies shows by providing antioxidants to children with kwashiorkor through their diet improves their survival (Becker, *et al.,* 2005; Badaloo, *et al.,* 2002) specifically the phytochemicals in vegetables and fruits (Liu, 2003).

The ALVs have long been and continue to be reported to significantly contribute to the dietary vitamin and mineral intakes of local populations (Oyejola and Bassir, 1975; Okon, *et al.,* 2014). The increased consciousness of the health protecting properties of non-nutrient bio-active compounds found in fruits and vegetables has led to enormous

concentration to vegetables as fundamental components of dietary intake (Gockowski, *et al.,* 2003). In Tanzania and sub-Saharan African (SSA) populations in general, this attention on vegetables as very important dietary components is significant, as leafy vegetables have long been known to be crucial ingredients in traditional sauces that accompany carbohydrate staples (Smith and Eyzaguirre, 2007). African indigenous as well as traditional leafy vegetables thus have an essential role in the achievement of the World Health Organization's (WHO) global initiative on fruits and vegetables consumption in the sub-continent (Vainio-Mattila, 2000,).

In East Africa and the most of tropical African countries where the daily diet is dominated by starchy staples, the leafy vegetables is added which contribute significantly to household food security and add variety of nutrients to cereal-based staple diets (Van-den-Heever, 1997; Jansen van Rensburg, *et al.,* 2004). The African leafy vegetables (ALVs) are the cheapest and most readily available sources of proteins, vitamins, minerals and essential amino acids (Johns, 2004). These dishes contain these GLV can be prepared with a single plant species like maize or banana or a combination of different species like beans in order to add flavor, taste, color and aesthetic appeal to diet (Marshall, 2001; Fasuyi, 2006; Vainio-Mattila, 2000).

Although it is known African leafy vegetables play an significant role in African agricultural, therapeutic and nutritional systems, still they are regarded as minor crops by African scientists; hence received little attention in most "research and development" programs. The Sub-Sahara area has a diversity of plants and their usage as food; unfortunately, this reservoir is in endangered owing to negligence, inadequate knowledge and population growth which lead to devastation of habitat.

The objective of this study was to investigates the African leafy vegetables commonly consumed in Tanzania specifically Dar es Salaam city. The proximate determination of important mineral content of the leaves was car conducted. Between May and June 2017, a number of knowledgeable persons from different ethinic groups with solid botanical knowledge were interviewed about commonly used green vegetables in their place in order to determine the nutritive as well as medicinal use of the green leaf vegetables in their areas.

METHODOLOGY

Sampling and sample preparation

The samples of 9 species of green leafy vegetables commonly used in Tanzania, were obtained from cultivated farmlands located at Mbezi Luis Dar es Salaam East of Tanzania (Fig 1). Triplicate of each sample (Table 1) had their stalks removed, rinsed with de-ionized water and the residual moisture evaporated at room temperature before sun-drying for 2 -3 days on a clean paper with constant turning over to avert fungal growth.

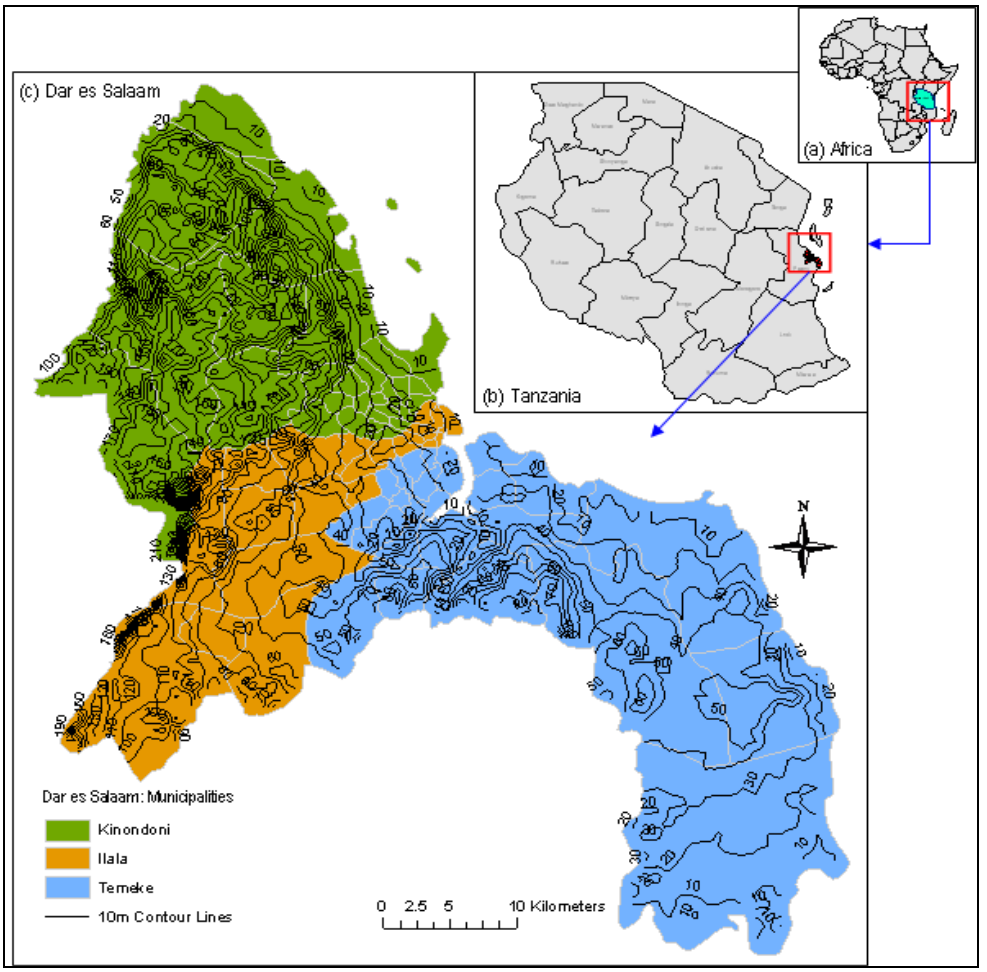

Figure 1: Map of Africa, Tanzania and Dar es Salaam

The sun-dried sample was ground into fine powder using pestle and mortar, and sieved through a 2.0 mm mesh sieve to obtain a dried powdered sample that was used for all the analyses.

Table 1: Samples Collected from Sampling Sites

S/No	Family	Genus and Species	Swahili	Different Vernacular Names
1	Amaranthaceae	*Amaranthus sp*	Mchicha	Kiana (Chagga), Mhahi (Bena) Soswa (Fipa), Iliseke (Wanji) Mzimwa (Nyiha)
2	Brassicaceae	*Brassica L.*	Sukuma Wiki	Figiri (Nyakyusa), Fipa (Mgagala), Nyang'angati (bena), Nyavulesi (Wanji)
3	Compositae	*Bidens pilosa L*	Mashona nguo	Mbeche (Chagga) Manyonyoli (Ngoni) Obukurura (Haya) Madadivilila (Wanji)
4	Compositae	*Lactuca Inermis Forssk*	Mchunga	Nsunga (Luguru), Kware, (Sambaa), Lekule (Maasai)
5	Solanaceae	*Solanum sp*	Mnavu	Mnafu (Chagga), Nyafu (Masai) Foene (Gogo)
6	Tiliaceae	Corchorus *L.*	Mlenda	(Hindawatu (Ngoni), Kuumbi (Fipa), Ilende (Gogo)
7	Euphorbiaceae	*Manihot esculenta Crantz*	Kisamvu	Mhoko (Chagga), Mayau (Ngoni) Katapa (Fipa), Majabhu (Nyakyusa)
8	Cucurbitaceae	*Cucurbita sp*	Maboga	Nanyungu (Ngoni), Msalu (Fipa) Amungu (Wanji), Nyamudza (Bena)
9	Convolvulaceae	*Ipomoea sp*	Matembele	Ibheju Nyakyusa: Mbatata Ngoni: Mafwa (Fipa), Nyamajavo (Wanji)

Mineral analysis

The macro-nutrients: Sodium, Magnesium, Calcium, Potassium and Phosphorus were determined according to the standard procedures l (Shahidi, *et al.*, 1999 and Pearson, 1976). About 2.0 g of each of the processed samples was weighed and subjected to dry ashing in a well-cleaned porcelain crucible at 550^0C in a muffle furnace. The resultant ash was dissolved in 5.0 ml of $HNO_3/HCl/H_2O$ (1:2:3) and heated gently on a hot plate until brown fumes disappeared. To the remaining material in each crucible, 5.0 ml of de-ionized water was added and heated until a colourless solution was obtained. The mineral solution in each crucible was transferred into a 100.0 ml volumetric flask by filtration through Whatman No.42 filter paper and the volume was made to the mark with de-ionized water. This solution was used for elemental analysis by atomic absorption spectrophotometer. Phosphorus content of the digest was

determined colorimetrically according to the method described by Pearson, (1976).

The Phyto-therapeutic potential of green leafy vegetables

In general, phyto-therapeutic potentials studies performed for cognitive and preservative purposes of local knowledge aim at collecting as much information as possible. However, when conducting interviews, it is sometimes useful to select a preferential topic to avoid wasting time, but above all, to investigate and preserve a specific and sometimes mostly endangered type of knowledge.

In the present study, beside the collection of general phyto-therapeutic potentials, the attention was focused on leafy green vegetable medicinal use. The Swahili names of nine (9) different leafy vegetables were given to different ethical group in which each group were represented with at least three members so that they can share common ideas. For each mentioned green leafy vegetable, the informant was asked to provide information regarding the parts of the plant used and whether the plant is still commonly used. Although a pre-structured questionnaire was used for the collection of this information, the candidate was left to speak freely and only at the end of the discussion specific questions were addressed to complete the data. The botanical plant classification was done at the University of Dar es Salaam, herbarium Unit

Quality control and quality assurance

Blanks and quality control standards were measured at every five samples to detect contamination and drift. The elemental concentrations of procedural blanks were generally < 5 % of the mean analyte concentrations for all the metals. Precision and accuracy of analyses were also ensured through replicate analyses of samples against standards reference material for all the heavy metals. The results were found to be within ± 2 % of certified values, thus demonstrating the accuracy of our findings.

FINDINGS AND DISCUSSION

Medicinal values of some commonly used leaf vegetables

Generally, the respondents reported that the indigenous vegetables they consumed had a medicinal value attached to it. Some vegetables were reported to cure more than one illness (Pereira, *et al.*, 1999). A wide range of illnesses was cited as being treated and/or managed by consumption of

leafy vegetables. Results in Table 2 are responses on the medicinal roles of indigenous leafy vegetables.

Table 2: Medical Values of Commonly Used Leafy Vegetables

	Botanical name	**Medicinal Use**
1	*Bidens Pilosa L.*	Used to treat dietary anemia, helping blood flow, prevention of malaria, diabetes, ear treatment, colds and coughs, alleviating toothache, chest pains, improving eye health, cleanse blood, Newcastle in chicken and in treatment of wounds, stomach ache, high blood pressure
2	*Sonchus Luxurians*	Used to treat diabetes, measles, malaria, hernia, stomach pain, blood pressure or body temperature problems, boils and other skin afflictions, chicken pox. Helping with common health complaints of HIV/AIDS patients such as in alleviating stomach pains and sores on the throat, mouth and body.
3	*Solanum villosum*	Increase good eyesight, combat anemia, high blood pressure, diabetes, constipation, peptic ulcers.
4	*Corchonus tritocularies*	Plaster to reduce swellings, treatment of gripe and nausea, high source of potassium, iron, copper, manganese and zinc and are an important high-energy source for both humans and animals.
5	*Brassica carinata L.*	Remedy for arthritis, foot ache, lumbago and rheumatism, treat tumours, anti-scurvy and diuretic.
6	*Manihot esculenta*	styptic, starch mixed with rum can be used for skin problems, treat female infertility, treat sore muscles, also used in treating malaria
7	*Cucurbita sp.*	Used in healing of wounds and internally for the treatment of peptic ulcers, improve the immune system, lower blood pressure, reduce the appearance of varicose veins, maintain healthy of hair, and ease weight loss efforts, can treat malaria, typhoid, stomach ache, constipation
8	*Amaranthus spp*	Stimulate growth and repair of cells, prevent certain chronic diseases, reduce inflammation, boost bone strength, can treat malaria, colds and coughs, AIDs, stomach ache, diarrhea, skin rashes, diabetes, back ache
9	*Ipomea batatis*	Used to increases red blood cells to increase appetite, and are easy to swallow especially for HIV/AIDS patients who may have mouth and throat sores.

The most common illnesses cited were malaria (*Manihot esculenta*, *Cucurbita sp.and Sonchus Luxurians*), diarrhea (*Amaranthus spp* and *Sonchus Luxurians*), anemia (*Solanum villosum* and *Bidens Pilosa L)*, HIV/AIDS (*Ipomea batatis, Amaranthus spp and Sonchus Luxurians)* among others. In addition to determining the medicinal value attached to indigenous vegetables by respondents, the survey also sought other values

attached to these vegetables. The most common values attached were that the vegetables were: satisfying, a delicacy, appetite booster, and able to make one live long. Other values included improved blood flow, able to cleanse blood.

Several scholars (Musinguzi, *et al.,* 2000 and Olembo, *et al.,* 1995), have further shown that countries that retain indigenous vegetable diets and had high consumption of these vegetables are much less likely to be affected by cardiovascular diseases, diabetes and other adverse consequences of the nutrition in transition (Olembo, *et al.,* 1995). These findings concur with those of Musinguzi, *et al.,* (2000), which found out that there was a potential relationship of indigenous vegetables and the ability to treat diabetes, gout, hyperlipidemia, gastro-intestinal tract infections, protozoan parasites, amongst others in Kenya and Tanzania (Olembo, *et al.,* 1995). Olembo, *et al.,* (1995) also states that traditional vegetables have medicinal properties for the management of HIV/AIDS, also indicated some of them can treat stomach-related ailments and other diseases. This is encouraging for intervention geared towards motivating individuals to increase the consumption and utilization of indigenous leafy vegetables.

Most of the traditional vegetables analyzed seem to be used in treating stomach ache or constipation or stomach upset or ingestion. The green vegetable is a calming and soothing herb that has been used to increase bile secretion and encourage bile flow, which helps to speed and ease digestion hence can balance the cholesterol (Ware, 2016).

Mineral content of traditional leafy vegetables

In the context of nutrition and health, the term minerals are chemical elements required as an essential nutrient by human being to perform functions necessary for life. In this study the micronutrient Ca, Mg, K and P content has been determined using extracts of fresh ALVs and the effects of cooking have not been taken into consideration. Cooking has variable effects on micronutrients in ALVs ranging from no effect to reduction due to leaching effect (Uusiku, 2010). The recommended intake obtained from the fresh GLV material is used to obtain the potential beneficial effect as indicated in this paper. Also, it worth to note that it was not possible to specify an average portion size for ALVs, as serving sizes of food even within a country vary considerably depending on season, availability, food traditions in different parts of the country,

people's knowledge, capacity and economy (Smith and Eyzaguirre, 2007).

Calcium content in different traditional green leafy vegetables

Calcium plays an important role in the development and maintenance of bones and, together with phosphate, it provides the main strength within the bones (Uusiku, 2010). Calcium is also needed in the formation of teeth, and has an important role in other body functions; for example, calcium is carried around the body in the bloodstream, where it plays an important role in blood clotting. Calcium is also needed in the body to enable muscles to contract, for the transmission of nerve impulses, and to help the heart function properly.

Calcium level ranges from 496.0 to 1763.5 mg/kg; with *solanum sp* detected with the highest followed by Corchorus L with 1271.1 mg/kg and the lowest detected in *Ipomoea sp* (Fig 2).

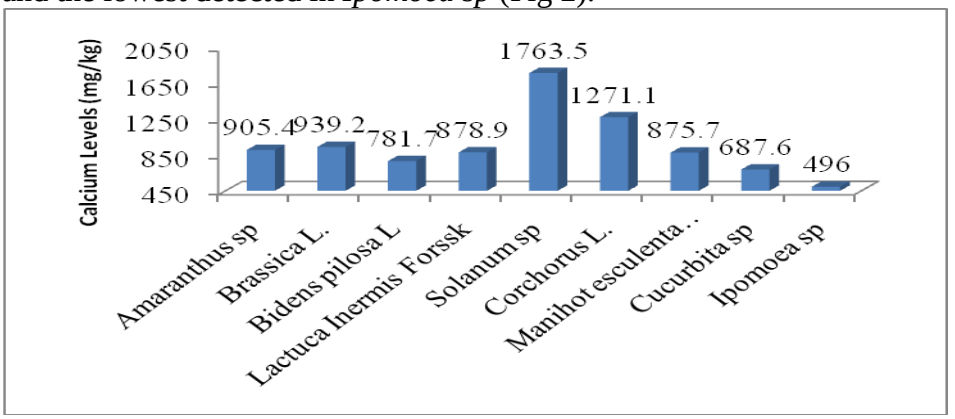

Figure 2: The Level of Calcium in Different Leafy Vegetables

The level detected is twice as much the level determined elsewhere (Akubugwo, *et al.*, 2007), who determine the level of calcium in *Amaranthus hybridus* L. leaves to be 542.0 mg/kg while in the analysis done in *Amaranthus sp* detected to be 905.4 mg/kg. However, the calcium level in the leaves studied was lower than the value reported in some green leafy vegetables consumed in Nigeria (Okon, *et al.*, 2014) detected 2340.4 mg/kg in *Cucurbita maxima* D. Majority of the analysed samples are within the FAO/WHO recommended daily intake for an adult which is 1000 mg (Uusiku, 2010).

Phosphorus content in different traditional green leafy vegetables

The phosphorus content in the analysed samples ranges from 309.8 to 572.3 mg/kg. The value compares favorably with 349.1 mg/kg values determined by Akubugwo, *et al.*, (2007), but lower than 1660 – 6400 mg/kg observed in some green leafy vegetables consumed in Nigeria (Ladan, *et al.*, 1996).

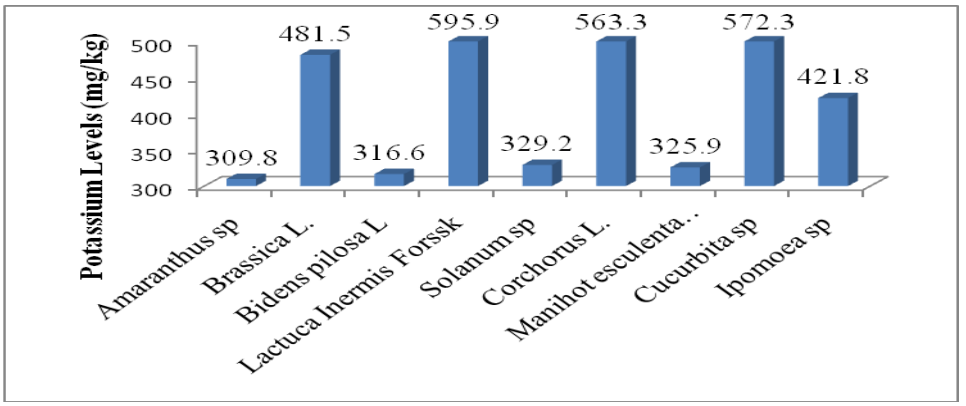

Figure 3: The Level of Phosphorus in Different Leafy Vegetables

The difference identified above could be the same as the one identified by Motherwell and Bullock (1986), which could be due to fertilizer application by the farmers and the amount of phosphorus which was already in the soil before cultivation. It is clear fertilizers such as NPK has phosphorus content which can increase the level of phosphorus in the soil and hence increase the level of phosphorus in plant tissues. However, the level of phosphorus in green leafy vegetables can decrease during cooking, due to leaching of mineral into the cooking medium (Motherwell and Bullock (1986). Care must be taken during preparation and stock used for cooking if phosphorus level is to be maintained.

Magnesium level in different traditional green leafy vegetables

The magnesium content ranges between 300.2 mg/kg and 366.7 mg/kg. *Solanum sp* had the highest magnesium content while the *ipomoea sp* has the lowest. The values are lower than the value determined earlier which ranges between 275.1 to 2886.5 mg/kg (Akubugwo, *et al.*, 2007). However, the levels obtained in this study is low to meet the recommended daily allowance (RDA) of 400 mg/day for men 19-30 years old and 310 mg/day for women 19-39 years old (FAO/WHO (2001).

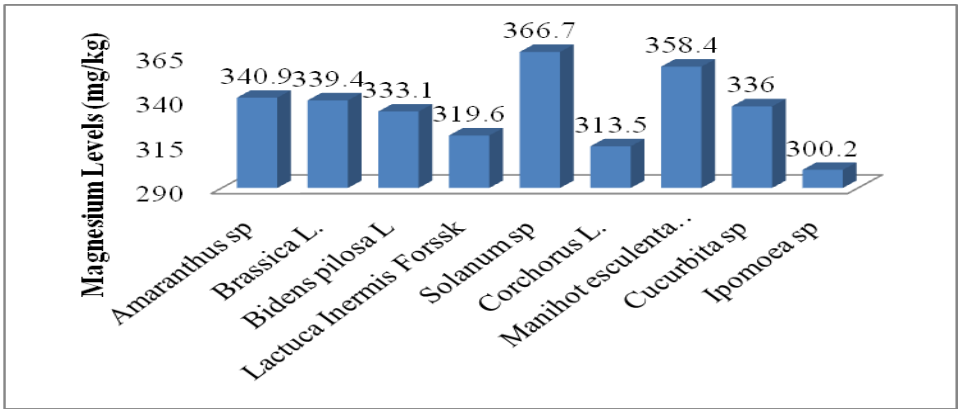

Figure 3: The Level of Magnesium in Different Leafy Vegetables

Magnesium is presumed to be the *"anti-stress"* mineral (Eneji, *et al.*, 2001). Magnesium wards off the formation of blood clots, lowers blood pressure, prevents complications related to diabetes, assists in maintaining bone strength, and reduces the risk of heart disease and limits the effects of free radical damage (Becker, *et al.*, 2005. The higher magnesium content in the leaves could be due to the fact that it is due to the frequency use of chicken and cattle manure in the soil by farmers. Animal manure contains significant amounts of nutrients (nitrogen, phosphorus, potassium, magnesium, copper and zinc) which are easily absorbed by plants (Eneji, *et al.*, 2001).

Magnesium is an essential element in biological systems. Magnesium occurs typically as the Mg^{2+} ion. It is an essential mineral nutrient for life and is present in every cell type in every organism (Lusk, *et al.*, 1968).

Sodium level in different traditional green leafy vegetables

Sodium ions are necessary in small amounts for some types of plants, but sodium as a nutrient is more generally needed in larger amounts by human due to their use of it for generation of nerve impulses and for maintenance of electrolyte balance and fluid balance. Sodium is involved in the regulation of plasma volume, acid-base balance, nerve and muscle contraction (Akpanyung, 2005).

The level of sodium in the analysed samples ranges between 72.4 to 187.3 mg/kg with *ipomoea sp* been the lowest while *brassica L* have the highest (Fig 4).

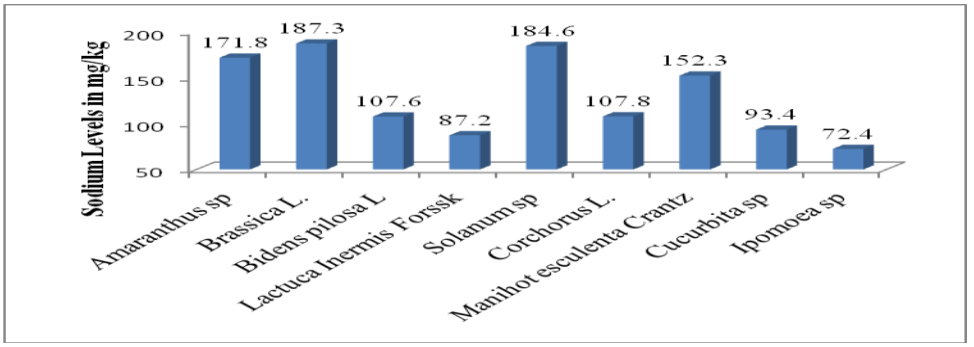

Figure 4: The Level of Sodium in Different Leafy Vegetables

These values compare favorably with the value reported in some green leafy vegetables consumed in Nigeria (Asaolu, *et al.*, 2012).

Potassium Level in Different Traditional Green Leafy Vegetables

The biological importance of potassium levels green vegetables is known to boost heart health by relaxing the blood vessels (Charlton, *et al.*, 2005). Potassium is a vasodilator, which means that it reduces strain and tension in the arteries and blood vessels, lowering blood pressure and reducing the chances of coronary heart disease (Charlton, *et al.*, 2005).

The level of potassium in the analysed samples ranges between 309.8 to 595.3 mg/kg with *amaranthus (mchicha)* been the lowest while *Lactuca Inermis Forssk* have the highest (Fig 5).

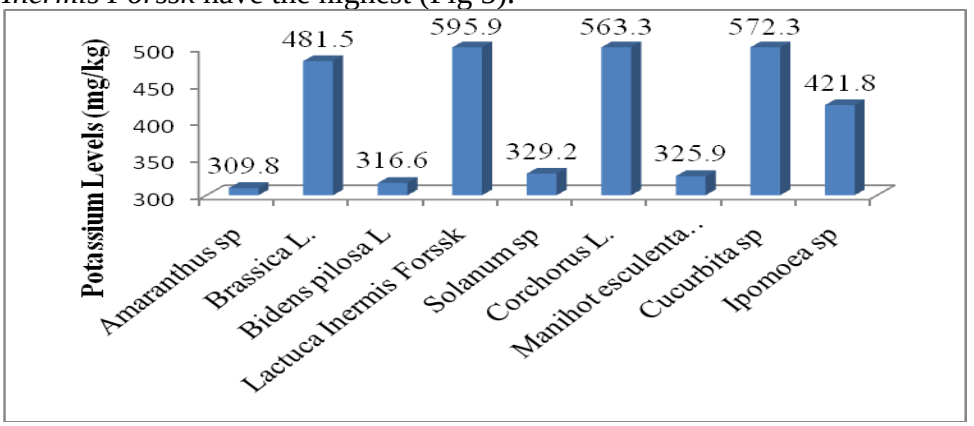

Figure 5: The Level of Potassium in Different Leafy Vegetables

The maximum levels detected by Asaolu, *et al.*, (2012), is three times higher than the values detected in our sample. The level of potassium intake in developed country like United States is recommended 4,700

mg/day (Charlton, *et al.,* 2005), in which the samples contribute half of the recommended.

The Ratio of Sodium to Potassium (Na/K) and Calcium to Phosphorus (Ca/P)

The ratio of sodium to potassium (Na/K) and calcium to phosphorus (Ca/P) are shown in Table 3.

Table 3: The Ratios of Important Minerals

Vegetable	Na	K	Ca	P	Na/K	Ca/P
Amaranthus sp	171.8	309.8	905.4	442.6	0.555	2.046
Brassica L.	187.3	481.5	939.2	484.7	0.389	1.938
Bidens pilosa L	107.6	316.6	781.7	388.5	0.340	2.012
Lactuca Inermis Forssk	87.2	595.9	878.9	396.4	0.146	2.217
Solanum sp	*184.6*	329.2	1763.5	562.2	0.561	3.137
Corchorus L.	*107.8*	563.3	1271.1	655.8	0.191	1.9382
Manihot esculenta C.	*152.3*	325.9	875.7	488.4	0.467	1.793
Cucurbita sp	*93.4*	572.3	687.6	371.5	0.163	1.851
Ipomoea sp	*72.4*	421.8	496	380.7	0.172	1.303

Each data is the mean of three replicates

The calcium/phosphorus ratio is mostly discussed in animal science, when designing diets for herbivorous animals, for example. It has been found (Kemi, *et al.*, 2006) that when a diet that is low in calcium, but high in phosphorus, they develop bone disorders and dental problems (Kemi, *et al.,* 2006 Akubugwo, *et al.*, 2007). According to Mepha, *et al.*, (2007), if the body absorb more phosphorus than calcium in the diet, the body will start to take calcium from its own reserves (the bones) to compensate the defficiency. In this study all samples have higher Ca than P and hence the lowest ratio is 1.3: 1 in and *Ipomoea sp* while the highest is 3.137:1 in *Solanum sp.* Because phosphorus is found in a wide variety of foods, the effect could be not observed, except in diseases that affect absorption, such as diabetes or Crohn's disease.

The Na/K ratio in the body is of great concern for prevention of high blood pressure. Na/K ratio less than one is recommended (FND, 2002). Hence, consumption of all samples analysed would probably reduce high blood pressure diseases because its Na/K is less than one.

CONCLUSION

This study revealed that the leaves of *green leafy vegetable* (GLV) contain considerable amounts of mineral nutrients which are necessary for growth and maintenance of the body. Thus, GLV can contribute significantly to the nutrient requirements of man and should be used as a source of nutrients to supplement other major sources. Indigenous people have basic knowledge of health status of its GLV users as a result of the presence of various compounds vital for good health. They are aware of some of the vegetables contain potent medicine, antihypertensives, malaria and blood building agents and also improves fertility in females when eaten in soups.

Chemical analysis, however, should not be the sole criterion for judging the nutritional value of this plant. It is necessary to consider other aspects such as the biological evaluation of the nutrient content of the plant in order to determine the bioavailability of the nutrients and also the effects of processing on the chemical and nutritive value of the plant.

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Impacts of Climate Change on Food Security and Adaptation Options for Smallholder Farmers in Malawi

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ABSTRACT
This article is based on the study that assessed the impact of climate change on food security and adaptation strategies among smallholder farmers in Salima district, Malawi. The research design deployed literature review and case study survey. A mixed approach of both qualitative and quantitative research methods was used for data collection and analysis. Findings revealed a felt slight increase in temperature. Rainfall seasonality changes (inter annual and intra variation) are suspected to lead to more frequent and intensified droughts and floods that affect four pillars of food security i.e., food availability, access, utilization and stability. Perceived climate change risks are based on smallholder farmers' experience and knowledge of their local farming. Majority of smallholder farmers in the study areas depend on subsistence farming that is rainfed and vulnerable to seasonality changes. Farmers are taking adaptation measures to ensure food security that includes indigenous knowledge based on past experiences and adoption of climate smart modern technologies. Adaptation limiting factors include limited livelihoods-based capitals, knowledge and skills of climate smart agriculture. There is need for reforming agriculture extension services provided by government through formal integration of climate smart agriculture in policy linkages to smallholder farmers.

Keywords: *Climate Change; Food Security; Adaptation; Smallholder Farmers; Community Perceptions; Indigenous Knowledge.*

INTRODUCTION

Climate change and food security are inextricably linked. The Food and Agriculture Organization warns that a global temperature rise this century of 1.5 °C above pre-industrial levels could lead to 122 million additional people to experience extreme poverty by 2030, mainly due

to higher food prices and declining health (FAO, 2018). This means that countries already struggling with food security are likely to find their struggle still harder in the future. The IPCC projects that yield from rain-fed farming in some African countries could be reduced by up to 50 percent by 2020 (IPCC, 2018).

The problem of food security will increase in the future due to climate change with population growth which are contributing the great share of the problem in addition to the pre-existing traditional determinants. Climate change will reduce crop yields and in turn will increase the price of food that force people to change production and consumption patterns and directly will reduce calorie intake. Climate change is undermining current efforts to address food security and malnutrition problems, one of the world's most serious but least addressed socioeconomic and health problem ((UNSSCCN, 2010). The main objective of this study was to assess climate change impacts on food security and adaptation strategies among small holder farmers in Salima district, Malawi.

METHODOLOGY

The research design deployed was literature review and case study survey. A mixed approach of both qualitative and quantitative research methods was used for data collection and analysis. Random sampling techniques were used to select a sample of 183 respondents. Various data collection methods were used to collect data such as survey questionnaire, Key Informants Interviews, Focused Group Discussions as well as analysis of meteorological data for 30-50years.

This study was conducted in Salima district, Chipoka Extension Service Area (EPA), Ndindi Traditional Authority (Figure 1). Salima is a district in the Central Region of Malawi location coordinates 3.6810° S, 34.4198° E. It has a total land area of 2,196 square kilometers, which represents 2.3% of Malawi's total land area. Salima district lies within the Great African Rift Valley system with Lake Malawi on the east side. Salima is bordered by Nkhotakota district to the north, Ntchisi district to the north-west, Dowa to the West, Lilongwe to the South West, Dedza to the south and south and Lake Malawi to the east (GoM, 2006).

Climate is subtropical with the rainy season extending from November to April, and the dry season from May to October. The study area, Ndindi, has a hot tropical climate with mean annual temperature of 22^{o}C. The

highest temperatures are experienced in October reaching as high as 33ºC while the lowest temperatures are experienced between May and July reaching 12ºC. The area has three seasons throughout the year: Hot dry season (August- October), Hot wet season (November- April), and Cool dry season (May- July). Vegetation in the area is composed of savannah woodlands characterized by grasslands with scattered trees. There are no evergreen forests in the area due to dryness of the land during the hot and cool dry seasons.

Figure 1: Map of Malawi Showing Salima District
Source: Salima District Council 2011

The study applied the following formula to determine required sample size with accepted confidence level of 90%:

$$\textbf{Sample Size} = \frac{\frac{z^2 \times p(1-p)}{e^2}}{1+\left(\frac{z^2 \times p(1-p)}{e^2 N}\right)}$$

Source: Adopted from Monkey Survey®, Sample Size Calculator

Note:
(Population Size = N) =8,153 | (Margin of error = e) =0.06 | (z=1.4), with Confidence Level of =90%. Therefore, the acceptable Sample Size for this study is equal to183 respondents.

All the target smallholder farmers were sampled using Simple Random Sampling (SRS) ensuring that the subset of a statistical population (8,153) has a total of 183 individuals chosen around the targeted areas in Ndindi Traditional Authority, Chipoka Extension Planning Area.

FINDINGS

Climate Change Impact on Food Production

Respondents to the research survey were asked to explain any trend of climate or natural phenomena that affected their crops, livestock, and fisheries production during the last 10years. The majority (98%) of 183 survey respondents indicated that they perceived intensity of changes in rainfall patterns with greater impact on crop farming. Crop farming is the most affected by both droughts, pest and diseases and flooding. This finding agrees with a study done in South America by (Seo and Mendelsohn, 2008) who found out that climate change affects the crops that South American farmers choose and that this has resulted to confusion as farmers switch away from maize, wheat, and potatoes towards squash, fruits and vegetables.

Respondents highly rated drought as the key climate change related hazard that was negatively affecting food security among the smallholder farmers. During the two rounds of focused group discussions, the participants explained that dry spells normally occur in January and February after planting of maize and/or other crops. Prolonged drought from March to December negatively affected crop production. Smallholder crop farmers in the study area depended on rainfed agriculture. Dryness and erratic rains during the 2017/18 cropping season were highlighted as an example that frustrated smallholder farmers and resulted to poor maize harvest. This finding is in-line with (IPCC 2018) report that rates drought as significant risk to farming. According to IPCC, risks from droughts and precipitation deficits are projected to be even higher at 2°C compared to 1.5°C of global warming in some regions (medium confidence) especially in several northern hemisphere high-latitude and/or high-elevation regions, eastern Asia and eastern North America (medium confidence).

FGDs further acknowledged that there was crop loss to insects. Participants mentioned the Fall Army Worm attack in 2016/17 season that especially affected maize. It should be noted that climate change is expected to bring with it an increase in agricultural pests, which will lead to significant crop loss (IPCC, 2018).

FGDs participants rated flooding a medium climate change hazard/risk to food security as it was a higher risk to settlement than crops and livestock. FGDs meeting participants mentioned that they were aware of the El Nino weather phenomenon as a major cause of floods in almost every February of the year. The February 2017 floods in Ndindi Traditional Authority and neighbouring Mtauchila Village was the most remembered event where floods intensified from Lifidzi River that burst its banks destroying homes, crops and the road network. During this flood episode, it was mentioned that there was also decipherable damage in maize farms a situation that worsened food shortages during the same year. Salima is said to be experiencing intensified rains in February of every year which result in flooding of low-lying areas of the district.

The impact of climate change events (drought and rainfall changes) on fishery sector was not so obvious but the common fish, Oreochromis specie known as “Chambo’’ in local Chichewa language is said to have declined in catch. According to FGDs and the interview with Salima district environmental officer, the decline in this fish catch can be considerably attributed to several factors such as overfishing. However, a study that carried out statistical relationship between Chambo fish catch and interdependent variables of temperature and rainfall provides evidence that climate change has a significant adverse impact on the total landings of chambo fish in Salima district and generally in Lake Malawi (Makwinja and M’balaka, 2017). In Lake Malawi, evidence suggests that both warming and eutrophication influence fish stocks (Vollmer *et al*. 2005). However, there need for evidence to determine whether decline in fish stock is attributed to rising water temperatures, lower and warmer inflows into the lake or limited overturning (Jamu, 2011; Jul-Larsen *et al*., 2003).

Climate Change Specific Impacts on Food Security Pillars

In 2009, the World Summit on Food Security stated that the "four pillars of food security are availability, access, utilization, and stability" (FAO, 2009). This study analysed how climate change spreads its impacts across

the four pillars of food security among the smallholder farmers in Ndindi TA.

Food Availability

The impact of climate change on food security in the case study area is more felt on food availability component due to declining agricultural productivity. Food availability is means that there must be sufficient quantities of food supplied mainly through domestic production. Changes in rainfall amount and patterns that lead to droughts and floods extreme events has resulted in poor food production. Majority of the respondents (47%) observed and felt that there were changes in rainy seasons as a key indicator of climate change in Ndindi. However, 31% of the respondents perceived changing temperatures. 16% and 5% perceived changes in drought seasons and changes in disease outbreaks respectively.

Older FGDs participants testified that they have observed changes in rain and drought seasons for more than the past 50 years. The older people (in their 60s and above) were probed further on what was the climate like when they were young and what has changed. FGDs participants testified that the rain seasonality has changed, and they termed this as ‘’Kusintha kwa Nyengo’’ a term in Chichewa (native language) that means changes in the weather and overall climate. During FGDs it was explained that there is a shift in when the rainy season starts.

> “In the 1960s, 1970s and 1980s rain would phenomenally start in October but these days it comes towards end of December. Moreover, when this rain comes a bit earlier in late November, it is interspersed with dry spells. Most crops grown by us, like maize dry up during unpredictable dry spells that occur in between rain season’’ (70 years old FGD participant at Kuntupa village).

The study area (Salima district) was one of the 15 districts affected by floods and drought in 2015/2016 agriculture season. A state of emergency was declared by the President of Malawi on 13 January 2015 after heavy floods. One year later state of national disaster was declared on 13 April 2016 following prolonged dry spells during the 2015/16 agriculture season. These two events led to increased maize deficit, and number of people were food-insecure and required humanitarian relief assistance for the whole 2016-17 consumption year (PDNA, 2016).

The implications of climate change for food availability is also due to the vulnerability of Ndindi smallholder farmers, who have been found to significantly have low capacity to adapt. 55% of the survey respondents asserted that their capacity to adapt to climate change depended on the government's extension services a system that is no longer effective. Food availability would require adapted production that is determined by land ownership and use, soil management, crop diversification and management, resilient livestock breeds and proper harvesting and post harvesting handling. Smallholder farmers in Ndindi lack resources to adopt climate smart agriculture technologies. The 39% of survey respondents mentioned that they lacked capital to invest in transforming agriculture that in turn increases vulnerability to food insecurity. The study observed fragmentation of smallholders' land holdings and it is on the rise owing to increasing population density in Ndindi TA. It was observed that smallholder agriculture on fragmented pieces of land is associated with low productivity. This finding is in line with (Rahman and Rahman, 2009) study findings in Bangladesh that revealed that land fragmentation has a significant detrimental effect on productivity and efficiency. In their findings, elasticity estimates of land fragmentation revealed that a 1% increase in land fragmentation reduced rice output by 0.05% and efficiency by 0.03%.

Climate Change Impact on Food Access

Access to food in this study refers to physical and economic access to food that is determined largely by purchasing power and income of the population (FAO, 2013). Majority of survey respondents who comprised 30% stated that they were not earning and that if they got money, it ranged from 0-10,000 Malawi Kwacha per quarter. This is followed by 27% and 12% who earned between 11,000 Mk-19,000 Mk and 20,000-29,000Mk respectively. Even this category was still earning less than $50 per a quarter. Most of the respondents who earned between 0-10,000MK were in fact earning a maximum of $15 according to 2018 average exchange rate. Only 19% of all survey respondents earned above $50 per quarter and majority of these were said to be in formal employment and fishing sectors. Crop farmers had the lowest quarterly incomes. Moreover, smallholder farmers in study area vastly depend on nature-based agriculture for both livelihoods and incomes. In such circumstances where there is low agriculture productivity, farmers will have less incomes to purchase food in enough quantities and quality. Other factors that affect access to food in Ndindi include high food prices during

famine, access to markets, the level of poverty, unemployment condition and dependence ratio, educational status and land/property rights as assessed in the previous sections on socio-economic findings. There is also high food price inflation. Cost of food in Malawi increased 10.40 percent in October of 2018 over the same month in the previous year. Food Inflation in Malawi averaged 21.20 percent from 1990 until 2018, reaching an all-time high of 113 percent in July of 1995 and a record low of 2 percent in September of 2003 (NSO 2018).

Impact on Food Utilization

Climate change affects food utilization capacity through challenges to production rate and pattern of different food items and this affects Ndindi smallholder farmers' nutritional requirements. Food utilization depends on how food is used, whether food has sufficient nutrients and whether diet can be maintained. In case of Ndindi, smallholder rain-fed maize production is main crop and the livestock sub-sector is underdeveloped. Fishing activity would complement nutrition but most of the fish caught is not consumed by households as it is sold (Study key informant interviews).

Climate change is affecting the income and capacity of the smallholder farmers to purchase a diversity of food items to get a balanced diet. Cost of food in Malawi increased 10.20 percent in September of 2018 over the same month in the previous year. Food Inflation in Malawi averaged 21.23 percent from 1990 until 2018, reaching an all-time high of 113 percent in July of 1995 and a record low of 2 percent in September of 2003 (NSO, 2018). For this, climate change (extreme weather events) is one of the root causes of the recent high and volatile food prices in Malawi (GoM, 2016). Due to this high food price, smallholder farmers in Ndindi spontaneously reduce both quality and/or quantity of food they eat, consume less preferred food and allocate nutritious food only to infant household members.

Impact on Food Stability

Food stability which refers to the ability to obtain food over time. Accordingly, food insecurity can be transitory, seasonal, or chronic (FAO, 2006). In transitory food insecurity situation of the study area, food is more available during maize harvest that starts in April-July. Food may also be unavailable especially in later and early months of the year (October – march). Below-normal rainfall in Ndindi more often results in

below-average production that causes localized food deficits as well as reductions in income from major cash crops. At the time of analyzing findings of this study, food security projection indicated a likelihood of localized acute food insecurity in study area, especially during the lean period starting from October 2018 to March 2019 (FEWS NET 2018).

At the food production level, climate change related disasters such as floods and droughts that regularly occur in the study area result in crop failure and decreased food availability. This often causes instability in markets resulting in food-price spikes which can cause transitory food insecurity. Seasonal food insecurity is not key since Ndindi does not experience regular pattern of growing season in food production. According to the FGDs, there has not been one farming season that has ever been the same as the other. This may be because of season-to-season differences in weather patterns, particularly rainfall among other factors especially with dry land farming. For example, the 2015-2016 agriculture season was characterized by national declaration of floods and drought disasters; nevertheless, this was followed by 2016-2017 (PDNA 2016) season that had copious rains that matched good agriculture season in Ndindi and Malawi at large. However, rainfall season in Ndindi is said to always characterized by a short planting window which farmers are aware of and somehow better in their season preparedness to suit the short planting window which has decreased climate change pushed chronic (or permanent) food insecurity. Climate change is likely to cause both chronic and transitory food insecurity, since repeated climate disasters can lead to the reoccurrence of transitory food security which makes households more vulnerable to chronic food insecurity.

Farmers' Adaptation Options

The study assed knowledge, attitude and perceptions of smallholder farmers in their natural environment towards adapting to climate change impacts on their food security. Focus was on an individual farmer's response to climate change that seeks to reduce the vulnerability of socio-economic and natural resource systems. This was intended to assess capacity and potential for the target communities to adapt to climate change felt impacts.

According to Adger *et al*. (2005), adaptation to the impacts of climate change should increasingly be observed in both physical and ecological systems as well as in human adjustments to resource.

Learning by smallholder farmers

Respondents were asked about how they learn about climate change adaptation. Figure 2 shows that radio, newspapers and mobile phones were preferred (78%) as the best mediums for learning about climate change.

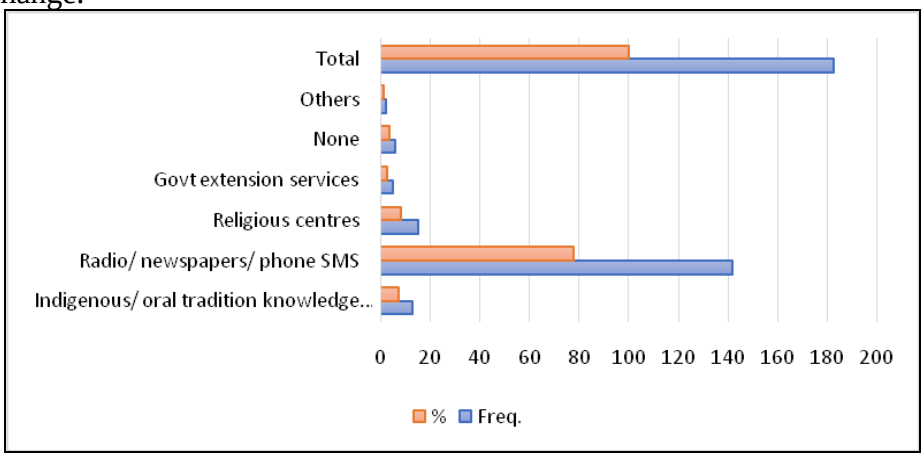

Figure 2: Source of Information about Climate Change

Source: Study field survey2018

The FGDs participants confirmed that Radio is the utmost source of information they have ever heard something concerning climate change and other development messages. While only 8% and 7% of the survey respondents have heard of climate change through religious places of worship and oral traditions/indigenous knowledge respectively. There was 3% of survey respondents that admitted having not got climate information while 4% claims that they have got information from other sources such as political rallies and personal observation. This means that the FM radios and newspaper channels of information can be more important for grassroots communities to get the information on climate change.

During KIIs with the district environmental officer asserted that;

> "the evolution of FM radio is a very important medium in creating climate change awareness. There are various radios broadcasting in Salima and with reach to Ndindi TA. Common radios include Zodiak Broadcasting Station, Chisomo FM and Love FM among others''.

These radios offer their services as both geographical and community interests since they were broadcasting beyond commercial and public services. This finding is in conformity with the view espoused by (Nwagbara *et al*. 2017) that the Radio is a very important medium in creating awareness and response to climate change among smallholder farmers in Edo, Nigeria.

FGDs participants at Kalonga II village also underscored the emerging use of telephone where early warning and market information is to some extent is shared. That there was use of social media tools especially WhatsApp to share information though most conversation over WhatsApp and Facebook was not revolving on climate issues. Although social media may play a vital part in the climate information sharing, some FGDs did not like it as they claimed that rumours and fake news are being spread through this channel of communication. Although Social media groups can be used to spread false and incorrect information about agricultural practices. This finding is in line with Thakur *et al*. (2018) study that was carried out in Northern India, Pradesh. The findings underscore WhatsApp social media platform as one of the emerging online destinations for rural mobile internet users with a sharp growth and a strong case to use social media platforms for dissemination and sharing of agricultural information among the farming community.

Majority of the respondents (57%) mentioned that the public Agricultural Extension services is one of the major sources of climate services to smallholder farmers. 19% mentioned they accessed demonstration farms that promoted by lead-farmer model.13% were getting market-based services such as climate smart agriculture technologies (for example drought tolerant seed varieties). While 7% claimed to access climate early warning and season prediction outreach services 3% said they had not accessed any of the above-mentioned climate services.

Majority (78%) of respondents mentioned that they would seek help and advice from government system especially the agriculture extension service. 10% would seek help from fellow farmers through their cooperative groups or cooperatives. While 10%, 3% and 2% would seek help from family, talk to village mates/neighbours and seek help from charities/NGOs. This means the local communities have hopes in the government to give adaptation solutions. This finding agrees with

Sustainable Livelihood and Transformational Adaptation framework which asserts that structures and processes which are largely government-based play important role (Scoones, 2015) in smallholder farmers' adaptation.

Most of the respondents (36%) asserted that they were still depending on indigenous knowledge and varieties of crops to survive the harsh environmental changes. Even the 24% who said that they change cropping calendar/cropping pattern, attributed this to their traditional coping strategies. Only 22% mentioned that they adopted improved crop and animal species to adapt and ensure food security. This finding agrees with Twinomugisha (2009) study among farmers in Uganda which revealed that indigenous knowledge is an integral part of smallholder farmers' lives and local coping strategies. Similarly, adaptation strategies among the studied Ugandan farmers were based on existing knowledge on how to cope, an understanding of seasonality and experience. From African Sahel region, Nyong *et al*. (2007) study reveals that the local populations in this region, through their indigenous knowledge systems, have developed and implemented extensive adaptation strategies.

Nevertheless, the indigenous knowledge is rarely taken into consideration in the design and implementation of modern and adaptation strategies by governments. Only 8% of survey respondents mentioned that as an adaptation measure, they have practiced irrigation on small scale during winter cropping (Plate 1). Mushy and Mbonile (2017) however revealed that, traditional irrigation system was the major farm-level adaptation strategy to climate change among smallholder farmers in Moshi Rural District, Tanzania. This was basically done on newly introduced crop varieties and horticultural crops which mature early and have high market demand.

Plate 1: Small scale Irrigation activity in Ndindi, Chipoka Extension Planning area

Source: Study field study 2018

Since drought is the most climate change challenge for smallholder farmers' food production in the study area, irrigation would be robust climate smart agricultural (CSA) technology to be deployed. There is need for government and other development agencies to support smallholder farmers with necessary irrigation infrastructure. According to (Turral *et al*., 2011), adaptation measures need to build upon improved land and water management practices to boost resilience to climate change. Rural farmers' adaptation responses will need the water variable in agriculture irrigation and the competing demands from other users. Freshwater availability is relevant to almost all socioeconomic and environmental impacts of climate and demographic change and their implications for sustainability (Elliott *et al*., 2014).

Survey participants were asked to describe their current system of farming in average normal production period. Figure 3 summarises the responses on the farming systems.

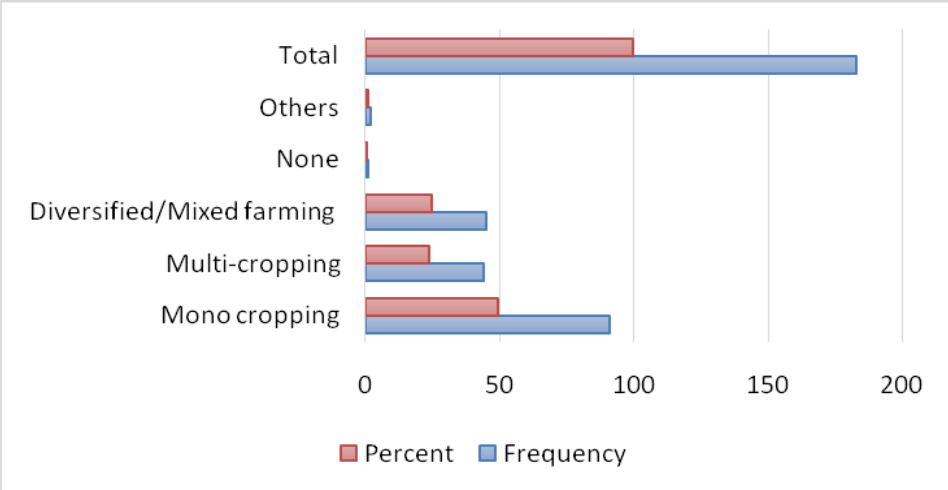

Figure 3: Farming Systems
Source: Field Study, 2018

The practice of growing the same crop on the same plot of land, year after year depletes the soil of nutrients (making the soil less productive over time). The biggest number (50%) of the survey respondents were still practicing mono-cropping. Only 25% and 24% of the survey participants practiced mixed farming and multi-cropping systems respectively. This indicates that majority of smallholder farmers are still stuck with mono-cropping. This finding agrees with FAO (2018) assessment which revealed that in Malawi, Zambia and Mozambique, maize monocropping is dominant though farmers currently adopt one of seven different cropping systems, based on a combination of four categories of crops: dominate staple (maize), alternative staples, legumes and cash crops.

For farming system adaptation, diversified cropping systems are needed among small holder farmers to contribute to climate smart agricultural pillars. Through crop diversification, farming households can spread production and income risk over a wider range of crops, thus reducing livelihood vulnerability to weather or market shocks. Crop diversification has potential to produce other pay backs such as in terms of pest management and soil quality. Moreover, diversified systems reduce crop income variability compared with monocropping maize. The greatest potential opportunity for increasing agricultural productivity exists through mixed farming in the sub-humid and wetter parts of the semi-arid

zone of Sub-Saharan Africa (Powell and Williams, 1995; Bradshaw *et al.*, 2004).

Indigenous Adaptation

Smallholder farmers in the study area, like other countries in Africa, have their own indigenous coping ways and adaptation practices of producing, preserving and storing food for future use especially in times of food shortage. FGDs participants at both Karonga II and Kuntupa villages agreed with (36%) survey respondents who asserted that they were still depending on indigenous knowledge to enhance food security amidst climate change challenge. Moreover, 24% said that they change cropping calendar/cropping pattern, attributed this to their traditional coping strategies. Only 22% mentioned that they adopted improved crop and animal species to adapt and ensure food security. FGDs confirmed that farmers have always adapted to seasonal and climatic changes through their local coping strategies that have already existed for ages and there were traditional measures of ensuring that the households did not suffer from food shortage during any part of the year.

This study probed further on the live examples of traditional knowledge and coping strategies that were maintained to improve local adaptive capacity. Table 1 highlights some of the findings on traditional knowledge of adaptation strategies for smallholder farmers' food production. This body of indigenous knowledge and initiatives ensured that food is properly and adequately produced and stored to avoid wastage and preserved for future use. This was used as a buffer for disaster-preparedness, allowing food availability, stability and accessibility by the household anytime it is needed.

Table 1: Smallholders' Indigenous Adaptation Strategies for Food Security

Food/Process-Local Language (Chichewa)	**Food Security Indigenous Adaptation Strategy**
Food Production	
Local language	*Indigenous Adaptation Strategies*
Dzinja	*Timing of growing or planting seasons*: This is application of local knowledge of season conditions especially rainfall in the part of the year during which it is suitable for plant growth. Proper timing of seasons helps smallholder farmers to determine when to sow or plant. Farmers can also use seasonal timing knowledge know a plant or crop that can be more productive in a specific growing season.
Chizimaluphya,	This is a sign to the start of the rainy season. short, sharp rains locally occur shortly before the rains start - to signal the start of the rainy season.
UlimiwamtayaKhasu	*Conservation Agriculture*: This practice traditionally includes various soil management practices that minimize the disruption of the soil's structure, composition and natural biodiversity. Traditionally this practice includes soil cover using a previous crop residue for example maize stocks. This also includes application of mulching locally known as "*kuphimbira*", pruning "*Kuthenela* and composite manure ' *'Manyowa"* among others. According to FGDs, covering soil naturally replenishes soil fertility and increases crop productivity as it enhances organic matter, improved water retention, reduced soil erosion and reduced weed infestation among others
Dimba	*Farming in Wet and Fertile land*: Dimba refers farming in all seasonally wet land areas which are important due to their multipurpose use for water supply, grazing and cultivation. Animals continue to graze in *Dimba* land during the dry season when grass is in short supply in other dry areas. *Dimba* gardens are areas of year-round cultivation including during the winter/dry season since there is irrigation due to location near rivers and swamps. Some of these *Dimba* gardens are often irrigated (kuthilira mbeu) supported by shallow wells dug into the river beds. However due to the increasing population in the study area, these Dimba areas are now in shortage. Most of the FGDs participants mentioned that they did not have capacity to own a *Dimba* garden since this is a highly priced piece of land reserved for the well to do families and those who customarily owned land in such places.

Source: Field study FGDs 2018

FGDs also mentioned that smallholder farmers still practiced indigenous knowledge in livestock production management in face the disasters. It was mentioned that there were traditional methods of treating animals effectively using some herbs to treat many diseases. This can be called ethnoveterinary medicine (EVM) which considers traditional practices of veterinary medicine. For example, herbs like aloe Vera were used on many livestock species like chicken, cattle, pigs and goats. It was argued that livestock farmers have knowledge on many aspects of animal health including administering right herbal dosage. FGDs participants also revealed that they knew indigenous ways of preparing and preserving animal feeds when droughts ravage pastures. Most farmers preserve maize stalk after harvesting as supplementary feed for the dry season when grass will be dry and insufficient. There was also expressed knowledge of caring for animals to mitigate the impact of flooding. For example, during flooding animals such goats and chicken are sheltered in off ground/ raised pens (Plate 2). It was mentioned that smallholder farmers ensure that the kraal for goats is properly off the ground and roofed since goats are easily affected by rain and die if they are continuously exposed to damp conditions.

Plate 2: Indigenous Goats' local flood shelter in Chimoga village
Source: Field Survey 2018:

However, it was mentioned that ethno-veterinary knowledge was declining since they were adopting hybrid animals that are not easily treated by ethnoveterinary herbalists who have more knowledge on how to deal with the traditional local breeds. This finding agrees with Jacob *et al*. (2004) study among the Masai pastoralists of Kenya that face a decline in their superior livestock diagnostic skills. The study among Masai reveals that with the advent of modern veterinary medicine, the Maasai ethnoveterinary practice appears to be on the decline. Likewise, in Kenya, the study revealed a testimony that government's veterinary services discourage development and utilisation of ethno-veterinary medicines and promote use of modern veterinary medicines. However, the KIIs with district environmental office alluded to the fact that traditional veterinary practices persist because that is what farmers can easily afford. Climate change is likely to increase livestock diseases which call for improvement in ethno-veterinary services to be relevant.

Other Short and Long-term Adaptation Options

Survey respondents were further asked to identify a shortlist of survival strategies adopted in their farming system to respond to climate change in short and long-term scenarios. Most respondents (52%) claimed to have adopted drought tolerant crops.

During FGDs it was mentioned that various seed companies are producing and supplying smallholder farms with drought-tolerant, disease-resistant and yield-improved legume and maize seeds. The outstanding performance of the drought tolerant varieties is raising hopes amongst smallholder farmers. To ensure that smallholder farmers produce enough food, there need to promote drought tolerant crop varieties. However, 18% of respondents were still relying on indigenous crops and livestock management strategies. They believed that indigenous coping strategies were more available, accessible and affordable. Smallholder farmers used traditional technologies to help increase agricultural productivity. These technologies are mainly built on an understanding of how soils are renewed and how to increase soil fertility whilst avoiding erosion. They include information on contour cropping, how to construct and use fencing and how best to manage mixed farming or agro-forestry to full effect. Traditional technologies also help control and manage pests. Much of this knowledge has tremendous value in the context of crop production and the threat of climate change. Local knowledge helps interpret changes in the weather and seasons, which are key ingredients of

successful adaptation. And maintaining the distinction between crops grown for food and for sale is also an important component of traditional knowledge on adaptation. 12% of the respondents said they were planting trees as a measure to conserve and moderate microclimate conditions. Trees and forests can provide part of the solution to limiting climate change, and to helping people to adapt to the changes. Trees are helping to adapt as they provide shade, alleviate flooding, and reduce on depletion of existing forests through providing more fuel wood. However, planting trees and new forests can largely be part of mitigating climate change. How to adapt and build resilience to the impacts of climate change on the other hand, should be activities that identify and address the impacts. Only about 9% of the respondents said to have adopted climate smart agriculture (CSA). They used modern farming methods (applied fertilizers, were irrigating, adopted modern pest management methods, used modern/improved seeds etc).

Main Barriers to Adaptation

Respondents were asked to mention the major challenges that they faced in their endeavour to adapt to climate change. Survey respondents were asked: What are the main barriers to you in employing climate change survival strategies as small-scale farmer? The majority 42% of survey respondents mentioned that unpredictable rain seasons, changes in pests and diseases remain a major barrier to sustainable adaptation (Table 2). The second most pronounced barrier mentioned by 39% was lack of capital to invest in modern technologies. 7%, 5% and 4% mentioned lack of extension service support, weak farmers' institution/cooperatives and lack of early warning information respectively.

Table 2: Barriers to Smallholders' Adaptation strategies

Main Barriers	Frequency	Percent
Lack of capital to invest in modern technologies	72	39.3
Lack of extension service support	12	6.6
Lack of early warning information on weather and diseases	8	4.4
Weak farmer institution or cooperative	9	4.9
poor post harvesting handling/ lack of storage facilities	4	2.2
poor markets for input technologies and farm produce	1	.5
unpredictable seasonal changes/ pest and diseases	77	42.1
Total	183	100.0

Source: Field Survey2018

The Sustainable Livelihoods Framework (SLF) places considerable importance to livelihood assets referred to as capitals that determine how people respond to the impacts of climate change. 39% of survey respondents mentioned lack of capital to invest in transformative and climate smart agriculture. During FGDs, lack of financial capital was talked about as the key challenge. One of the participants mentioned that; ''*with availability of money all other adaptation requirements can be secured*''. It was also mentioned that the banks loans were not accessible to smallholder farmers due to lack of collateral for loan. Moreover, the banks' interest rates were also said to be so high and not friendly to small holders' farming business. Even worse, there was lack of Microfinance Institutions (MFIs) operating in the study area. MFIs provide access to financial credit for smallholder farmers as commercial banks hardly invest in small scale agriculture (Levy 2005). The nature and combination of the lack of livelihood assets, to which smallholder farmers and communities have access, determines adaptation choices.

Despite many respondents having said that they had accessed extension services, FGDs and the state of agricultural extension services report got from Civil Society Agriculture Network CISANET indicated that there were gaps. The agriculture extension services are under Ministry of Agriculture, Irrigation and Water Development which receives meagre share of national budget allocation. The FGDs participants mentioned that services have declined compared with the agricultural sector in the 1970s and 80s where the sector used to enjoy adequate financing. Accordingly, in the 1980s extension policy emphasised the need to maintain an extension worker/farmer ratio ranging from 1:750 to 1:850 which was recommended for effective and efficient extension service delivery. During that time extension workers were following the block extension system (a modified training and visit system) which had a well specified visitation schedules with regular in-service training programmes. With this, farmers, field extension staff as well as their supervisors including research staff interacted very frequently. Funding for the sector declined leading to dwindling of extension staff/farmer ratios ranging from 1:1500 to 1:3900.

Conclusion and Recommendations

This article analysed how climate change spreads its impacts across the four pillars of food security and how smallholder farmers adapt in Salima, Malawi. The study findings indicate that, food security is affected by

climate change across the four pillars of food accessibility, availability, accessibility, utilisation and affordability. Changes in rainfall amount and patterns that lead to droughts and floods extreme events has resulted in poor food production. Continuous rainfall variability and drought are likely to intensify food insecurity. The majority (39%) of survey respondents mentioned lack of capital to invest in transforming agriculture as a key barrier to response to climate disasters that in turn increases vulnerability to food insecurity. Lack of diversification of livelihoods, high levels of unemployment and poverty may continue to be a barrier to many households 'efforts to achieve their food needs. There is need for government and other development stakeholders to promote diversification of smallholder farmers' livelihood strategies through multiple income sources, both on and off-farm, with a solid asset base source since this is extremely critical factor as it enables households to spread risk against climate shocks/tresses. This will possible through promotion of importance of learning from proven practices by successful farmers.

In terms of adaptation strategies, it was found out that many of the smallholder farmers in Salima still depended on indigenous knowledge. Analysis of adaptation strategies indicates that the four (4) pillars of food security would be to some extent warranted amidst climate change if there was deliberate effort to preserve and improve local/indigenous adaptation practices in the short-term. However, indigenous knowledge systems have been eroded over the past years due to changes in social structures and adoption of new farming technologies and changes in lifestyles. It should be noted that indigenous knowledge as heritage is many pieces that form adaptation masterpiece to comprise smallholder farmers' journey of adaptation to climate change. Indigenous knowledge remains and integral part of Malawi's smallholder farmers' lives and local coping strategies that provide affordable solutions and the foundation for them (smallholder farmers) to apply their own ideas on how to survive during harsh times.

However, given the increasing intensity and occurrences of climate change impacts, indigenous knowledge will not be enough to address smallholder farmers' adaptation needs. There are expected new and unique climate change risks and conditions which are outside the range of those previously experienced. The indigenous adaptations which were being practiced will be rendered insufficient in face of new vulnerabilities. Despite some few farmers adopting improved

technologies, there is a great need to invest in technologies that will resist and manage climate risks to food security and address the vulnerabilities and weaknesses in food systems. The study found out that agricultural extension service plays a critical role to initiate transformative climate change responses within smallholder farming system and that the Government of Malawi has put in place policies for example National Climate Change Management Policy 2016 and National Agriculture Policy 2016, however, due to lack of funds, these policies are not fully implemented to address smallholder farmers' climate change extension services concerns and needs.

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Utilization of Extended Postpartum Family Planning among Post-Delivery Women in Mvomero District, Morogoro-Tanzania

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ABSTRACT
This study aimed at examining factors associated with the use of Extended Postpartum Family Planning (EPPFP) methods among post delivery women in Mvomero District, Morogoro, Tanzania. Based on cross-sectional design, the data collection activity was conducted on March 2020 to 256 post delivery women who delivered a child between January 1, 2019 and January 31, 2020. Purposive and convenience sampling were used to get respondents of the study. Data were collected using questionnaire. Through SPSS tool, descriptive analyses comprising of Pearson's chi squire test was employed to establish association between independent and dependent variables. The prevalence of extended postpartum family planning utilization was 46%, the utilization of EPPFP was significantly associated with awareness of the reason for EPPFP use (P-value=0.013), awareness of EPPFP method (P-value=0.014), awareness of EPPFP side effects (P-value= 0.024), counselling sessions (P-value=0.000), menses resumption (P-value=0.010), duration of sexual activity (P-value=0.011) and history of previous pregnancy (P-value=0.000). Prevalence of EPPFP utilization among post delivery women is still low in Mvomero district. Enhancement of the utilization of EPPFP during the postpartum period needs effective response by stakeholders through provision of family planning education particularly during all maternal and child health contacts.

Keywords: *Extended Post-Partum Family Planning, Post-delivery mothers, Tanzania*

INTRODUCTION

Although a number of efforts have been made by the government of

health facility deliveries from 47% in 2005 to 63% in 2015; and increasing the number of health facility deliveries attended by skilled health workers from 46% in 2005 to 64% in 2015 (UNICEF, 2018), yet the prevalence rate of family planning methods is still 32% (MoHCDGEC, 2017) and EPPFP in Tanzania is 40%(TDHS-MIS, 2016).Studies reveal high unmet need of EPPFP among women in Tanzania evidenced by the findings that the total unmet need from 0-5 months postpartum is 81% and 61% from 6-11 postpartum months (Winfrey & Ross, 2001; USAID, 2014; USAID, 2017).

In Morogoro specifically, in spite of the knowledge of FP being widespread at 100%, only 45.7% of women use PPFP methods with unmet need of 16% (TDHS-MIS, 2016). It is known that, provision of EPPFP help to address women's unmet need for EPPFP in the first year after delivery, and in so doing become the best intervention in reducing maternal and infant mortality (Vernon, 2009). Since the number of deliveries attended by skilled health facilities has increased from 819 in 2009 to 4,435 deliveries in 2016 in Morogoro; it is expected that, health care workers would use that opportunity to offer information and knowledge about the use of EPPFP to the post delivery mothers during ANC and PNC period, but that is not mostly done in the facility (Thamini Uhai, 2016).

The DHIS -2, (2019) shows that in Mvomero district, the majority of the pregnant women visit prenatal services and finally deliver in health facilities. The total number of women delivered at health facilities for three consecutive years from 2015 to 2018 were 30,327 while the number of women who used EPPFP from 2015 to 2018 were 1221which is equal to 4% (DHS-2, 2019). In 2015, a total of 7638 (56%) women delivered at health facility, whereby among them 308 (4.8%) used EPPFP. In 2016, a total of 7010 (50.5%) women delivered at health facility, while only 127 (1.8%) among them used EPPFP. In 2017, a total of 7329 (51.5%) women delivered at health facility, and 344 (4.6%) among them used EPPFP. Furthermore, records show that in 2018, a total of 8350 (57.3%) women delivered at health facility and 442 (5.2%) among them used EPPFP (DHS-2, 2019). The facts presented reveal a very low use of EPPFP when compared to the health facility deliveries in Mvomero district. The low EPPFP uptake necessitated a study on factors associated with utilization of EPPFP among postpartum women in Mvomero District.

METHODOLOGY

Study Design and Setting

The study adopted a facility-based cross-sectional survey design to obtain information from 256 post delivery mothers who were within 12 months' post-partum period. This study was conducted in Mvomero district, Morogoro region, Tanzania. Data were collected from four health facilities, two were public owned health facilities and two were private owned health facilities.

Study Population and Sampling Procedure

The study population were all reproductive women aged 15 to 45 years who delivered a baby between January 2019 and January 31, 2020 in Mvomero district. The sampling frame of this study was 737 post delivery women; the sample size was 256 post delivery women whom were determined using the previously published sample size table by Israel (2003). Purposive sampling method was used to select Morogoro region, Mvomero district, the four selected health facilities and the health facility workers while post delivery women were selected using convenience sampling technique.

Data Collection, Processing and Analysis

A structured questionnaire was developed to gather information from respondents. The questionnaire was developed in English and translated into Swahili to aid understanding of respondents and it was pre-tested to ten respondents in order to improve it. The filled questionnaires were reviewed daily throughout the data collection activity, and the collected data were entered into Microsoft excel daily in order to facilitate the process and have confidence on the data, then data were cleaned on the Microsoft spread sheet and transferred to the Statistical Package for Social Science (SPSS) version 20 ready for data analysis. Descriptive statistics which led to creation of frequencies and tables to describe findings. The descriptive statistics was applied to analyze frequency and cross tabulation to explore the association between independent variables and dependent variable. The Pearson chi-square test was used to test association between dependent variable (EPPFP use) and independent variables (socio-demographic factors, knowledge and information factors, fertility and reproductive factors and method related factors).

FINDINGS

Social Demographic Characteristics

The study examined 256 post delivery mothers with a response rate of 100%. Almost three quarter of the respondents, 110 (43%) and 111 (43.4%) were between 15-24 and 25-34 years of age respectively. The mean age of study participants was 26.9 (SD ± 6.017) and the minimum and maximum age was 18 and 43 respectively. A total of 198(77.3%) respondents were married, both mothers and their husbands 177 (69.8%) and 178(72%) respectively had primary level of education, nearly half of mothers 114(44.5%) were doing small businesses and majority of them 136(53.1%) were Christians. (Table 1)

Knowledge and Information of Post Delivery Mothers

Almost all mothers 249(97.3%) were aware that EPPFP is used to space pregnancy and prevent unwanted pregnancy, majority of respondents 246(96.4%) were aware of the EPPFP method(s). More than half, 162(63.3%) were not aware of the side effects of the EPPFP. Majority of mothers, 160 (67.7%) attended counselling sessions about family planning and almost all mothers, 153 (94.4%) understood the sessions. Nearly half of them, 71(43.8%) attended the counselling session on RCH. More than half, 138(53.9%) of mothers were not current users of EPPFP methods and nearly half of them, 51(43.2%) started using EPPFP on the second month post delivery (Table 1).

Fertility and Reproductive Factors of Post Delivery Mothers

The average post partum duration (in months) of study participants was 4.54 (SD ± 3.395). Majority of mothers, 174 (71%) had delivered within six months before the study was conducted. 196 (76.6%) of mothers reported that their recent pregnancy was planned and 243 (93.9%) preferred to have birth spacing. The average number of children mothers wished to have in their entire life was 4 (SD ± 1.597), the minimum was 1 child and maximum was 10 children while the average number of children mothers were currently having was 2 (SD ± 1.324), the minimum was 1child and maximum was 6 children. A total of 161 (62.9%) respondents wished to have less than six children in their entire life and 201 (78.5%) respondents had currently less than 4 children. Majority of respondents, 213(83.2%) reported that their menses had resumed after their recent birth and almost three quarter reported to have resumed menses within 3 months, the average months were 1.6 (SD ± 1.262) and maximum was 9 months. Majority of women resumed sexual activity

within 3 months after recent birth, the average months were 2.3 (SD ± 1.835) and the maximum month was 8. A total of 200 (78.1%) respondents reported to have attended PNC services and more than half, 173 (62.6%) respondents used family planning prior to the recent birth. (Table 1).

Table 1: Social-Demographic, Knowledge and Reproductive Characteristics of Post-Delivery Mothers in Mvomero District, (N=256)

Variable	Frequency	Percent
Social demographic characteristics		
Age		
15-24	110	43.0
25-34	111	43.4
35-44	35	13.7
Marital status		
Married	198	77.3
Not married	58	22.7
Education level of a maternal mother		
No formal education		
Primary	2	.8
Secondary	177	69.1
Tertiary	61	23.8
	16	6.3
Spouse's Education level		
No formal education	2	.8
Primary	178	72.4
Secondary	50	20.3
Tertiary	16	6.5
Religion		
Christian	136	53.1
Muslim	120	46.9
Occupation of client		
Employed,	32	12.5
Small business,	114	44.5
Farming,	62	24.2
Housewife	48	18.8
Knowledge and Information of Post Delivery Mothers		
Awareness of the reason for EPPFP use		
No		
Yes	7	2.7
	249	97.3
Awareness of EPPFP method		
No	9	3.5
Yes	246	96.5
Awareness of EPPFP side effects		
No	162	63.3
Yes	94	36.7
Attending FP counselling session		
No	96	37.3
Yes	160	67.7
Place of counselling session		
RCH	71	43.8
During admission	37	22.8
During delivery	26	16.0
During hospital discharge	28	17.3

Understanding counselling session		
No		
Yes	9	5.6
	153	94.4
Current use of EPPFP method		
No	138	53.9
Yes	118	46.1
Start time of EPPFP use (Months)		
1st		
2nd	25	21.2
3rd	51	43.2
4th	38	32.2
5th	3	2.5
	1	.8
Fertility and Reproductive Factors of Post Delivery Mothers		
Post partum duration (Months)		
≤6	174	71.0
>6	71	29.0
Planned birth		
No	60	23.4
Yes	196	76.6
Prefer birth spacing		
No	13	5.1
Yes	243	93.9
Number of children wish to have		
≤4	161	62.9
>4	95	37.1
Number of children having		
≤4	201	78.5
>4	55	21.5
Menses resumption		
No	43	16.8
Yes	213	83.2
Duration of menses resumption		
≤3	207	93.7
>3	14	6.3
Resumed sexual activity (months)		
Not yet	20	7.8
≤3	182	71.1
>3	54	21.1
PNC visit		
No	56	21.9
Yes	200	78.1
History of previous use of FP		
No	83	32.4
Yes	173	62.6

Source: Field data (2020)

Factors Associated with the Utilization of EPPFP

Results showed variables explicitly awareness of the reason for EPPFP use, awareness of EPPFP method, awareness of EPPFP side effects, attending FP counselling session, the menses resumption, duration of return to sexual activity and history of previous pregnancy were significantly associated with women use of EPPFP with p-value of 0.013, 0.014, 0.024,0.000, 0.010, 0.011 and 0.000 respectively (Table 2).

Table 2: Factors Associated with the Utilization of EPPFP among Post Delivery Mothers in Mvomero District(N=256)

Variable	Non use	Use EPPFP	Total Frequency	P-Value
Awareness of the reason for EPPFP use				
No	7	0	7	0.013
Yes	131	118	249	
Awareness of EPPFP method				
No	9	0	9	0.014
Yes	129	118	247	
Awareness of EPPFP side effects	96	66	162	0.024
No	42	52	94	
Yes				
Attending FP counselling session	68	28	96	0.000
No	70	90	160	
Yes				
Menses resumption				
No	29	14	43	0.010
Yes	109	104	213	
Resumed sexual activity (months)	17	3	20	0.011
Not yet	91	91	182	
≤3	30	24	54	
>3				
History of previous use of FP				
No	58	25	83	0.000
Yes	80	93	173	

Source: Field data, (2020)

DISCUSSION

Women's exposure to family planning knowledge and information, increases the demand for FP methods and gradually causing behavior change; it is crucial that they be exposed to FP education on every health facility contact. Actually, women attendance to counselling sessions showed significant association with the EPPFP utilization in the current

study. This was also found in the study done in Kebribeyah Town, Somali Region, Eastern Ethiopia by Nigussie et al. (2016) which found that women who received family planning counselling during delivery were more likely to use the contraceptives during postpartum period than their counter parts. In point of fact, FP counselling provides a woman with adequate knowledge on various FP issues which enable her to make an informed decision concerning her maternal and child health. Health facility workers during the interview reported that, women were going to the health facility with their EPPFP choices in heads; this indicates inadequate knowledge concerning FP issues and thus calls upon stakeholders to make strategies on how family planning education particularly during postpartum period can be publicly provided to the community.

Moreover, the study found women who were aware of the reasons for EPPFP services like pregnancy prevention and spacing were also utilizing EPPFP method. Similarly, the study done in Liberia by Kaydor et al. (2019) concerning Barriers to acceptance of post-partum family planning among women in Liberia, found that women who were aware of the PPFP were four times likely to use contraceptives on their postpartum period. Essentially, it was very important to understand whether women knew the reason for using EPPFP methods because having known the reason for such service to her, increases the demand for it, thus this again, calls upon healthcare workers to create awareness of EPPFP at every contact of care to increase demand for EPPFP among women.

Furthermore, awareness of women on side effects of EPPFP methods showed significant association to EPPFP utilization. Women who were not aware of the side effects of EPPFP methods, were found to be using EPPFP compared to their counterparts. This result was consistent to the study done by Kaydor et al. (2018) in Liberia, where they found fear of side effects was among the barrier to acceptance of PPFP methods. The reason for the fear of side effects, might be inadequacy knowledge of family planning, because the current study showed majority of women who reported to have attended the FP counselling session (assumed to have relatively adequate FP knowledge) were also using EPPFP.

Awareness of EPPFP methods showed significant association with EPPFP utilization and the most known FP methods were injections, pills and implants. This result was related to the study of 2018 done by

Gebremedhin and his fellow in Ethiopia concerning Family planning use and its associated factors among women in the extended postpartum period where they found majority of women had awareness on PPFP methods and the most known and preferred method was Injectable. The same results were found in Tanzania by USAID (2014) and Mtae (2018) in a study conducted in Mvomero that the most known and preferred method is Injectables (32%) and 28% respectively. The possible reason might be not only that injectables are easy to take and maintain privacy to the woman's partner but also its availability and accessibility.

The study indicates prevalence of extended postpartum family planning method (EPPFP) utilization to be moderately low (46%). This result is quiet higher than the study of 2018 by Towriss & Timæus from Eastern African countries which reported the prevalence of 37.3% and 26.6% for Urban and Rural Tanzania respectively. This increase might be due to exposure to family planning education to post delivery mothers as the matter of fact all nurses interviewed testified to provide FP counselling to women before and during delivery.

Women whose menses returned were more likely to use EPPFP, as a result majority of woman who used EPPFP started after menses resumption. This result was consistent to studies conducted by (Gebremedhin et al. 2018) and (Gejo, Anshebo, & Dinsa, 2019). The possible reason for this similarity might be due to the higher risk of getting pregnancy that women have immediately after menses resumed and this triggers them to use EPPFP methods. Borda and Winfrey, (2010) did an analysis from 17 countries on the postpartum fertility and contraception, and they found Tanzania as one among countries where women felt low risk of getting pregnancy before returned to their menses and subsequently started thinking of taking contraceptives after menses resumption, the percentage of women who used contraceptive after menses returned was two times than their counterparts.

Moreover, women who had history of FP use on previous pregnancy were also found to be utilizing EPPFP than those who had no history of FP use on previous pregnancy. This result is related to the result found in Addis Ababa-Ethiopia by Gebremedhin et al. 2018 that women who had history of FP use on the previous pregnancy were two times likely to use contraceptives in their postpartum period.

Duration of return to sexual activity also showed statistically significant association with EPPFP utilization in the current study. This might be due to the fact that women who resumed to sexual activity have great fear of getting unexpected pregnancy at anytime. This result was parallel to the study done by Gejo et al. (2019) concerning postpartum modern contraceptive use and associated factors in Hossana town where they found positive relationship between contraceptive use and resumed sexual activity. Among 17 countries including Tanzania where sexual activity was delayed postpartum, shorter birth interval was relatively rare (Borda & Winfrey, 2010). In Tanzania, during the second half of the first year postpartum is when the risk of pregnancy peaks (USAID, 2014). This might be due to the fact that women in the first six months post delivery their sexual desire is low while on the second half of first year postpartum their sexual desire is high.

CONCLUSION AND RECOMMENDATION

The findings of the study found that, the prevalence of EPPFP utilization was still low (46%) in Mvomero district, Morogoro-Tanzania. The utilization of EPPFP was significantly associated with awareness of the reasons for EPPFP use, awareness of EPPFP method, awareness of EPPFP side effects, receiving FP counselling sessions, menses resumption, and duration of return to sexual activity and history of previous pregnancy. In order to increase the demand and need for EPPFP service during postpartum period, healthcare workers should provide effective family planning counselling from the time a woman starts to attend ANC, during delivery and during PNC visits. This education exposes them to the family planning issues, guarantee better understanding of family planning and consequently women make informed decision on the EPPFP method during the postpartum period.

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