

ASSESSMENT OF INTEGRATED WATER RESOURCES MANAGEMENT PRACTICE IN YATTA CANAL, MACHAKOS DISTRICT, KENYA

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ABSTRACT

Yatta Canal is situated in Yatta division, Machakos district about 100 km from Nairobi along Thika- Garissa road. It is about 60 Km long and supplies water for domestic, livestock and irrigation use. Over the years, the water supply has been unreliable especially during dry season leading to conflicts between upstream and downstream consumers. Sometimes the Government has been forced to intervene to restore order. The study aimed at assessing the use of Yatta canal, based on the principles of Integrated Water Resources Management (IWRM) which stipulates efficient use of water and involvement of all stakeholders in decision making for sustainability. Based on this concept, it was established that the current water demand outstrips supply and that there is inefficient water use especially for irrigation. Water allocation process favours landowners, and stakeholders are not fully involved in planning, management and development. Further, women's participation in decision-making is minimal. There is no environmental voice during water allocation and thus the reserve/ base flow in the canal has not been maintained. This means that IWRM concept has not been practiced and this has resulted to conflict among various water users. As Yatta canal gets water from Thika river, there is need to establish Thika river basin water users association where stakeholders can influence decisions on water allocation and management. This will create a forum to discuss efficient water use at all levels and promote internal policing to ensure fair allocation, thus minimizing conflicts and promoting the IWRM concept.

1. INTRODUCTION

Construction of Yatta canal was undertaken by African Land Development Board (ALDEV) using Mau Mau detainees from December 1953. Main excavations were completed in August 1958. The canal works costed Kshs 6,499,680 (£324,982) and was officially opened on 18th September 1959 (7).

The canal is unlined except for the first 80m up to the washout gate and another 130 m at Mathauta river Bifurcation point. Its length is divided into sections of one kilometer each and named by these distances (the intake is termed kilometer zero- Km 0, canal length at kilometer ten is termed Km 10 while the canal end is termed Km 60) (9). It has auxiliary structures like storm overpasses, bridges,

flumes and cut off drains that ensure continuous flow and protect it from excessive siltation. It is served by a 59 km long access road.

The canal's initial slope from intake to Mathauta river (Km 49) is 1:2,500 while that from Mathauta river to the end (a distance of 10.5Km) is 1:1,000 (10). It was designed to have a flow of 1.13m³/s between the intake and Mathauta river section and 0.283m³/s between Mathauta river and canal end section. Average bottom width is 2m, side slopes are two vertical to one horizontal and mean velocity is 0.45m/s. A controlling device has been constructed to guarantee a flow of 143 l/s into Mwita Syano river (9). Figure 1 below shows the layout plan of Yatta canal.

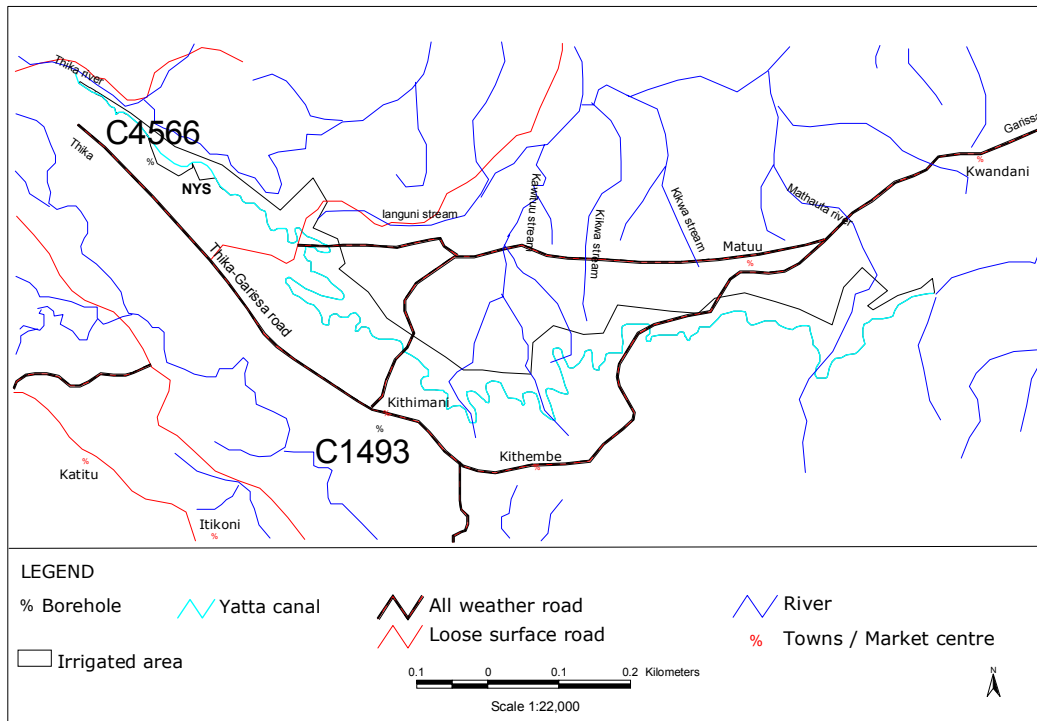


Figure 1: Layout plan of Yatta Canal

Objectives of the Study

- i) To establish the current practices of water resources use and their effectiveness along the canal;
- ii) To determine the level of stakeholder participation and awareness in water resources management along the canal;
- iii) To identify the integrated water resources management approaches suitable for effective and efficient water use along the canal including supply to Matuu town;
- iv) To establish whether or not the water source is adequate to meet the ultimate demand.

2. RESEARCH METHODOLOGY

The research aims at assessing efficient use of water along Yatta canal and Matuu water supply. It involves assessment of water use, quantity, quality and rights, stakeholder awareness and their involvement in decision-making, reliability of the water supply, management and problems associated with water use, and recommendations made thereof. Data was collected through discussion with key stakeholders, observation in the study area, laboratory tests of water samples and use of semi-structured questionnaires. 116 questionnaires were administered by enumerators to respondents along the canal within 1Km on either side and Matuu water supply area.

3. RESULTS AND DISCUSSION

3.1 Water Resources Planning

3.1.1 Socio economic Issues

Yatta division has a poverty rate of 67.5% which is higher than the average rate for the district (66.2%) (8). From the survey, the mean monthly income per household is Shs. 15,337 while the average number of people in a household is seven, thus each person lives on Kshs. 73 per day, which is less than a US Dollar (Kshs. 75) and hence below poverty line as per United Nations Classification.

No poverty reduction strategies have been introduced in Yatta canal which promote equity in water use like prioritizing development of water resources to populations at water risk (those more vulnerable to drought and water scarcity) like those around Matuu town and towards the end of the canal (4). Also strategies promoting IWRM practice like protection of traditional and customary water rights enjoyed by the poor (for example advocating for reservation of shallow wells and feeder stream flows recharged from the canal) need to be supported by all stakeholders (1).

Main sources of income include farming, employment and business. The bar chart in Figure 2 shows the main sources of income against the

respective percentage of respondents. The main source of income for the residents is farming and since this is an ASAL area, farming is practiced

mainly through irrigation along the canal. Thus the canal is the main source of livelihood for Yatta people.

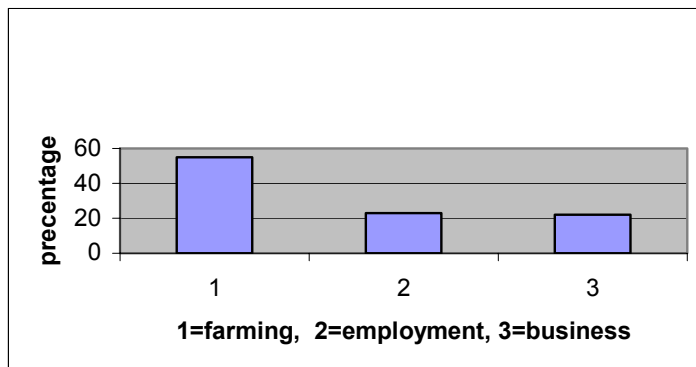


Figure 2: Sources of income
Source: Survey, 2006

One of the principles of IWRM recognizes that water has an economic value (2) despite the fact that it is also a basic right to have access to clean water and sanitation at affordable price (5). From the survey, 78% of respondents said they are willing to pay more for water if services are improved but they did not support a higher tariff than what is now proposed by Yatta Canal Water Users Association (YCWUA). This may be due to high poverty levels in the area and poor services currently offered.

One of the challenges facing implementation of IWRM is lack of entry point (5). Social groups are forums that can be used to assess the community’s cohesiveness and be the entry point for IWRM. When asked whether they are members of at least one self help group 73% of respondents said they are, showing they are cohesive enough to implement IWRM. YCWUA can promote the self-help group approach in its activities to get support of water users to implement IWRM.

Women and children suffer most when there is water scarcity (1). IWRM provides positive policies, which address women’s specific needs by equipping and empowering them to participate at all levels of water resources programmes (2). Though women are active in self help groups (90% of respondents said women are engaged in leadership of self help groups), they do not participate in planning for the rehabilitation of the canal or Matuu Water Supply. There is only one woman trustee out of sixteen in the Board of Trustees (BOT) of Yatta Canal Water Association (YCWA) Trust. In order to promote IWRM

practice, there is need to have special representation of women in the BOT.

3.1.2 Integrated Approach

IWRM approach in designing and managing infrastructure makes it possible to capitalize on potential synergies, like developing water supply schemes that provide water for domestic and livestock use (5). The main purpose of constructing Yatta canal was to provide water for irrigation, domestic and livestock and to date it has continued to serve these uses thus maintaining integrated approach (9).

3.1.3 Water Resources Assessment

Availability of accurate and reliable water resources data, to be used by decision makers, is an important instrument for practicing IWRM (5). Data on daily rainfall, evaporation and mean canal flow for the past record of 24,11 and 45years respectively was obtained for river gauging station (RGS) 4CC3 from Ministry of Water and Irrigation (MWI) and analysed using Gumbel’s statistical distribution to obtain dependable monthly rainfall (at 80% exceedence probability), optimum monthly evaporation rate (20% exceedence) and dependable mean monthly flow (80% exceedence). These are shown in Figures 3, 4 and 5 respectively. Other sources of water are:

- (i) Boreholes No. C4566 (at NYS farm) and C1493 (near Kithimani shopping center) with yields of 6.28 m³/hr and 9.06 m³/h respectively
- (ii) Two water pans constructed to supplement water supply from the canal for Matuu town during dry season, with a joint capacity of 18,000m³

(iii) Several shallow wells which are located at feeder streams and are recharged from

seepage of the canal and therefore their discharge depend on canal flow.

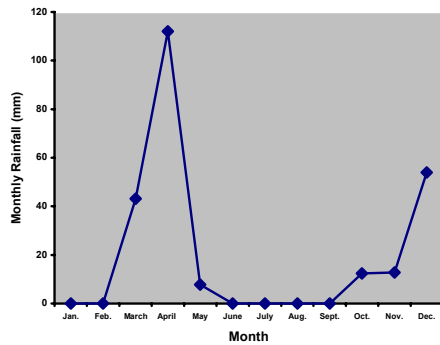


Figure 3: Dependable monthly rainfall January 1982 to rate, mm for January 1981 to January 2004 to December 2005

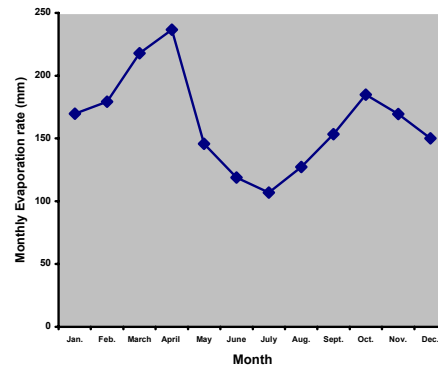


Figure 4: Optimum monthly evaporation in mm for December 2005 1990 and

3.1.3.1 Analysis of water demand and supply in Yatta Canal

Human, livestock and irrigation water demand was calculated based on population census and irrigated area of 800ha (12). Water supply was obtained from dependable mean monthly canal flow for RGS 4CC3, water pans and boreholes. Water losses due to seepage and evaporation rate for the canal and water pans were subtracted from the supply to obtain net water supply. Net water supply was compared with demand to determine the short falls which is an important objective of the study. This is shown in table 1.

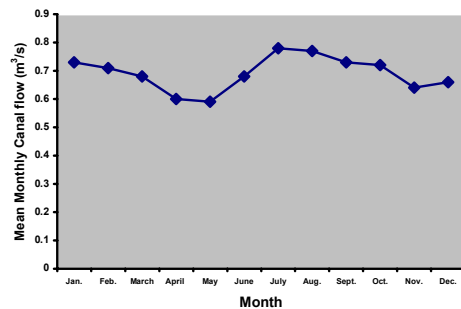


Figure 5: Dependable mean monthly canal flow, m³/s for January 1961 to December. 2005

Table 1: Comparison of water supply and demand in the study area

Period	Present Year 2006	Initial Year 2007	Future Year 2017	Ultimate Year 2027
Water supply, m ³ /s	0.46	0.46	0.46	0.46
Water demand, m ³ /s	1.28	1.28	1.3	1.32
Water supply shortfall, m ³ /s	0.82	0.82	0.84	0.86
Percentage of demand met(%)	38	38	37	36

The results show that the demand outstrips supply within the planning period. The inadequate supply is a potential source of water conflict and can be addressed by creating awareness among stakeholders so that they support irrigation scheduling and promote fair water allocation as is advocated in IWRM practice.

3.1.3.2 Analysis of water demand and supply in Matuu Water Supply

Water demand was estimated for domestic use (using human population) as livestock served by the water supply is negligible. Present, initial, future and ultimate water demand was estimated as

0.03m³/s, 0.021m³/s, 0.026m³/s and 0.033m³/s respectively. Main water source for the scheme is the canal but two water pans (of 18,000m³ capacity) were constructed to supplement the canal source during dry seasons. From the field it was established that under normal flow, the scheme receives 0.018m³/s from the canal. Assuming 20% water loss due to backwash and unaccounted for water, the water supply supplies 0.014m³/s to the consumers, showing it cannot meet the demand within the planning period. Effective management in the canal and practicing water demand management (thus reducing unaccounted for water)

will avail more water for beneficial use in line with IWRM (5,1).

3.1.4 Water Quality

Sources of non-point pollution in the study area include fertilizer, cultivation, animal feed lots, pasture and dairy farming. From the survey, 66% said they use fertilizer with 50% using inorganic and 16% using organic types. 70% said they use pesticides/ insecticides to control diseases. Point sources of pollution include direct access to the water body in the canal like people washing, livestock drinking and water fetching for household use. 97% of the respondents said they use pit latrines to dispose human waste, 1% said they use septic tanks while the rest do not use any safe disposal method. This shows most of the people safely dispose human faeces.

Water samples were collected at nine sampling points on 6th April 2006. The samples were analyzed for physical, chemical and bacteriological quality.

Bacteriological analyses show presence of general coliforms, *Escherichia coli*, *salmonella shigella* ssp while protozoa and *vibrio cholerae* are absent at all sampling points. This means water is polluted by faecal contamination and contains micro organisms that cause typhoid fever, diarrhea and dysentery (25). Therefore water in Yatta canal and Matuu water supply is not recommended for drinking before treatment; disinfection at Matuu water supply is not effective and need to be improved.

Physical analyses show high levels of colour and turbidity in all samples except at Matuu water supply treatment works (treated water) and NYS borehole No. C4566. High level of colour and turbidity is due to poor land use practices.

Chemical analyses show that salinity in Kaawani and Kauthulini is caused by presence of boron. Presence of organic matter from animal feedlots, decaying vegetation and waste from humans and animals is the cause of high concentration of total

suspended solids, nitrites, high permanganate value, BOD₅ and COD in all samples except in Matuu water supply (treated water). High concentration of selenium is due to pollution from insecticides.

Generally water analyses results show that pollution is due to water use and poor waste disposal and hence there is need to practice efficient water use to promote IWRM (3). Effective public campaigns through public meetings will raise public awareness on safe disposal of waste and promote IWRM practice (6).

Matuu town has no sewerage system. The waste water generated is drained through natural drains and most of the premises are served by pit latrines. Field survey established there are no immediate plans by Matuu Town Council (MTC) to construct conventional sewage and wastewater disposal system though their strategic plan 2005 – 2010 recognizes the need to protect the environment. This negates IWRM process, as the waste is a threat to those depending on streams receiving it (1).

3.1.4.1 Effect of water pollution

From the survey, 70% of respondents said they contracted water related diseases (Malaria, Bilharzia) while 67% contracted water borne diseases (diarrhea, cholera and dysentery) in the last one year. Malaria is the most prevalent water related disease while amoeba and typhoid were the most prevalent water borne diseases. Though respondents said they had contracted amoeba and cholera in the last one year, absence of protozoa and *vibrio cholerae* pathogens in the water samples show these were not caused by waterborne transmission.

3.2 Water Use

From the survey carried out, 60% of the respondents practice irrigation using canal water. The prevalence of methods of irrigation used are shown in figure 6. Examples of furrow and sprinkler irrigation types practiced along the canal are shown in Plate 1 and 2.

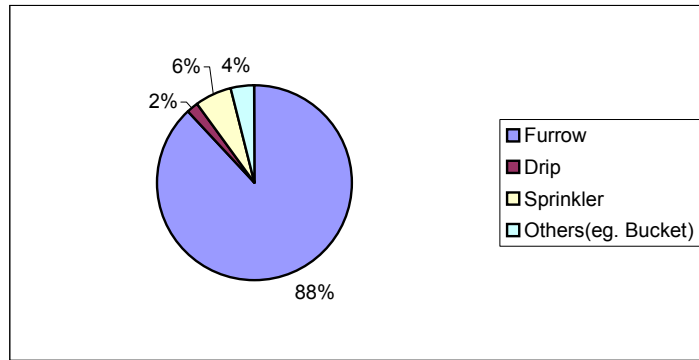


Figure 6: Prevalence of irrigation methods
Source: Survey, 2006



Plate 1: Furrow irrigation
 34



Plate 2: Drip irrigation for grapes at (gravity) at Km Kenya Wine Agencies Ltd farm

Furrow irrigation is preferred by smallholder irrigation farmers because of low investment and maintenance cost. The outflow from irrigation is used to recharge the feeder streams and ground water aquifers that supply water for domestic, livestock and irrigation to other riparian users and therefore is beneficially used.

Figure 7 shows the percentage of farmers practicing irrigation per location in the supply area.

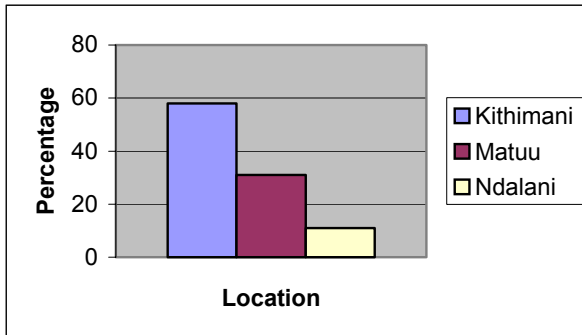


Figure 7: Percentage of respondents practicing irrigation per location
Source: Survey

Most farmers come from Kithimani location because this is where the canal starts and water flow is reliable most of the time showing that there is unfair water allocation among users, which negates IWRM practice (1).

From the survey, 76% of respondents get their water for domestic use from the canal, 16% from shallow wells and Matuu water supply scheme (whose main source is the canal), the rest (i.e. 8%) get from other sources. This shows Yatta canal is the main source of water for domestic use in the area.

Matuu water supply has been constrained by unreliable source (due to low flows in the canal) and this has made consumers to patrol the canal during dry season to restrain irrigation farmers from using canal water. This has been a recipe for conflict between them and farmers, negating IWRM practice which advocates for fair water allocation, giving priority to domestic water use (3).

From the survey, 64% of respondents said their livestock get water from the canal, 16% from shallow wells, 15% from feeder streams and the

rest from other sources, thus the canal is the main source of water for livestock.

There is no environmental voice to articulate environmental issues during water allocation hence the voices of farmers, livestock and domestic users have completely blocked it (1). IWRM recognizes environmental water need and support its consideration during water allocation (3). There is need to have environmental voice in water allocation committee, e.g. Forest Department representative or an NGO well versed with environmental water requirements.

3.3 Water Management

When it was completed in 1959, the canal management was under ALDEV but was later handed over to Masaku County Council. Later Director of Water Development was appointed as the water undertaker in 1975 (10) and delegated the management to the District Water Officer, Machakos. The District Water Officer established Yatta Canal Field Unit and 6 camps along the canal.

Yatta Canal Water Users Association (YCWUA) was registered in 2004 under the Societies Act Cap 108 after enactment of Water Act 2002. The aim of the Association was to be the service provider for water services along the canal.

During the survey, 75% of respondents said they are aware of YCWUA while 25% said they are not aware. When asked whether it is effective 13% said yes while 62% said it is not effective, the rest were not aware of it. This shows that although most of the water users know the Association exists, it has not been effective enough to be appreciated. As one of the main challenges facing implementation of IWRM is lack of support from all levels (5), the Association needs to gain support of water users by improving services and responding to their needs effectively.

When respondents were asked to propose methods of making YCWUA effective, majority said they want the management to revert back to the MWI. This is because they fear change to unknown and view YCWUA as an association not interested in improving service but increasing tariff.

Other proposals made by respondents for making YCWUA effective are that more women and youth be included in the committee; officials to call regular meetings and work in a coordinated manner; involve local people in decision making;

sensitize water users on functions of the association among others. This is in conformity with IWRM practice. The Association needs to formulate ways of ensuring that all water users participate in water management and develop clear consultative processes in decision making which have to be approved by all stakeholders.

Office bearers of YCWUA decided to register the Association as a Trustee and change its name to YCWA trust so as to be exempted from taxes of materials and equipment when carrying out major construction of water works. During the field survey, water users were not aware of this change hence they were interviewed on YCWUA.

3.3.1 Water demand management

Improving efficiency in the use of water is another way to maximize the economic and social welfare derived from water as a scarce resource, and is an integral part of an IWRM approach (5).

The high demand for irrigation against a fluctuating supply calls for efficient water use, achieved through practicing water demand management. The respondents were asked the methods they use to economize on water use at farm level. 27% said they economize through farm terracing, 20% through practicing deficit irrigation while 28% through timely removal of weeds, ensuring good soil structure or combining cropping with animal husbandry. These are effective water demand management practices. The challenge faced is that irrigation scheduling is rigidly set among the users. Sharing water on a rigid rotational basis often leads to wasteful use, since users will generally take full share at each turn irrespective of the water need of their crops (24). This should be discouraged by introducing policies that reduce misuse (like pricing policy with tariff structure that makes water wastage expensive but should not make water too expensive to deprive the poor and vulnerable groups from use and negate IWRM practice (2).

When respondents were asked whether they are aware of methods they can use to economize water at household level, 54% said yes while 46% said no. Then methods used to economize water include encouraging water reuse (50%), washing house once a week (1%), ensuring children do not misuse water (2%) and use water conserving utensils (1%). These are effective water demand management practices at household level.

Unaccounted for water (UFW) for Matuu water supply doubled to 20% between 1995 and 2005,

which is not a good practice in water demand management. The increase was due to slow response to bursts and breakdowns, malfunctioning water meters, illegal connections and errors in meter reading. These have to be addressed in order to reduce the UFW (though it is still low compared to the national average of 50% (11)).

Yatta canal is not lined (except for a 210m stretch) and water losses occur through evaporation, seepage and deep percolation along the main, primary, secondary and tertiary canals. Water loss through deep percolation and evaporation is not beneficiary used and there is need to control it as this negates IWRM practice (1). There is also no operation and maintenance manual to assist in effective irrigation scheduling and fair distribution among users and users. There is need to prepare a manual in collaboration with stakeholders as proposed by Cap Net, 2002 so as to promote IWRM practice.

3.3.2 Water rights

Water permit for the canal expired on 30th June 2004 and YCWA Trust has applied to Water Resources Management Authority (WRMA) for renewal. While Athi Water Services Board (AWSB) is responsible for water and sewerage services in Thika and Machakos districts where Thika river and Yatta canal are administratively located, water permit management is under WRMA Tana basin managed from Embu. This has constrained implementation of IWRM because the management is fragmented (1).

The requirements for authorization to abstract water for irrigation at the canal discriminate against women and the poor and marginalized who usually do not own land and are not members of any group. Conditions like proof of land ownership and membership of a group can be replaced with a letter from land owner authorizing use of land by applicant.

In Matuu water supply, there is no special tariff for the poor and most of them are served at two water kiosks where water is sold at Kshs. 2 per 20-litre jerrican (as per gazetted rate). As they are paying above the flat/metered rate (which is 40cts per 20-litre jerrican), water accessibility is discriminative against them, which is not a good IWRM practice (4).

3.3.3 Water conflict management

Much of IWRM practice is essentially about conflict management (2). IWRM practice is the best

way of solving conflicts since all stakeholders will influence water allocation and management between the following groups:

- i) Upstream and downstream farmers along the canal
- ii) Thika river abstractors (above canal intake) and canal water users
- iii) Farmers and Matuu water supply consumers
- iv) Irrigation farmers and livestock / domestic water users.
- v) YCWA Trust and water users

When respondents were asked to state their relationship with upstream water users, 68% said it is bad while 32% said it is good. Most people felt that the upstream users block the canal to get more water while those downstream have none. Those upstream said they have bad relationship with downstream users because they assume they block water during dry seasons.

Other causes of conflict identified by the respondents include mismanagement, unfair water allocation, ineffective rationing programme and unfair water charges. These conflicts can be solved if a forum is established to discuss water allocation and charges among the users, as advocated by IWRM practice. Decisions agreed upon should be respected and implemented (2).

3.3.4 Coordination among water and related sectors

IWRM brings together coordination among sectors, plus stakeholder participation to achieve effective local management for sustainable socio-economic development (1). No coordination exists in the study area among water and related sectors like forest, land, agriculture and environment.

One of the reasons for formulating the National Water Policy was lack of proper inter-linkages with other water related sectors. Lack of coordination has been a major constraint in implementing IWRM and it is proposed that a coordination committee be established in Yatta division to discuss and accept all projects that affect Yatta canal. Membership of the committee can be heads of government departments related to water and NGO's active in these sectors like Plan International, World Vision and German Agro-Action.

3.4 Communication and Stakeholder Participation

Constraints experienced in Yatta canal like misuse of water by over irrigation, water pollution and ineffective water management are due to poor

stakeholder participation. Water users are not made to actively participate in decisions concerning water use. An independent organization or a reputable NGO needs to be mandated to effectively sensitize various stakeholders on the benefits of active participation in decision – making process.

3.4.1 Awareness of reforms

The country's legal and policy changes have been finalized and support implementation of IWRM concept, however when respondents were asked whether they are aware of National Water Policy, only 7% said they are aware while 93% said they are not aware. When asked about Water Act 2002, 16% said they are aware of it while 84% said they are not. This shows most of the water users are not aware of the reforms in the water sector. This is due to lack of information, understanding, appreciation or motivation/incentives (6). Developing advocacy programmes targeting the stakeholders can solve the problem of low awareness of reforms.

3.4.2 Types of stakeholders

Stakeholders in the study area include domestic and livestock water users, irrigation farmers, NGO's, government departments and local Authorities, local politicians, opinion leaders, policy makers and planners.

The membership of Board of Trustees (BOT) of YCWA Trust is based on stakeholder representation along the canal only. Other stakeholders like planners (professionals), women and the poor and marginalized, domestic and livestock consumers are not represented; yet planners, policy makers and politicians have been the main decision makers.

3.4.3 Participation in planning, development and management

Participatory decision making process by different user groups influences strategies for water resources planning, development and management, bringing additional benefits, as informed users apply self regulation which promote efficient water use for sustainability. When respondents were asked whether they participate in water management, 33% said they do while 67% said they don't. Failure by the majority to participate in management denies them the opportunity to influence decisions made by managers and policy makers on the water issues affecting them, a practice that is not advocated in IWRM approach.

3.5 Capacity Building

IWRM requires capacity building at all levels for democratic and demand responsive approaches, especially at the community level to which local planning of resource use, management and maintenance of services will increasingly be devolved (4).

3.5.1 Capacity requirements

In order to implement IWRM in Yatta canal, full time services of Water/ Irrigation Engineer, Hydrologist, Pollution Control Officer, Sociologist and support officers qualified in operation and maintenance are required. Other personnel who will be needed on short term basis like Public Administration/ Relations Officer, Poverty Reduction Specialist, Water Economist and Institutional Management Specialist can be available at AWSB for use when needed.

3.5.2 Existing capacity

The personnel currently deployed in Yatta Canal and Matuu water supply include Water / Irrigation Engineer and other staff for operation and maintenance. In terms of vehicles, plant and equipment, the unit has enough capacity though it lacks telephone services and efficient billing system. The personnel shortfall needs to be addressed, telephone services installed and billing computerized in order to serve consumers effectively thereby embracing IWRM concept.

4. CONCLUSIONS

1. Water sector reforms in Kenya have been guided by IWRM practice since the overall objective of reforms is to involve stakeholder and decentralize management of water resources. However stakeholder participation at local level has not been clearly defined since the functions of Water Resources Users Association are not defined in the Water Act 2002.
2. The current management structure of the canal, where YCWA Trust is in the process of taking over, support IWRM practice as the Trust is composed of representatives of various stakeholders. The Trust has to improve the services offered to water users and be responsive to their requests and expectations to gain their support to succeed.
3. Lack of basin management structure for Thika River Basin where stakeholders are involved, including those in Yatta Canal and Matuu water supply, has constrained

- implementation of IWRM concept as there is unfair water allocation among the users.
4. Only the planners, policy makers and politicians have been involved in planning and rehabilitation of the canal and Matuu water supply. The other stakeholders like women, farmers, domestic/ livestock consumers, NGOs and institutions have not been involved.
 5. In YCWA Trust board of trustees, women, the poor and marginalized are not represented so as to advocate for their rights as required in IWRM practice. NGOs and planners are also not represented in the BOT, though it is necessary to have them to guide the Trust on professional and advocacy issues.
 6. Integrated approach has been applied during planning and rehabilitation of the canal since its inception.
 7. Water rights have been biased towards men, neglecting women, the poor and marginalized in the canal. Generally there is unfair water allocation, pollution of feeder streams and unreliable supply due to lack of operation manual and inefficient management.
 8. There are no mechanisms that have been laid down to resolve water conflicts among the uses and users.

5. RECOMMENDATIONS

1. Currently YCWA lacks goodwill to effect the pricing policy and improve the management for self-sustainability of the project. An independent organization, supported by MWI and AWSB, like National Irrigation Board, need to be contracted for two years to prepare the stakeholders for takeover. This institution should have capacity to develop an operation model which will be used to regulate supply and ensure fair water distribution among users at all times, and develop strategies for effective stakeholder participation (including women and vulnerable groups) at all levels of development and management.
2. Promote water demand management practices like irrigating at night during dry seasons, effecting pricing policy that ensures one pays for what he/ she uses, having efficient water use advocacy campaigns at schools, markets and during public meetings. Encourage irrigation water use on the uphill part of the canal as misuse will be minimal due to pumping requirement.
3. Establish a section in the MWI and AWSB to deal with IWRM issues.

4. Establish Thika River Basin Water Users Association, incorporating most of the stakeholders, including representatives from Yatta canal and Matuu town to advocate for their interest so as to implement IWRM and make water use sustainable.
5. Include women, NGOs, the poor and marginalized and planners in the BOT.
6. Establish strong irrigation extension service to advice farmers on appropriate irrigation technologies, practices, and water scheduling.
7. Carry out further study for storage required to meet ultimate demand in Yatta canal, alternative source for Matuu water supply, hydro-geological survey to map up groundwater flow pattern aimed at controlling non-beneficial seepage, and acreage under irrigation.
8. Formulate strategies that ensure water use addresses poverty reduction, the poor and marginalized.
9. Establish coordination committee for water and related sectors at national level (by MWI) and Yatta division (initiated by AWSB) to coordinate sectoral activities affecting Yatta canal.
10. Develop monitoring and evaluation programme to follow up on implementation of IWRM, especially on fair water allocation, stakeholder participation including involvement of women in decision-making and coordination of water related sectors.

6. LIST OF REFERENCES

- Cap-Net, (2002):** Tutorial on basic principles of IWRM
- Global Water Partnership, (2000):** TEC background paper No.4, *Integrated water resources management*
- Global Water Partnership, (2003(1)):** TEC background paper No. 9, *Water management and Ecosystems: Living with change*
- Global Water Partnership, (2003(2)):** TEC background paper No.8, *Poverty Reduction and IWRM*
- Global Water Partnership, (2004):** Technical Committee, TEC, *Catalyzing change: A handbook for developing integrated water resources*

management (IWRM) and water efficiency strategies pp.6-37

Government of Trinidad and Tobago, (1997): *Integrated water resources management: Proceedings of workshop held on June 24-27 in 1997 on Institutional and Policy reform*
<http://www.sarp.org.za/documents/doo00575/index.php>.

Ministry of Agriculture, Animal Husbandry and Water Resources, (1962): *African Land Development in Kenya 1946-1962 pp.32-37*

Ministry of Planning and National Development, (2002): *Machakos District Development Plan 2002-2008 pp.23,79*

Ministry of Water Development (irrigation section), (1984): *Yatta canal rehabilitation proposals*

Ministry of Water Development (irrigation section), (1989): *Yatta canal rehabilitation proposals, request for donor assistance*

Ministry of Water Resources Management and Development, (2003): *First National Water Resources Management Strategy*

Ministry of Water Resources Management and Development, (2003(1)): *Yatta Canal Technical report*

Ministry of Water Resources, (1999): *Sessional Paper No.1 of 1999 on National Policy on Water Resources Management and Development pp.1-8*

Noelink Consulting Associates, Belgian Technical Cooperation and Government of Kenya, (2005): *Study on sustainable management model for Matuu water supply and sanitation project pp.69*

Office of the President, (1999): *National Poverty Eradication Plan 1999-2015*

Prof. Dieter Prinz, and Dr. Amir H. Malik of Institute of Water Resources Management, Hydraulic and Rural Engineering, University of Karlsruhe, Germany, (undated): *More yield with less water. How efficient can be water conservation in agriculture*

Ralph A.Warbs, and Wesley P. James, (2002): *Water Resources Engineering, Eastern Economy edition*

Strategic Design Consultants, (2005): *Matuu Town Council Strategic plan 2005-2010 pp.52*

UN-Habitat, (2002): *Water demand management in practice pp.42-8*

United Nations Commission on Environment and Development, (1992): *Agenda No. 21*

World Bank DC, 20433, (2004): *Water resources sector strategy; strategic directions for the world bank engagement*

World Bank, (2003(3)): *Water Resources and Environment Technical Note E.1: Irrigation and Drainage development pp.11, 12; 16-20*

World Health Organization, (1999): *Guidelines for drinking water quality volume2 pp.9-62*