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Assessment And Proposal Of Innovative Waste Water Supply System For Informal Settlement Residences 'The Case Of Ikuti Sub-Urbs, Mbeya City – Tanzania'

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Abstract

The problem of informal settlement that is characterized by low quality houses and inadequate infrastructure has continued to affect societies; Ikuti Sub-Urbs is inseparable of this. In Ikuti sub-urbs, waste water is noticeable flowing along the adjacent houses of the residences, a problem is even exacerbate with the built-in informal settlements. Such situation creates unpleasant and discomfort living condition to the households. This study investigates performance of waste water supply system within Ikuti Sub-Urbs and proposes an innovative concrete trapezoidal channel that would hygienically convey wastes to a disposal unit. A survey was conducted to outline waste water performance issues: i.e. waste water generation, awareness and consciousness by the community about these waste water's effects, identifying current initiatives by respondents and identifying distances between houses together with the topographical levels of the underlying ground. Four issues appear as the study's findings (i) waste water occur from diverse sources: from the off points of uncontrolled taps, kitchen utensils, baths and toilets (ii) waste water flows on uncontrolled strips at the adjoin households; causing discomfort to the street walkers, in addition to the effects to children that keep to play-in (iii) Few residences are noted to be familiar with the waste water's hazards; information further denote that, in the village's level, there is little/no efforts to improve waste water supply systems (iv) spaces between houses provide clear sizes ranging from sixty to one hundred fifty centimeters and a down fall topographical land necessary to support an open, with a cover, trapezoidal concrete channel that conveys waste water to a disposal unit. Generally, despite the likely specific benefits to the Ikuti residences, this study's finding has implication of adaption in many other places of the developing countries.

Keywords: hazards; improvement; informal settlements; trapezoidal channel; waste water.

1.0 Introduction and background

Over countless years, water has become critical element to all human beings. This is so because, every human depend it for variety of reasons, including personal washing, drinking, irrigation activities, just to mention a few. This demand creates diverse challenges of affordability by the people; such as, the water: generation, availability, supply, suitability together with its after use (end product)'s supply system. As for this, water related studies have been done in order to solve the prominent problems. Related researches have been mostly focused on, for example: water supply system [1], waste water uses in agriculture [2], water supply and waste water treatment [3]; [4] and water supply and distribution [5], Integration of water supply and waste water management [6].

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Despite the focused efforts put in the aforementioned studies, little 'waste water related researches have been done. For example, its generation, communities' awareness with its effects amongst others. As a result, scientific and appropriate solutions are hard to be found in literature. While this area is not yet properly searched, the problem is even more acute to the small scale personnel whom find their places of living in the confined and squatter areas.

Ikuti sub-urbs is the village within the Mbeya city. It is located very proximity to the Mbeya University of Science and Technolgy (MUST). While MUST is a result of a rapid transformation of the then Mbeya Technical college, that also transformed through the Mbeya Institute of science and technology (MIST) before becoming into a fledge university; its appreciable changes must go in line with the improved proximity infrastructure of the Ikuti premises. The population of Ikuti amounts to two thousands six hundred [7].Residences of Ikuti depend mainly on small scale farming and on business activities. Its population has grown rapidly due to two reasons, firstly, it adopts similar trends like in other places where many people migrate to the major cities, and secondly, wide enrolments of students at MUST make many students to find dwelling places at Ikuti sub-urbs. As for this, social services that relate with water issues perform below expectation. The poor performance of waste water supply system is causing hazards to Ikuti's residences: such situation creates unpleasant and discomfort living condition to the households.

Tanzania has its strategic vision 'the vision 2025' of becoming a middle-income country by the year 2025 [8]. The vision advocates that, every individual or sector strive to make this vision achieved. In line with the vision, this paper tries to contribute on achievement by assessing waste water performance system at a confined and squatter area of Ikuti sub-urbs, and then suggesting an innovative proposal of a relevant trapezoidal channel infrastructure that would convey waste water to an identified disposal unit, thereby, creating health living standards to the residences of Ikuti. The paper is achieved through attempting to five tasks as follow:

(i) Identify the sources of waste water supply system at Ikuti sub-urbs;
(ii) Determine the effects caused by the waste water supply system at Ikuti sub-urbs;
(iii) Determine the available initiatives to curb waste water hazards;
(iv) Estimate the topographical levels and clear spaces between households; and
(v) Propose a well planned trapezoidal channel which covey waste water to an identified disposal unit.

While waste water is noticeable flowing randomly within the Ikuti's premises; causing inconveniences/effects to the residences, the proposal of trapezoid concrete channel would modernize the lifestyles of the residences because of its functionality: i.e. conveying waste water in hygienic way and a provision of hard bases, clean, and durable structure for people to walk over.

The paper is organized into five sections, whereas section one provides introduction and the background information, section two covers reviewing of the relevant literature. Section three describes methodology of the study. In section four, the study findings and discussions are presented. Finally, section five presents the concluding remarks and recommendations.

2.0 Reviews of the water issues: waste water generation and the conveyance systems

2.1 Water and its uses

Water is a critical element that must be used to support life of any individual. It is used in domestic buildings; say for personal washing, disposal of the human waste products, preparation of food and washing kitchen facilities [9]; [1]. After its use, the waste water product must be disposed of so that it does not pollute the environment or cause a health risk to the occupants.

Since the present study focuses on the performance of waste water system in order to propose an appropriate conveyance infrastructure; then, it is important to discuss the types and the functionality of these infrastructures. Waste water infrastructures can be put into two categories, firstly, components for generation of the waste water, and secondly, components for conveyance of the waste water. The two categories of infrastructures are discussed as follow.

2.2 Components for generation of waste water

Consumption of water occurs from the households' premises. Therefore, the components that are used on the functionality of the waste water are outlines as follow:

- washing sink, provided in the kitchen or on the external area for washing purpose;
- bath tub, provided for personal (body) washing;
- shower, an elevated showers for provision of personnel washings;
- basin, provided mainly in the baths/toilet rooms for washing the hands thereof;
- water closets, serves as the devices for receiving and conveying human waste products;
- Taps, mostly provided externally for directly tapping of the water; and
- Masonry or a structure placed externally to aid washing of the kitchen items and the like.

These components are depicted in Figure 2.1. From the Figure: the components show that clean water is used on them before it converted in a form of waste water. The used water, then, are referred to as 'the waste water' which can be harmful to the people; they must be conveyed to an appropriate conveyance point. Two issues are crucial in these components: firstly, they must be properly fitted in position and secondly, they must properly been used by the household users in order to hygienically serve their lives [3]; [4]. Systems for conveyance of waste water to the disposal units are discussed in a section that follows.

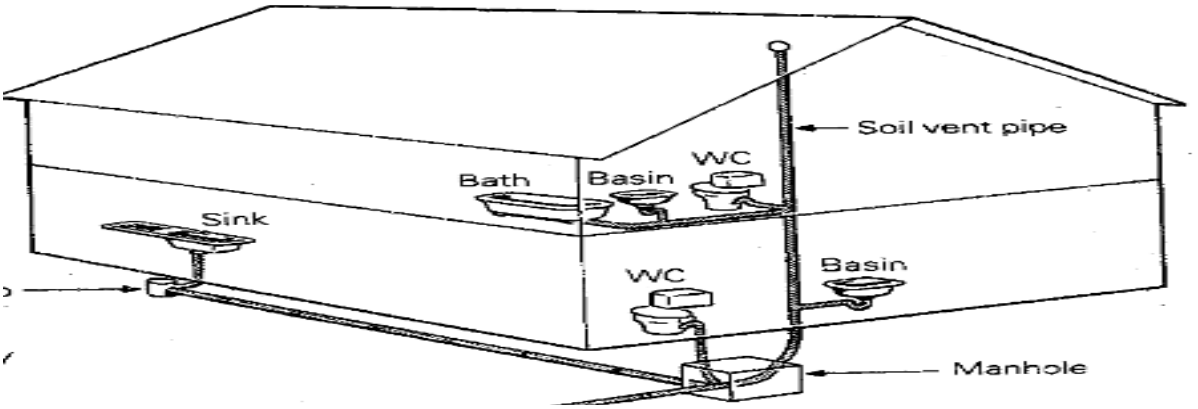

Figure 2.1: Components for generating waste water in a house (Adopted from Walton, 1995)

2.3 Waste water conveyance system

Water that generated from the components above (section 2.2) turn into a form of waste that need to be conveyed into a suitable disposal point. A suitable infrastructure for this functionality is generally provided in the underground structures where a closed or opened channels are secured. They may be open or closed, depending on the preference, but mostly due to the functionality. On its use, closed channels bring difficulties especially when the system get blockage; however, they are suitable for preventing unpleasant smells that arise from the fault (waste) water. Since closed channels occur in different design forms, e.g. an open with a movable cover or a completed closed system; the formal system may be preferred; since they may easily been opened for cleanness if blockage occur. Open channels on the other hand are appropriate for easy cleaning. However, these structures are easily been dirtied; the problem also accelerated by the culture of people that throw in gabages (this depends mainly on the people's built-in culture and their levels of understanding). This study has the views that normal indigenous people are likely to inherent a culture of throwing solid wastes roughly. This situation is not friendly with the open channels as the wastes would block the flows' functionality. This view favours the adoption of the open trapezoidal concrete channels that are provided with a movable covers. This infrastructure has two benefits, namely: (i) fulfilling its primary functionality of conveying waste water and (ii) providing a platform of concrete base for people to walk over. The trapezoidal channel structures made with concrete materials are preferred in most design approaches [10], because they can be made into various shapes to serve diverse functionality; and, they give a stable and a long life structures.

3.0 Methodologies

Two approaches were adopted: one of which involved reviewing waste water components and conveyance systems. It provided understanding on how waste water is generated together with a means of conveyance into disposal units. Review work also provided comparisons of the closed concrete channels against the open concrete channels to aid the choice category of this research. The other approach involved a survey research which dealt with the two tasks. Task one involved with a physical visit to the Ikuti premises to observe waste water performance issues. In a physical visit, waste water generation sources were revealed, together with taking dimensions of the spaces between residences houses or fences and estimating topographical levels of the land. In task two, two respondent categories: namely, the villagers and the village chairman were involved. This survey adopted semi-structured interview which guided a researcher to obtain useful information from the respondents. Villagers' categories were divided into three levels of their ages: two elders (parents) of the ages above 55 years, two middle group personnel, aged between 28 – 35 years, and two low level group personnel of the ages 16 – 20. These categorizations of respondents were involved because they are directly influenced or affected with the waste water and the informal settlement issues. They also assumed to have diverse ideas with appropriate insights into the current research. Therefore, a sample size adopted in a research comprises of one village chairman and the six villagers' categories.

Sampling strategy adopted was preferably, non-probability sampling that achieve purposely and convenience. This strategy allows addressing research issues by obtaining respondents that are relevant, accessible and ready to participate [11]. A semi-structured questionnaire ensures one thing is asked to all groups. It is noted that questions were set in Swahili, a national language in Tanzania; therefore, it is fairly used by majority people including Ikuti residences. The obtained information was thereafter, converted in English language. Information obtained helped to develop a closed trapezoidal channel for conveying waste water to a disposal unit.

4.0 Findings and discussions

This study was aimed at assessing performance of waste water supply system at Ikuti sub-urbs in order to propose a hygienic conveyance infrastructure system. For this aim to be achieved, the study engaged with the following tasks, to investigate:

- waste water generation sources;
- the awareness and consciousness of the residences about the effects of waste water that overcome them;
- available measures to curb waste water problems;
- determine spaces between houses or fences together with estimating the topographical land levels necessary for provision of appropriate concrete channel infrastructure to convey waste water to a disposal unit.

The study findings are presented as follow.

4.1 Sources of waste water and the prevailing situation

One issue in question was to identify waste water sources at Ikuti sub-urbs. Three tools were used to identify relevant information, they include: semi-structured questionnaire which was used against the village chairman, to the villagers and direct observation by a researcher. From interviewed questionnaire, respondents (a chairman and the villagers) all maintained that there is mainly, only one source of water supply which is normally a direct supply, served by MUWSA – Mbeya Urban Water and Sewerage Authority. This supply goes directly to the taps along the fixed water meter to each house hold. From a distribution meter, water gets into fittings for use by the households, thereafter, it generates waste water. A researcher through physical visit observation concurs on the four sources of waste water generation in Ikuti sub-urbs. They include sources from off points of the water tap that allow water to flow randomly on the surface [see Figures 4.1, 4.2 and 4.3]. Other sources include: waste water that deviate from the toilets, baths and other washings such as kitchen utensils.

It is noted that these waste water flow randomly within the premises of the households that generate it, flows to the neighborhoods and to the small streets that surround residences. In some points, where spaces allow, some holes have been dug to allow percolation of the waste water. However, due to a problem of limited spaces, few sites accommodate this, yet it is not well controlled. As a result, shallow pits are excavated, garbage are poured in, animals play in, non friendly insects are generated in, amongst others. Moreover, some ground conditions do not

allow sufficient percolation of the waste water; this situation causes more rotten liquid to flow on the vicinity of the residences, thereby, creating unpleasant environment.

4.2 Awareness and consciousness of residences about the effects of waste water problems

In an interview, a question was designed to seek understanding of, or the extent of awareness and consciousness of residents about the effects of the waste water problems. This question was asked to the villagers and to a village chairman respondents. Results from the villagers maintain that only few people are aware of the waste water effects. Out of six respondents asked the question, only two of them had answered it appropriately. One elder and a middle man respondent outlined two main effects of waste water, namely: (i) they transmit diseases and (ii) they cause unpleasant smells. This low responses rate indicates that majority residences are unfamiliar with the waste water effects. Results from these respondents (i.e. transmitting diseases and the effect of unpleasant smells) concur with the ones given by the village chairman. From these results, one may have perception of a need for provision of education to the villagers about the waste water effects.

4.3 Effects of waste water supply systems against the Ikuti residences

The effects of waste water supply system were been sought. The question was, 'what inconveniences caused by the waste water supply system within your residences? The question was posed to the six villagers. Only four out of six respondents (67%) and a village chairman provided appropriate responses. Compounding their results with a similar theme evaluated in the literature review; the inconveniencies caused by waste water supply system at Ikuti sub-urbs can be put into four categories as follow:

- Discomforts to the residents and others that are walking on the surrounding of the premises. The problem is even chaotic where a person enters the perch water during the night – as some walking corridors are covered by darkness.
- Nuise occur from pollutant waste water, especially during the day and are disturbed by animals such as hens, ducks, dogs etc. Waste water that does not percolate appropriately into the dug pits tend to have bad smell without, even, been disturbed by animals.
- Since some water forms standing perches, some food garbage are contained-in that allow generation of bacteria that are harmful to the children that keep to play-in (see Figures 4.4, 4.5 and 4.6). The contact of waste water to children skins can be perceived to have wider impact on their health –diseases causing effects such as cholera and dysentery are the possible effects, to mention but few. This problem may occur if these children touches and, or drink such contaminated water.
- Random and uncontrolled flows of waste water strips cause discomforts to the residences together with the nearby households – this occurs because of proximity sites also exacerbated by the sloppy land of the areas. During interview, one respondent maintained that the persistence of waste water problems is due to individual's in-built culture.


Figure 4.1


Figure 4.2


Figure 4.3


Figure 4.4


Figure 4.5


Figure 4.6

Figures 4.1, 4.2 and 4.3 show the flow of waste water within the walking corridor of, or around the nearby households. On the other hand**, Figures 4.4, 4.5 and 4.6** show the children playing with the waste water as have been caught by a camera.

4.4 Current initiatives to improve waste water performance system

The question about present initiatives to improve waste water performance issues have been responded from three sources of information, namely: from the village chairman, villagers and from the policy documentation. Despite few residences that are perceived to be aware of waste water effects, there is no collective effort within the village to curb the situation. Village chairman has maintained that, no any measure from the government that is in place to alleviate the problem despite the periodic campaigns from the health officers that sensitize residences to ensure placement of good toilets, fumigating them and the surroundings together with making general environments clean. Critical view of these campaigns by health officers brings one good argument in research. Their advocated issues are not permanent solution to a problem, nor it does lack critical rigor and the scientific knowledge about the problem; as such, an appropriate solution can hardly been identified.

From other six respondents' perspective, two respondents maintain that strategies for equipping of well waste water supply depend solely on the specific household efforts. This research does not contradict with this view; however, the argument is that, individual effort is the one that brought the situation to a stage it is now. Wider view of this problem may perhaps focus on more appropriate solution; this study tries to focus on this.

In addition, three respondents have suggested a need for the government to find mechanisms that develop infrastructure for small scale indigenous such as Ikuti residences like it develops infrastructures for the major cities. They note that, these infrastructures are usually forgotten by the government forever. In line with this view, this research has the concerns that when several researches would be conducted that relates with waste water issues the government may place attention to on them, because scientific researches give viable and reliable solution to problems.

When needing information about the current initiatives to improve waste water issues, the policy documentation was not sought immediately at the village's office. This situation may show reluctance or low efforts available in the government to handle waste water problems.

4.5 Proposal of waste water conveyance infrastructure to a disposal unit

Issues that guide to propose appropriate infrastructure to convey waste water to a disposal unit as been sought in a physical survey are summarized in Table 4.1. This Table presents the identified spaces between houses and an estimate of the topographic down falls of the land.

Table 4.1: Clear space between houses and the topographical levels of Ikuti sub-urbs

s/n	Physical survey observation	Findings
i	Determine average space sizes between households	Spaces sizes between houses or fences vary between sixty to one hundred fifty centimeters.
ii	Estimate topographical level of the underlying ground	Physical observation maintain that Ikuti sub-urbs's area is (a sloppy) down lying land where waste water may be conveyed to down fall.
iii	Identify position or low landing area as an effluent point	The conveyed waste water need free land to percolate in/drained of. Therefore, an open land of approximately size of 70 X 35 meters is available for farming activities by one household. Negotiation and compensation may be possible to secure a disposal unit within this site.

From Table 4.1, space between households and the nature of the topographic map (Figure 4.7) can be sufficiently innovated. This Figure shows a topographical land lying ground, where two designations are marked, namely 'the highest and the lowest level; which denote that waste water can flow by gravity from the highest to the lowest level and, again to the disposal unit.

From the literature review an open trapezoidal channel with a movable cover was identified as an appropriate underground waste water conveyance system when compared with a completely opened or closed type. This system has advantages of preventing nuise that result from waste water, in addition to providing a platform base for the people to walk over; this infrastructure is sufficient for confined spaces like the Ikuti sub-urbs.

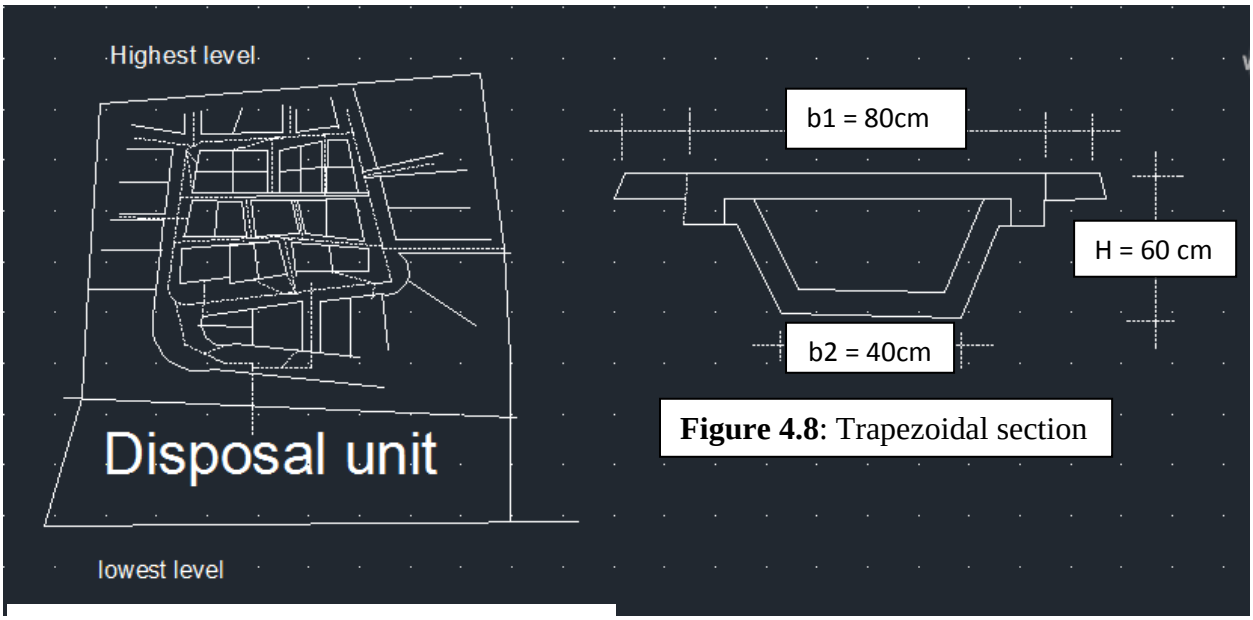

Figure 4.8: Trapezoidal section

Figure 4.7: Proposed trapezoid channel for conveying waste water at Ikuti Sub-urbs

4.6 Functionality of the proposed trapezoidal concrete channel

Based on a survey work, information necessary to secure a trapezoidal channel was identified as follows:

- Space between houses or fences range between sixty to one hundred fifty centimeter
- Within the houses or fences spaces that are identified in bullet one above, a trapezoidal channel with the approximate sizes of: b1 = 80cm, b2 = 40 and h =60cm can be introduced in. This trapezoidal structure is represented by dashed lines as shown in Figure 4.7. A section of a trapezoidal channel is presented in Figure 4.8. the overlap portions that are put without dimensions join the end points of either the walls or fences of households.
- When an average of a half girth of each house's length may be taken as the twenty meters [20 meters] - i.e. possible area for inclusion of the channels, an average of five cubic meters ($5m^3$) concrete may be required for a project of a trapezoidal channel to be implemented. Thus, if small indigenous households are educated about the benefits of the proposed structure; they may afford its implementation costs.

5 Conclusion and recommendations

This study was aimed at assessing performance of waste water supply system at Ikuti sub-urbs in order to propose a hygienic conveyance infrastructure system. A physical survey and interview questionnaires were conducted, where, four categories of information were obtained as follow:

(i) Waste water generation: waste water at Ikuti sub-urbs occur from various sources, including: from off points of the water tap that allow water to flow randomly on the surface. Other sources include: waste water that deviate from the toilets, baths and kitchen utensils.

(ii) When research sought about the effects of the waste water issues, respondents identify these effects as follows:

- Discomforts to the residents and others that are walking on the surroundings;
- Nuise that occur from pollutant waste water, especially during the day while disturbed by animals such as hens, ducks, dogs amongst others.

- Since some water forms standing perches, some food garbage are contained-in that allow generation of bacteria that are harmful to the children that keep to play-in.

(iii) The other issue posed was about community's awareness to the waste water effect. Results maintain that only two villagers and the village chairman respondents show to be aware of the waste water effects. It is therefore suggested that villagers should be educated about the waste water effects.

(iv) When seeking to propose appropriate and hygienic infrastructure to convey waste water, an open trapezoid concrete channel with a movable cover was found as a suitable structure due to its merits of preventing fault smells, non prone to be blocked; and further, it provides a platform base for people to walk on and provision of the lifelong infrastructure.

As a final word, although the estimate parameters have been estimated of the proposed trapezoid channel (Figure 4.8), a further study is proposed that would design these structures into net sizes. In addition, the future work would also investigate the strength bond between the mud-walling against the cement or lime motor that may be used as a rendering structure. Thus, in future, if ground portions are secured with the hard concrete bases; their adjoining mud walls would also improve.

A study summarizes that an overall effort of investigating waste water performance issues that aided the proposal of a new trapezoid channel contributes to the existing knowledge due to the fact that the theoretical issues on water, waste water and concrete structures when synthesized, evaluated and embedded with the actual site information, they guided in formulation of new knowledge. Generally the overall findings of this study concur with Meleg [12]'s view, that advocates the importance of planning, implementing and maintaining the water supply vs waste water systems; both of them linked with the social, technical and financial matters. It is henceforth, noted that, this research findings have major implication of use in many other places of the developing countries.

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Appendix 1

Semi-structured questionnaire to the village chairman
General information [maswali ya ujumla]
PART 1: General information

a) Jina la kijiji (Name of village)……Tarehe (Date……
Years time the chairman is in power (miaka mingapi uko madarakani?)……

b) Ukubwa wa kijiji (the boundary of the village (square kms)……jumla ya watu? (Population) …… [census study yr,……]
c) Wakazi wanajihusisha na shughuli gani za kiuchumi? (what are economic activities of the villagers?)……
……

PART II: Specific questions [maswali halisi ya dodoso]

Q1. Ni vyanzo gani vya maji vinatumika katika kijiji cha Ikuti? (What sources of water supply system that are applicable in the village?……..
Q2. Ni matatizo gani unayoyajua yanayo sababishwa na maji yanayotiririka katika makazi? (what inconveniencies/problems that are caused by waste water supply within households' premises? ……
Q3. Mna mkakati gani kama kijiji kuthibiti maji haya yanayotiririka au madhra yanayosababishwa na hayo maji? (What strategies are in place to curb waste water and related problems within Ikuti's residences)?……
……..

Q4. Mna sera (by-law yoyote inayozungumzia tatizo hili au linalofanana na hili?.....

Asante kwa ushirikiano (Thank you for cooperation)

Part two
Semi-structured questionnaire to the villagers
General information [maswali ya ujumla]

Jina la kijiji (Name of village)……Tarehe (Date……
Your age (umri wako)?……mkazi wa? (Residence of)……

Specific questions [maswali halisi ya dodoso]
Q1. Ni vyanzo gani vya maji vinatumika katika kijiji cha Ikuti? (What sources of water supply system that are applicable in the village?……..
Q2. Ni matatizo gani unayoyajua yanayo sababishwa na maji yanayotiririka katika makazi? ……
Q3. Kuna mkakati gani, wa kikijiji au kibinafsi kuthibiti maji yanayotiririka kwenye makazi?
……
Q4. Nini maoni yako binafsi kuhusu uamarishaji wa mtiririko wa maji yatokeayo katika makazi yenu? ……

Asante kwa ushirikian: Taarifa hizi ni kwa ajili ya tafiti hii tu (Thank you for cooperation – this information is strictly restricted for research purposes only).