RESEARCH ARTICLE

SCALING UP WATER SERVICES IN KENYA – SECTOR SENSITIVITY TO INFRASTRUCTURE INVESTMENTS.

Victor Mose.
Kenya Institute for Public Policy Research and Analysis P.O. Box 56445 – 00200, Nairobi.

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Manuscript Info	*Abstract*
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	Sector sensitivity to infrastructure investments is critical in ascertaining the threshold investments towards achievement of sector objectives. The study investigates the relationship between water sector public investments and sector contribution to gross domestic product (GDP), water coverage and irrigation. Vector error correction mechanism and vector autoregression are applied on time series data spanning the period 1980-2016. The results indicate that Kenya requires approximately seven times more of development expenditure as initial drift followed by sustained medium term increment of over 10 percent to achieve and sustain 10 percent growth in both GDP contribution and water coverage, together with 14 percent increase in irrigation tonnage. Water investments take about 3 to 4 years to register significant positive results, showing that Kenya may need at least five 5-year medium term cycles to realize universal access to water and sustain growth in real GDP and irrigation productivity.

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Introduction:-
Growth in Kenya's water sector has remained relatively low with an average annual growth of 3.6 percent and 7 percent in sector real and nominal Gross Domestic Product (GDP) respectively. This growth is below the Vision 2030 target of 10 percent growth in overall real GDP. The population which could access water from water utilities was 53 percent in 2016, which was below the 76 percent target for each by 2015, with annual increment which is below 1 percentage point (WASREB, 2016). It is expected that increased investment to the water sector should have a positive impact on the key performance indicators like accessibility and infrastructure development. Sector sensitivity provides a multiplier which can be used to estimate sector investment needs. However, what is not known is how sensitive are the sector outputs to investment, especially capital and labour.

The first perspective of sector sensitivity to investment is to investigate the link between investment in the sector and the overall growth of the economy. This aims at analysing the relationship between investments into the water sector and contribution to the economy especially through GDP, employment and inflation. The second perspective is to assess the sensitivity of the key performance indicator(s) specific to the sector to investments. This is one way of assessing value for money or factor productivity.

Water activities in Kenya have continued to receive finances from the public sector, private sector and development partners. Financing primarily targets improvement in water service and resource management. Financing of water

Corresponding Author:-Victor Mose.
Address**:-** Kenya Institute for Public Policy Research and Analysis P.O. Box 56445 – 00200, Nairobi.

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sector since 1980 is shown in figure 1.1. Since 2000 the sector funding has been increasing, with a drop in 2010-2014. This is against sustained increasing trend of total government budget as supported by Wagner's Law[1]. However, the kinked nature of the expenditure is also supported by Peacock-Wiseman hypothesis[2].

Figure 1.1:-Development and Recurrent Expenditure on Water Sector
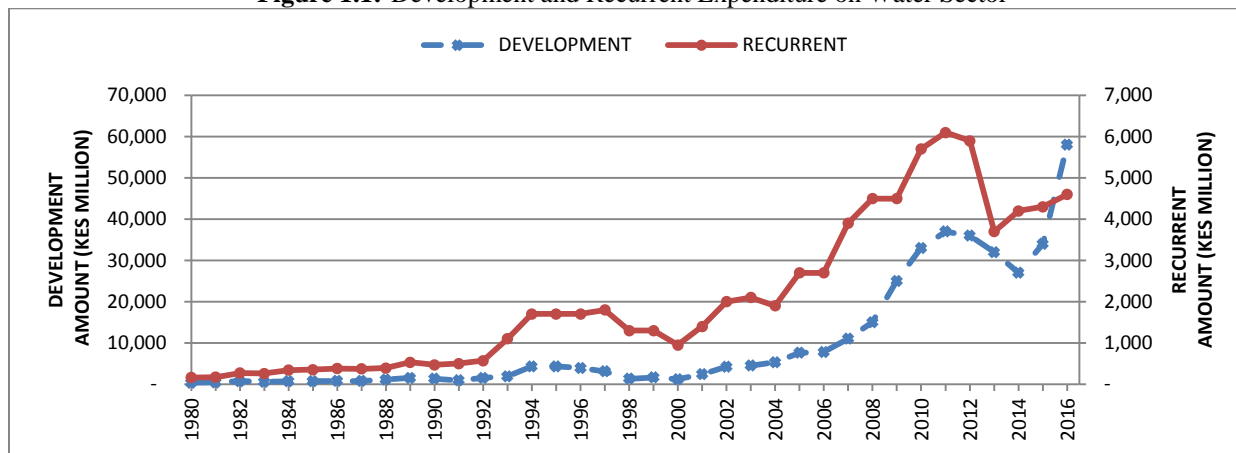
Source of Data: Ministry of Finance (1980-2012) or National Treasury (2013-2015)

The sector has also been witnessed increasing trend in contribution to GDP in real and nominal terms (figure 1.2). Besides the increase, the growthrate has not been consistent with the national targets in overall GDP and the share has remained below 1 percent. A spike is witnessed in 1999, a year when the national policy on water came into force, introducing reforms in the management of water resources, institutions and supply.

Figure 1.2:-Contribution to GDP by Water Sector
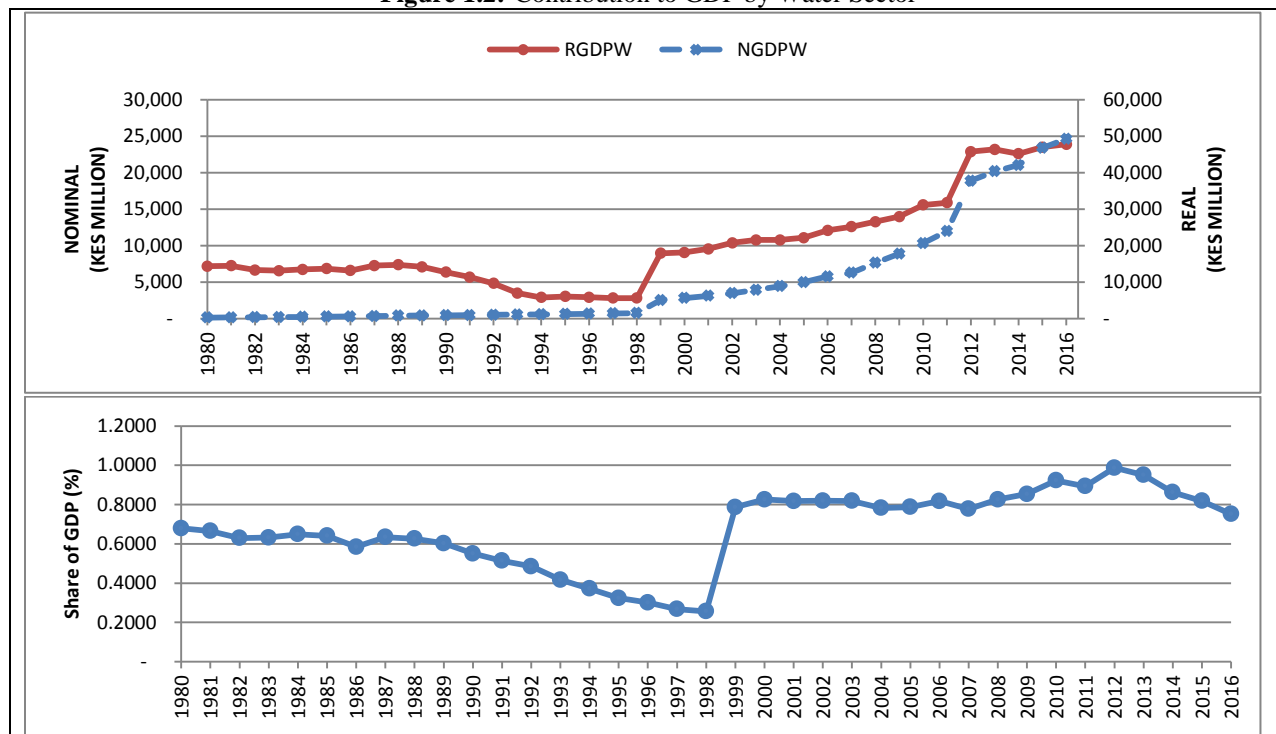
[1]Wagner's Law indicates that public spending is constantly on a continuous increasing trend
[2]Peacock-Wiseman hypothesis – Public spending has stepwise and kinked patterns due to displacement, inspection and concentration effects

The water sector needs to grow its share in contribution to GDP, to be over 1 percent. Sector GDP in current prices grew from KES.29 billion in 2010 to KES.49 billion in 2016 (table 1.1). However, using 2009 prices the real sector GDP grew from KES.27 billion to KES.32 billion between 2010 and 2016. In terms of the contribution of the sector to the employment agenda formal employment grew from 7,600 in 2010 to 12,700 in 2016. The value of output from irrigation also grew from KES.2 billion to KES.5.6 billion which corresponds with growth in tonnage of irrigated crops from 72,500 tonnes to over 100,000 tonnes in the period 2010-2016.

Table 1.1:-Contribution of Water to the Economy

Indicator	2010	2011	2012	2013	2014	2015	2016
Sector GDP (Current Prices, KES. Million)	29,407	33,428	37,779	40,406	42,072	46,794	49,251
Sector GDP (Constant 2009 Prices, KES. Millions)	27,493	28,489	29,358	29,616	30,690	31,654	32,487
Sector Contribution to GDP (Percentage)	0.9	0.9	0.9	0.9	0.8	0.7	0.7
Sector Wage Employment (KES. Thousands)	7.6	7.6	8.5	9.5	10.4	11.5	12.7
Irrigation Gross Value of Output (KES. Millions)	2,097	4,338	4,932	4,347	4,536	6,717	5,673
Actual Rice output – (Tonnes)	72,500	80,244	83,572	90,703	96,029	116,473	101,510
Area Cropped (Hectares)	17,611	21,101	21,872	21,313	19,411	-	-
Total Area Available for Irrigation (ha)*	29,099	28,034	29,630	31,349	28,390	-	-
Production tons*	110,494	111,229	138,204	125,256	112,263	-	-
Consumption(tons)*	410,000	520,000	540,000	509000	564000	-	-
Projected Rice Output – (Tonnes)**	87,393	95,530	104,424	114,145	124,772	136,389	149,087
Projected Rice Deficit – (Tonnes)**	216,368	216,433	215,963	214,891	213,148	210,656	207,328

Source of Data: KNBS (2016),*MOALF(2016) and **MOA(2008)

Sector performance in water coverage indicates an average of 60 percent over the period 2007-2014 (World Bank, 2016). This indicator shows the proportion of the population that has access to improved sources in water. The coverage increased by 5 percentage points in 7 years, averaging 1 percentage point annually. For the urban population MWI[3] (2016) shows that water coverage grew from 37 percent in 2007 to 58 percent in 2016. However, the population which is underserved in the urban areas showed an increasing trend from 7.1 million people to 9.3 million people in the period 2007-2015 (MWI, 2016). Water infrastructure also contributes to agricultural output through irrigation. The value of output from agriculture rose from KES. 2 billion in 2010 to a high of KES 6.7 billion in 2015, this was due to an increase in output from 80 thousand tonnes to 100 thousand tonnes. However, this was below the projected production of irrigation tonnage. According to MOALF[4] (2016), rice production declined from 125,256 tonnes in 2013 to 112,263 tonnes in 2014, the area planted increased from 29,630 ha in 2012 to 31,349 ha in 2013, but declined to 28,390 ha in 2014, mainly due to a dry spell (MOALF, 2016).

Research Problem
Kenya seeks to attain universal access to improved water sources by 2030. However, there is low access to improved water in Kenya (estimated at 58 percent of the population) yet the sector continues to record low growth, less than 1 percent annually which raises concerns as to whether the sector will be able to achieve the 2030 target of 100 percent coverage. On the other hand, Kenya's population is growing faster than the growth in infrastructure thus intensifying water scarcity and insecurity. The sector is a capital-intensive with 1:3 ratio of recurrent to development expenditures, respectively. The effectiveness of such capital investment is of policy concern with respect to productivity and optimal investment. The country spent over KES.20 billion annually over the period 2008-2016 on the sector, but this has not registered remarkable improvement in water coverage, food sufficiency and contribution to the economic growth.

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[3] MWI stands for Ministry of Water and Irrigation

[4] MOALF stands for Ministry of Agricuture, Livestock and Fisheries

Irrigation is identified as one of the solutions to agricultural productivity and food security in Kenya (Government of Kenya, 2007) and critical for food sufficiency. However, Kenya has continued to import food to fill the food deficit. For instance, production of rice which is the main irrigated crop served only 20 percent of the consumption (MoA, 2008 and 2009). By 2016 the annual production was about 0.12 million tonnes of rice (KNBS, 2016) against a projection of0.149 and 0.36 million tonnes of rice production and consumption respectively (MoA, 2008), the deficit

is filled by imports. Projected deficit remained above 0.21 million tonnes annually, which casts doubt on robustness of the supply-side plans of the agriculture sector to meet the demand. Irrigation infrastructure is developed by the water sector (especially on water harvesting and storage), to facilitate growth in output from agriculture to meet the demand. There is need to assess how water investments are linked with irrigation output, towards bridging the food deficit.

Vision 2030 targets the economy to grow by 10 percent. However, the sector contributes less than 1 percent to GDP and grows at about 3.6 percent annually. One of the key challenges the sector faces is financial gap (MEWNR,2013, 2014 & 2015; WASREB, 2013, 2014, & 2015). This hinders investments and has adverse effect on sector outputs and outcome. The task ahead is to establish optimal investment to trigger desired socioeconomic impact.

Research Objectives
The overall objective of the study is assessing the level of sensitivity of the water sector to investment. In order to fulfil this objective, the study investigates 4 specific objectives which are;
1. Examine the relationship between gross domestic product and investments in the water sector Kenya.
2. Measure a multiplier of water investments for universal access to water in Kenya.
3. Establish the relationship between water investments and irrigation output in Kenya
4. Explore the factors contributing to investment optimality in water sector in Kenya.

Justification of the Study
The Vision of Kenya with respect to the water sector is targeting universal access to improved water sources and increased agriculture productivity through increased irrigated land (Government of Kenya, 2007). Various programmes and projects have been dedicated towards the realization of the sector agenda in the medium-term plans (I and II). In addition, the country aspires to record 10 percent growth on real GDP and this is possible if respective sectors grow simultaneously with optimal contributions, relative to their share of GDP. The progress towards meeting the sector targets has been slow rasing doubts whether the sector goals will be achieved within the timelines. It is therefore, important to assess the performance of investments into the sector towards achieving the intended outcomes.

In the annual water sector reviews, the Ministry of Environment, Water and Natural Resources (MEWNR, 2013 and 2014) and Ministry for Water and Irrigation MWI (2015 and 2016) recognize that for water sector to have remarkable impact on economic development it should take into account the investment needs and exploit financing options. In addition, investment plans should consider demographic patterns. It is in this context that the quest for optimal investment to yield desired effects on economic growth is emphasized and becomes significant.

Literature Review
Theoretical Literature
Endogenous and Exogenous Economic Growth Theories
Theories explaining economic growth can be classified broadly into two classes; exogenous and endogenous. Exogenous theories like the neoclassical assert that economic output is attributable to capital accumulation, growth in labour and level of technology (total factor productivity) but their changes are determined by external forces from the economic or production model. In the short-run Capital-labour ratio elucidates a steady state of economic growth whose change is exhibited through external factors that cause variations in inputs and diminishing marginal returns to inputs. In the short-run growth and movement towards the steady state depends on relative changes in capital and labour. Change in capital depends on saving rate and level depreciation whose net effect translates to investments. One of the external factors is technological progress which improves total factor productivity.

For instance, Harrod (1947) and Domar (1948) argue that output is proportional to some fixed proportions of capital to labour, at given level of technology. This assumption of fixed proportions in factors is relaxed in Solow (1956) by introducing variable proportions which allows for factor substitutability. Dynamics will require that for changes in

output to occur and attain a steady path there must be changes in at least capital or labour and technology, with concurrent growth rates at the steady state. The difference between Harrod-Domar (1947, 1948) and Solow-Swan (1956) perspectives is that in the latter the ratio of capital to labour is varying over time to maintain a steady state in economic growth while the former holds the ratio as constant. This is because, by variable proportions capital and labour are substitutable and that provides room for maintaining the growth path. This means that the various factor productivities can take any composition to yield the same growth rate. In fixed proportions, for growth to occur and maintain a steady path both capital and labour must increase such that they maintain equivalent ratios. In exogenous

growth, factors like saving rates, education and research are determined outside the model, thus externally influence the steady state by increasing capital or labour.

Proponents of endogenous economic growth mainly Kenneth Arrow (1962), Hirofumi Uzawa (1965), Paul Romer (1986), Robert Lucas (1988) argue that changes in growth is internally determined especially by human capital development through learning and experience as well as technological progress through innovations, which inherently drive the output and improve productivity of capital or labour. They are shift factors in the sense that technological change is described by a shift on the production function (Uzawa, 1965).

For instance, Arrow (1962) introduces learning and experience which grow over time in the growth of output to explain exponential growth in the economy above missing correlations with capital-labour ratio. Experience can be regarded as technological accumulation (stock) and it grows over time. Learning is the product of experience and can only take place through problem solving thus during activity (Arrow, 1962). Uzawa (1965) augmented labour with technological knowledge arguing that technological knowledge is embodied in labour and its effect reverses diminishing returns to settle at constant returns to scale. Technological knowledge is labour efficiency while technological change is rate of change in labour efficiency (Uzawa, 1965). Romer (1986) adds that knowledge is a capital good with increasing marginal product. This means that according to Romer (1986) growth in knowledge has increasing effect on marginal returns, thus an economy can experience increasing growth rate with increase in capital-labor ratio. Therefore, in endogenous economic growth long-run growth is driven primarily by the knowledge accumulation (Arrow, 1962; Uzawa, 1965 and Romer, 1986). This implies convergence to a steady state may be a mirage since knowledge is an increasing function over time.

Growth Accounting and Decomposition of Economic Growth
In Solow (1957) and Lukas (1988) variations in output emanate from technological change and variation in capital and labour. In this case growth is steered by growth in contribution of factors of production. Therefore, the factors of production have shares in the overall growth of the economy (Solow, 1957 and Lukas, 1988). Inputs with larger shares have higher effect on the growth of the economy and that total factor productivity tends to be inversely related with the share of capital and directly proportional to the share of labour (Senhadji, 1999).

In structural transformation, reallocation of factors of production across activities and sectors can lead to higher growth driven by technical change and efficient factor allocation (Dabla-Norris, 2015). More specifically, within-sector productivity, reduction in resource misallocation and improved efficiency has positive effect on total factor productivity (Dabla-Norris, 2015). The author indicates that there is significant misallocation of resources within-industry than there is across sectors and that if such misallocations are reduced higher economic productivity and output are feasible.

In this regard, growth in the economy is the incremental change in gross domestic product (GDP) over time which may not only be attributed to investment is capital, labour and technological progress but also sector productivities through aggregation of output of various sectors of the economy. Therefore, overall growth of the economy depends on the growth patterns and trends of the sectors and the resource allocations within and across the sectors. In this regard, scaling up a sector like water is expected to have a positive impact on the economy. However, the positive impact to the economy by growth in one sector may be insufficient to ensure growth in overall GDP; if the decline in some sectors is insurmountable. This is because sectors with large shares in the overall GDP is significant in determining the overall growth direction of the economy. Nevertheless, growth in sectors is relevant to the extent of contributing to the economy even though the share of a sector may be limiting its overall impact on the economy.

Public Goods and Public ExpenditureTheory
The discussion on capital accumulation, saving rate and depreciation rate hardly hold in the context of public goods which are inclined to being social needs like water. Growth in investments in public goods is mainly influenced by external forces. A public good is non-excludable, non-rivalry and once produced for some users, additional users can consume it without additional cost (Samuelson, 1954). Due to the nature of goods, public or private, the shares of investment by the government and the private sector differs. Infrastructure development in public goods tends to receive a larger financial share from the government allocation than the private sector investments. For public goods or quasi-public goods, the government has public contractual obligation to protect the public interest.

Water may largely be perceived as a pure public good whereas it is in reality a quasi-public good (White, 2015). Quasi-public goods exhibit some degree of excludability and rivalry traits, which deny it the qualities of being a pure public good. By rivalry, water is a scarce resource in terms of per capita availability, quality and storage thus use by one agent reduces its supply. However, if right of access water is used to describe rivalries, then water may be classified as a pure public good. Similarly, water infrastructure is non-excludable as evidenced by illegal connections to the main water infrastructure (White, 2015). However, water tariff introduces exclusion characteristics since it will be available for those who can afford or without accumulated water bills. Price mechanism drives the market into equilibrium quantities and prices which may not be necessarily be universally binding, fair and just given the social stratification. The government therefore invests in the water sector to protect the interests of the public especially those who may not access quality water if is left to the market forces (demand and supply). Government injects welfare maximization impetus by ensuring distributive justice and price fairness which market mechanism often fails in the water sector.

In the hands-off market approach water sector may not be competitively viable as an investment for the private sector given alternative investment opportunities like real estate. Therefore, it will limit investment from the private sector which will constrain the supply. Water shortages are recipe for upward trends in water prices. These prices and quantities may be discriminatory for the low-income social classes.

Water sector is also prone to negative externality tendencies whose effect on welfare government cannot tolerate. For instance, water usage in the upstream introduces rivalry through the externality created to the population downstream in terms of availability and quality. In the same vein, given the scarcity of water exposure to market mechanism especially perfect competition it will lead to over exploitation and diminish water availability per capita. These tendencies lead to market failure thus justifying the push for government intervention in the water sector.
Public capital is essential in provision of public goods and stimulating economic growth (Frone and Frone, 2014). Private savings do not accumulate and transform fast enough into public infrastructure thus creating the need for government investment. This does not mean that private investment is absent in the water sector. Private investment complement public investment thus marginal productivity of private investment is boosted by public sector investment (Frone and Frone, 2014).

Sector growth is expected to be directly proportional to growth in public expenditure. Growth in public expenditure is mainly explained by Wagner's law and Peacock-Wiseman Hypothesis (Rowley and Tollison, 1993). Wagner's law indicates that public expenditure is always growing in a smooth and continuous manner due to expansion of traditional economic activities, expanding demands on the public utilitiesand growth in incomes. On the other hand, Peacock-Wiseman Hypothesis proposes that though public expenditure is expected to grow over time, the growth is stepwise with irregular patterns based on displacement effect and sustained by concentration and inspection effects. Displacement expenditure is due to social disturbance like wars, insecurity and political instability. Concentration effect involves factors that sustain the pressure on expenditure to maintain the new equilibrium while inspection effect is related with adaptation and acceptance of the new tax equilibrium by the population (Rowley and Tollison, 1993).

Efficient infrastructure is associated with higher productivity. Productivity of inputs may be focused on average, marginal or total factor productivity levels (Um, Straub &Vellutini, 2009). Average level productivity is output per unit of input. It is a fallacy to compare productivity across inputs for the same entity, as though inputs are the same. Therefore, two dimensions of per unit output are analytically relevant. Firstly, analysis of productivity for a given entity using the same input over time reveals changes in productivity which should be of interest to policy makers in terms of dynamics of productivity. Secondly, it is also of benefit to compare productivity in a given input across entities; this will reveal the differences in factor productivities across entities and impact on total factor productivity.

Marginal change in output over time or due to an additional unit of input becomes a central focus in policies targeting productivity.

Investments and Economic Growth (Accelerator Principle and Multiplier)
By the multiplier effect, changes in output are linked with investment levels or changes in investments by a factor referred to as multiplier.Domar (1947) reiterates that "an increase in income is not a function of the amount invested; it is the function of the increment of investment" The multiplier is often the reciprocal of marginal propensity to save (MPS), where changes in output is taken to be directly proportional to changes ininvestment and equated through the reciprocal of MPS. It may be construed that the reverse of multiplier effect is the accelerator effect since in accelerator effect changes in investments are reenergized through the growth in output. Nevertheless, through accelerator effect, investments tend to follow the economic cycle.The accelerator measures the speed of adjustment of investments due to changes in economic activity. These two effects suggest bi-causality between investments and output (income).

Investments in water infrastructure contribute to economic growth and job creation. For example, cumulative investment and proper balance in water institutions and infrastructure are positively correlated with contribution of water to growth (Grey and Sadoff, 2006). Infrastructure investments lead to economic growth through reduction in input costs which can encourage expansion of existing firms as well as entry of new firms into the economy due to effective and efficient infrastructure. Lower water tariffs are possible from economies of scale, density economies, and technical efficiency (Schwartz and Johnson, 1992). Institutional investments are equally important especially in ensuring a good balance of governance, capacity, organization, policies, regulations and incentives to address water allocation, quality, rights and pricing, asset management and service delivery (Grey and Sadoff, 2006).

However, investments are faced with policy lags which may influence their impact on the sector. The lag-effect emanates from the tendency of some variable having their full impact on another after some period, as it accumulates energy or gains momentum over time. However, lag-effect may be seen as a delay in taking effect. Present status of an output (variable) may rely on lagged variable(s) as a predictor in policy analysis (Eberly, Rebelo, and Vincent, 2012; Hall, 1977; Nerlove,1972).

There are various ways water infrastructure can contribute to growth. Water is used for domestic, industry and agriculture purposes (Schwartz and Johnson, 1992). These have impact on economy level especially through water goods, labour productivity and job creation. Water goods are those products which rely on water as an input (Schwartz and Johnson, 1992). Water for domestic use has an effect on labour productivity through reduction in associated costs like health costs and opportunity costs of education and productive use of water collection time.

Empirical Literature
The appraisal of water infrastructure investments has been linked with GDP (output) at levels and per capita as well as employment creation and sector specific variables like water coverage and irrigation output. The transmission mechanism of how water infrastructure investments links with outputs and employment is through inputs or sector analysis.

Investment in water infrastructure was found to have positive impact on GDP per capita (Frone and Frone, 2012; Amusa, 2016; Musouwir, undated). The authors used public spending for water infrastructure. These results were consisted in 22 countries which Musouwir (undated) investigated. Frone and Frone (2012) analyzed Romania counties while Amusa (2016) focused on South Africa municipalities. In Amusa (2016) increase in public capital spending in water by 1 percent increases GDP per capita growth by about 4.75 percent; 1 percent increase in repair and maintenance increase growth by 3 percent while 1 percent increase in operating expenditure decreases the growth in GDP by 4.8 percent. GDP per capita increases by 0.5 percent if investment in water infrastructure is increased by 1 percent (Frone and Frone, 2012).However, Um, Straub and Vellutini (2009) did not find significant relationship between investment in water infrastructure and economic growth. The authors targeted the relationship between growth in GDP per capita and water per capita as well as per capita water growth. The mixed results may not be surprising since the shares and growth rates in GDP by non-water sectors may have an effect on how water impacts of the overall growth of the economy due to their higher correlations. This is pronounced when the variable of GDP used is the overall GDP or contribution by the sector to GDP.

IMF (2015) estimated that the elasticity of real GDP to public investments is between 0.098 and 0.346, depending on the efficiency of public investments. Cohen, Freiling and Robinson (2012) found that USD 1 expenditure on water and sewerage infrastructure generates USD 6.77 value in GDP with an elasticity of 0.0086. In addition, Pereira and Pereira (2015, 2017) assessed the effect of different infrastructure investment on GDP for Portugal and established elasticity of 0.0296 for water Infrastructure. In Fasoranti (2012) expenditure on water was insignificant in explaining GDP growth in Nigeria over the period 1977-2009.

Different sectors respond differently to changes in infrastructure investments. The marginal impact on GDP due to USD 1 spent on other sectors in the United States of America was; Highways and streets (USD 1.15), Transportation and power (USD 14.15), health, education, office and public safety (USD 3.28), conservation, development, nonmilitary equipment (USD 10.59). In terms of elasticity, water and sewerage expenditure had about 0.0086 and the rest as follows; Highways and streets (0.0055), Transportation and power (0.0210), health, education, office and public safety (0.0173), conservation, development, nonmilitary equipment (0.0049), (Cohen, Freiling and Robinson, 2012). Further Pereira and Pereira (2015, 2017) found that in Portugalpublic investments ininfrastructure in other

sectors other than water had the following elasticity to GDP; Petroleum Refining Infrastructure (0.0066), Electricity and Gas (0.0050), Telecommunications (0.0707), Health Facilities (0.1166), Educational Buildings (0.0427), Railroads (0.0433), Ports (0.0057), Airports (0.0197), National Roads (0.0442), Municipal Roads (0.0040), Highways (0.0226). In Nigeria, Fasoranti (2012) found that only expenditure on defense and internal security was significant with elasticity of 1.3 on GDP expenditure, while expenditures on other sectors including water, education, environment and housing, health services and agriculture were insignificant.

The impact on economic growth by different sources of support for infrastructure investment differs. In (Musouwir, undated) oversees development assistance has less multiplying effect than national budget on water sector. This result was consistent in 16 out of 22 countries which were studied. Such an outcome can be associated with the means of disbursement and systems which are in place for monitoring and evaluation. In addition, terms of aid play critical role in productivity of the investments. For instance, output based aid is assumed to be more productive than input-based aid.

Insignificant link was found between the number of water connections and GDP growth in Um, Straub and Vellutini (2009). However, the author recognizes that investment in water may have indirect impact to growth through external effects such better health and better productivity of workers. In contrast, in Musouwir (undated), water coverage had positive correlation with GDP.

Public investment in irrigation increases the level of irrigated land and its effect can be assessed through output or price effects (Mitik and Engida, 2013). Mitik and Engida (2013) simulations showed that in Nigeria agriculture output increased by 2 percent with increase in public expenditure by 15 percent. Tir, Momeni and Boboivich (2014) found the effect of water investment on agriculture output in Iran to be positive and significant with 1.3 elasticity. Public investments in various projects in Pakistan took 6-11 years to yield the planned yield, depending on the region, (Kumar, Bhardwaj and Singh, 2015). Chittedi and Bayya (2012) found that in India gross area under cultivation had elasticity of 4 to public expenditure on irrigation, however Selvaraj (1993) had found earlier that the elasticity between agriculture GDP and public expenditure to be 0.7.

Infrastructure investments also have effect on level of employment of an economy. For instance, Pereira and Pereira (2015, 2017) invested the effect of different infrastructure investment on employment for Portugal and established elasticity of 0.0181 for water Infrastructure. The infrastructure investment in other sectors had the following elasticity to employment; Petroleum Refining Infrastructure (0.0032), Electricity and Gas (0.0031), Telecommunications (0.0295), Health Facilities (0.0587), Educational Buildings (0.0268), Railroads (0.0162), Ports (0.0077), Airports (0.0081), National Roads (-0.0042), Municipal Roads (0.0159), Highways (0.0088).

Various methods have been used to assess the sensitivity of GDP and employment to public investments in infrastructure. For instance, Fasoranti (2012) used Error Correction Mechanism (ECM) after establishing stationarity of order 1 to all variables. Pereira and Pereira (2015, 2017) and Cohen, Freiling and Robinson (2012) used vector autoregression (VAR) method. Um, straub and Vellutini (2009) applied fixed effect regression on panel data. Others have used Ordinary Least Squares, correlations and descriptive statistics.

Economic growth accounting (Straub et al., 2008; Um et al., 2009) and structural transformation (Dabla-Norris, 2015 and Herrendorf, Rogerson &Valentinyi, 2013) have been commonly used in analyzing sources of economic growth. The latter assesses sectorial contributions while the former targets input productivity or shares.

Overview of Literature
Theory has linked relationship between investment and the economy as well as sector outputs. It is expected that increased investments will have direct effect the economy and sector outputs. The role of public sector in funding water investments is immense in relation to private sector, mainly due to the limited rate of returns that are associated with water services.

It has been established through empirical literature that elasticity of output to water infrastructure investment falls between 0.002 and 0.004. However, this is in relation to the overall GDP and not necessarily GDP attributable to water sector only, besides other studies focusing on GDP per capita. Empirical interest focusing on GDP attributable to the water sector specifically is missing. Key variable used in assessing sector sensitivity to water investment are public expenditure and the labour, with some studies using recurrent expenditure in place of labour. There has been interest in comparing productivity of investments in water infrastructure with other public infrastructure investments.

Key estimation techniques in linking the water infrastructure with the economy and the sector outputs are ordinary least squares, error correction mechanism and vector autoregression. These developments inform the theoretical and analytical framework that follows.

Methodology:-
This section presents the theoretical framework and analytical framework.

Theoretical Framework
The study is based on the economic growth accounting which links changes in output of the economy with changes in capital, labour, and technology. Following the work of Solow (1957), Straub et al., 2008, and Um, Straub and Vellutini (2009), output (Q) can be linked with capital (K) and labour (L) as show in equation 3.1, assuming a level of technology or total factor productivity (A).

$Q = F(A, K, L)$ Equation 3.1

Assuming neutral technology

$Q = A(t)f[K(t), L(t)]$ Equation 3.2

By total differentiation of Equation 3.2 with respect to time we form Equation 3.3 as follows;

$\frac{\partial Q}{\partial t} = \frac{\partial Q}{\partial A}\frac{\partial A}{\partial t} + \frac{\partial Q}{\partial K}\frac{\partial K}{\partial t} + \frac{\partial Q}{\partial L}\frac{\partial L}{\partial t}$

$\frac{\partial Q}{\partial t} = \frac{\partial A}{\partial t}f(K, L) + A\frac{\partial K}{\partial t}\frac{\partial f}{\partial K} + A\frac{\partial L}{\partial t}\frac{\partial f}{\partial L}$ Equation 3.3

Dividing Equation 3.3 by Q in the LHS and RHS we have;

$\frac{\partial Q}{\partial t}\frac{1}{Q} = \frac{\partial A}{\partial t}\frac{f(K,L)}{Q} + A\frac{\partial K}{\partial t}\frac{\partial f}{\partial K}\frac{1}{Q} + A\frac{\partial L}{\partial t}\frac{\partial f}{\partial L}\frac{1}{Q}$

$\frac{\partial Q}{\partial t}\frac{1}{Q} = \frac{\partial A}{\partial t}\frac{f(K,L)}{Af(K,L)} + \frac{\partial K}{\partial t}\frac{\partial f}{\partial K}\frac{1}{f(K,L)} + \frac{\partial L}{\partial t}\frac{\partial f}{\partial L}\frac{1}{f(K,L)}$ Equation 3.4

Multiplying the last two sections in the RHS of Equation 3.4 with K/K and L/L respectively, we obtain Equation 3.5 as follows;

$\frac{\partial Q}{\partial t}\frac{1}{Q} = \frac{\partial A}{\partial t}\frac{1}{A}\left(\frac{f(K,L)}{f(K,L)}\right) + \frac{\partial K}{\partial t}\frac{1}{K}\left(\frac{\partial f}{\partial K}\frac{K}{f(K,L)}\right) + \frac{\partial L}{\partial t}\frac{1}{L}\left(\frac{\partial f}{\partial L}\frac{L}{f(K,L)}\right)$

Let $\frac{\partial Q}{\partial t} = \dot{Q}$; $\frac{\partial A}{\partial t} = \dot{A}$; $\frac{\partial K}{\partial t} = \dot{K}$; $\frac{\partial L}{\partial t} = \dot{L}$ and $\epsilon_k = \left(\frac{\partial f}{\partial K}\frac{K}{f(K,L)}\right)$; $\epsilon_L = \left(\frac{\partial f}{\partial L}\frac{L}{f(K,L)}\right)$

Such that;

$\frac{\dot{Q}}{Q} = \frac{\dot{A}}{A} + \epsilon_k\frac{\dot{K}}{K} + \epsilon_L\frac{\dot{L}}{L}$ Equation 3.5

Equation 3.5 makes the basis for analysing sensitivity of the water sector to water sector investments. In the equation growth in output is an aggregation of the effects of growth in technology, capital and labour. The parameters ϵ_k and ϵ_L are capital and labour elasticity of output respectively. The specific model is defined in the analytical framework which follows.

Analytical Framework

The theoretical framework indicates that growth in output can be decomposed into contributions by technology, capital and labour as shown in Equation 3.5 which can be written in log form as shown in equation 3.6, where for instance, $\frac{\dot{L}}{L}$ *is represented by lnL*. This study follows Straub et al., 2008, Um, straub and Vellutini (2009), and Pereira and Pereira (2015, 2017) such that it uses similar model as equation 3.6 where $Q_{w,t}$ is any output attributed to the water sector at time t, $G_{w,t}$ is the public expenditure on water infrastructure at time t, $L_{w,t}$ is the labour engaged in the water sector at time t and $A_{w,t}$ is the level of water technology adopted at time t.

$$lnQ_{w,t} = lnA_{w,t} + \epsilon_k lnG_{w,t} + \epsilon_L lnL_{w,t} \qquad \text{Equation 3.6}$$

Since the analysis involves time series data unit root test will be conducted. This will involve the use of Augmented Dickey Fuller (ADF) test whose null hypothesis is the existence of unit root, which will imply non-stationarity of the variable. If all variables are found to be stationary, then OLS will be used in the analysis. However, if the variables are integrated of same order or different orders then co-integration or error correction mechanism are used respectively.

Model specifications:

The analysis will be assessed at absolute and log forms to target marginal products and levels of elasticity respectfully, like Pereira and Pereira (2015, 2017) and Cohen, Freiling and Robinson (2012). The elasticity and marginal products will inform the multipliers required in increasing resources towards universal access to water.

Some of the model specifications adopted take the forms shown in Equation 3.7 – 3.9. These are not system of equations to be analyzed together, they will be independently analyzed.

1. $lnGDPW_t = lnA_t + \epsilon_1 lnDEV_t + \epsilon_2 lnREC_t + \epsilon_1$ Equation 3.7
2. $lnWACS_{w,t} = lnB_t + \theta_1 lnDEV_t + \theta_2 lnREC_t + \epsilon_2$ Equation 3.8
3. $lnTON_t = lnC_{W,t} + \gamma_1 DEV_t + \gamma_2 REC_t + \epsilon_3$ Equation 3.9

Where;

GDPW = Contribution of Water sector to GDP
A/B/C = Level of technology
DEV = Public Expenditure on development of infrastructure
REC = Public Expenditure on recurrent spending
WACS = Population accessing improved water sources
TON = Tonnage which is output from irrigation
t = time

In order to estimate equations 3.7 to 3.9 ordinary least squares can be used if all variables are stationary (do not have unit root). However, most of time series data are nonstationary which calls for other methods like; autoregressive distributed lags, vector autoregression or error correction mechanism.

Estimation Techniques

Assuming dependent variable Y and independent variable X and Z.

1. Error Correction Model

$\Delta Y_t = \varepsilon_t + \alpha_1 Y_{t-1} + \sum_{j=1}^{\rho} \beta_j \Delta X_{t-j} + \sum_{j=1}^{\rho} \theta_j \Delta Z_{t-j}$ Short term relationship   Equation 3.10

$c\varepsilon_t = -a_0 + Y_t + \beta_1 X_t + \beta_2 Z_t$ Long term relationship   Equation 3.11

2. Vector Autoregression (VAR)

$Y_t = b_0 + \sum_{j=1}^{\rho} \alpha_j Y_{t-j} + \sum_{j=1}^{\rho} \beta_j X_{t-j} + \sum_{j=1}^{\rho} \theta_j Z_{t-j} + \varepsilon_t$ Equation 3.12a

$X_t = b_0 + \sum_{j=1}^{\rho} \alpha_j X_{t-j} + \sum_{j=1}^{\rho} \beta_j Y_{t-j} + \sum_{j=1}^{\rho} \theta_j Z_{t-j} + u_t$ Equation 3.12b

$Z_t = b_0 + \sum_{j=1}^{\rho} \alpha_j Z_{t-j} + \sum_{j=1}^{\rho} \beta_j Y_{t-j} + \sum_{j=1}^{\rho} \theta_j X_{t-j} + v_t$ Equation 3.12c

3. Autoregressive Distributed Lag (ARDL)

$Y_t = c_0 + \sum_{j=1}^{\rho} \alpha_j Y_{t-i} + \sum_{j=0}^{\rho} \beta_j X_{t-j} + \sum_{j=0}^{\rho} \theta_j Z_{t-j} + \varepsilon_t$ Equation 3.13

Where ρ represents the optimal number of lags, Y is the dependent variable, **X** is a vector of independent variables, (α, β, θ) are coefficient parameters, (a_0, b_0 and c_0) are constants and ε is the error term.

Data Sources and Description

Time series data over the period 1980-2016 was used and sourced fromKenya National Bureau of Statistics (KNBS), Ministry of Finance or National Treasury, Ministry of Water and Irrigation (MWI) and The World Bank. The key variables used are water GDPobtained from KNBS, Infrastructure investment represented by public development expenditure in water infrastructure and labour represented by recurrent expenditure in the water sector were obtained from the Ministry of Finance or the National Treasury. Water coverage, being the number of people accessing improved water source, was obtained from the Ministry of Water and Irrigation and The World Bank. Agriculture output being the tonnage from irrigation activities was obtained from KNBS. In addition, total population was obtained from The World Bank.

It is expected that the GDP of the water sector should increase with increases in expenditure in infrastructure development and recurrent expenditure. This is in line with growth theory in which as long as the economy or sector is below full employment more inputs are expected to yield more output. Similarly, the population accessing improved water should increase with increase in investments in the water sector. The output from agriculture should increase when more investments are allocated to the water sector. However, distortions and lag-effect in the investments may limit these relationships. The distortions may arise from other limitations in the sector like inadequate capacity or suboptimal usage. Limited capacities are likely to affect the efficiency with which the investments are utilized. The efficiency is expected in proper planning for investments, timeliness incompletion of water projects, and the use of appropriate technologies to optimize on the output and outcomes of the water projects. An optimal mix of the investments towards provision of water for domestic and industrial use as well as for irrigation is required in order to maximize the effect of the investments on socioeconomic objectives of the economy. The overall assessment of the effectiveness and efficiency with which the investments are used is obtained through the relationship of the water investments and the contribution GDP.

Analysis and Findings:-

This section provides a summary of descriptive statistics and analysis of the relationship between the variables. The effect of water investments is divided into four by linking the investments with the economy, access to water, population patterns and irrigation outputs.

Descriptive Statistics

Since 1980 the contribution of the water sector to the Kenyan Economy has grown by over KES.48 billion (table 4.1). In order to achieve this growth in GDP the investment in infrastructure development grew by over KES.57 billion and the recurrent expenditure increased too by over KES.5 billion. The population of Kenya grew from about 16 million to about 46 million while the population with access to improved water source is estimated to have grown from about 7 million to around 29 million. Irrigation investments increase the tonnage from 15 thousand tonnes to about 116 thousand tonnes, mainly from rice which is the main crop under irrigation.

Table 4.1:-Descriptive Statistics

Variable	Description	Obs	Mean	Std. ev.	Min	Max
NGDPW	Nominal Water GDP (in KES. Million)	37	10,400	14,600	302	49,300
NDEV	Nominal development expenditure (in KES. Million)	37	10,100	14,400	353	57,700
NREC	Nominal Recurrent Expenditure (in KES. Million)	37	2,070	1,830	156	6,060
RGDPW	Real Water GDP (IN KES. Million)	37	10,100	6,290	2,840	23,900
RDEV	Real development expenditure (in KES. Million)	37	10,700	6,380	1,960	28,000
RREC	Real Recurrent Expenditure (in KES. Million)	37	3,310	829	1,530	4,640
WACS	Population accessing to Improved Water (in KES. Million)	36	NA	NA	7.00	29.10
POP	Total Population (in KES. Million)	36	NA	NA	16.30	46.10
TON	Tonnage from irrigation (Tonnes)	37	48,432	24,719	15,682	116,473

Test for Stationarity

The study used ADF test to check for unit root. All variables were found to be non-stationary (table 6.1, at the appendix). The variables were subjected to detrending as one way of checking for the source of nonstationarity, with 8 of them confirming the significance of trend but still had unit root. In order to assess the long-run relationship between variables assessment of the order of integration $I(d)$ is critical. A variable is said to be integrated of order

(d) if it is non-stationary at level but becomes stationary after differencing d-times. If the variables are integrated of the same order cointegration model is used, otherwise error correction mechanism is used to recover the longrun relationship through the estimation of the shortrun relationship. The short run relationship indicates the speed with which the equilibrium is restored. Regressions on non-stationary data estimate spurious results. The analysis was done with both nominal and real values of GDP, infrastructure and recurrent expenditures.

Population accessing improved water sources and real value of infrastructure expenditure were integrated of the second order. The rest of the variables were integrated of order 1. In order to capture the elasticity of the economy's output to changes in infrastructure investments the variables were transformed to log form and all of these variables are integrated of the first order (table 6.1). The optimal lag length was obtained by picking the criteria which suggested a parsimonious model among the **Akaike Information Criterion** (AIC), **Hannan–Quinn information criterion**(HQIC) and **Schwarz' Bayesian Information Criterion** (SBIC) given the small sample.

Effect of Water Investments
The Error Correction Mechanism was used to estimate the relationship between the variables. This method yields the short-run relationship which is helpful in assessing how fast the dependent variable recovers after the short-run effect in changes in the independent variables. In order to recover the long run relationship presented in table 4.2, cointegration process is used based on the corrected error (ce) arising from the estimated short-run (SR) relationship and the speed of adjustment. Further analysis was done using the VAR specifically aimed at determining the policy lags in delivering desired results (appendix). The intuition is that if variable is significantly and positively related with variations in the dependent variable after some time lags, then the time difference marks the time lag for policy on that variable to register desirable effect. In table 4.2 the cointegration results from the VECM are presented including the coefficients and probability of rejecting or failing to reject the null hypotheses. The presentation is such that the corrected error term is equated with the constant term and the variable terms as shown in equation 3.10.

This is a long run relationship recovered after the estimation of the short run equation. The analysis was done for transformed variable to logs and at their level targeting elasticity and marginal products respectively. Further categorization is in terms of nominal and real values to investigate existence of inflationary distortions in the sector.

Table 4.2:-Long Run Relationship

BETA	COEF.	P>Z	BETA	COEF.	P>Z	BETA	COEF.	P>Z	BETA	COEF.	P>Z
_CE1	LAGS(2)		_CE1	LAGS(4)		_CE1			_CE1	LAGS(1)	
LGDP	1	.	GDP	1	.	LRGDPW	1	.	RGDPW	1	.
LNDEV	-0.6192	0.083*	NDEV	2.3745	0.001*	LRDEV	-1.1106	0.000	RDEV	-0.8087	0.000
LNREC	-0.5131	0.275	NREC	-4.2419	0.262	LRREC	0.13867	0.817	RREC	4.9856	0.000
_CONS	3.0671	.	_CONS	-4.24E+08	.	_CONS	-0.3127	.	_CONS	-1.69E+09	.
BETA	COEF.	P>Z	BETA	COEF.	P>Z	BETA	COEF.	P>Z	BETA	COEF.	P>Z
_CE1	LAGS(1)		_CE1	LAGS(2)		_CE1			_CE1	LAGS(1)	
LWACS	1	.	WACS	1	.	LWACS	1	.	WACS	1	.
LNDEV	0.2158	0.028*	NDEV	0.00046	0.003*	LRDEV	-1.0189	0.000	RDEV	-0.00031	0.000
LNREC	-0.6619	0.000*	NREC	-0.0085	0.000*	LRREC	2.4942	0.000	RREC	0.001794	0.000
_CONS	-7.0762	.	_CONS	-1.09E+07	.	_CONS	-47.8201	.	_CONS	-1.51E+07	.
BETA	COEF.	P>Z	BETA	COEF.	P>Z	BETA	COEF.	P>Z	BETA	COEF.	P>Z

_CE1	LAGS(4)		_CE1	LAGS(4)		_CE1			_CE1		
LPOP	1	.	POP	1	.	LPOP	1	.	POP	1	.
LNDEV	-.4718	0.000*	NDEV	0.0041	0.000*	LRDEV	-.3419	0.000	RDEV	-.0014	0.000
LNREC	.6160	0.000*	NREC	-0.0219	0.000*	LRREC	.4508	0.000	RREC	.0107	0.000
_CONS	-21.7731	.	_CONS	5.25E+07	.	_CONS	-20.4376	.	_CONS	-5.01E+07	.
BETA	COEF.	P>Z	BETA	COEF.	P>Z	BETA	COEF.	P>Z	BETA	COEF.	P>Z
_CE1	LAGS=1		_CE1	LAGS=4		_CE1			_CE1	LAGS(1)	
LTON	1	.	TON	1	.	LTON	1	.	TON	1	.
LNDEV	-0.6286	0.000*	NDEV	-0.000068	0.001*	LRDEV	-0.714794	0.000	RDEV	-.0000035	0.000
LNREC	0.5637	0.000*	NREC	0.0000677	0.573	LRREC	1.0891	0.000	RREC	.000015	0.000
_CONS	-8.6654	.	_CONS	17148.11	.	_CONS	-18.16809	.	_CONS	-55766.95	.

The degrees of association tabulated in table 6.6 indicate that water sector GDP, accessibility, population and tonnage are highly and positively correlated with development and recurrent expenditure in nominal terms. Similar case is experienced with real development expenditure. However, real recurrent expenditure has low and negative correlations with all variables. These shows that the variables tend to move in the same direction in terms of increases and decreases.

Water Investment and the Economy
This section responds to the objective which seeks to establish the relationship between GDP and water investments. Assuming economic agents provide for inflationary effects then nominal values can be analysed over time, just like real values (values adjusted for inflation).

In nominal terms, an increase in investment for infrastructure by 1 percent is associated with about 0.6 percent increase in the nominal GDP of the water sector (table 4.2). The marginal product of water investments is KES.2.4 of nominal GDP regardless of a decrease in investments for infrastructure development. On the other hand, real GDP increases by 1 percent with increase in infrastructure investments by similar margin and links with KES 0.8 marginal product of real GDP (table 4.2).

Nominal recurrent expenditure is not significant to sector GDP which implies variations in recurrent expenditure do not necessarily result in significant variations in water GDP. Nevertheless, the sector demonstrates resilience to decreases in real recurrent expenditure with sustained marginal product of KES.5 regardless of a unit decrease in real recurrent expenditure. The effect of the policy on staff productivity which caps staffing size does not necessarily overrun the growth momentum of the water sector. However, the overall assessment shows that recurrent expenditure is not well linked with the sector outcomes.

In order to further analyse the policy lag in meeting the desired results the VAR model was used. Water sector GDP is positively impacted by infrastructure investments lagged by 3 years (table 6.2). In other words, it takes 3 years for infrastructure investment to have a positive impact on the water sector GDP. Recurrent expenditure of 4 years lag has positive effect on water GDP. This means that it takes around 3 to 4 years for the investments in the water sector in Kenya to have a positive impact on the GDP. Changes in infrastructure expenditure have significant effect on the sector after the first and second years.

Water Investment and Water Coverage

The relationship between changes in population accessing improved water services with development and recurrent expenditure indicate opposite results with respect to use of real and nominal values respectively.

In real terms changes in investments on water infrastructure by 1 percent can cause 1 percent increment in access to improved water (table 4.2). The marginal product of infrastructure investments is 0.0003, meaning that additional KES.10,000 invested for development of water infrastructure is associated with additional 3 people accessing improved water source. In contrast, the relationship between expenditure on infrastructure development has negative coefficient with changes in the number of people accessing improved water service. Besides a decrease in nominal expenditure on infrastructure development by 10,000 the water coverage still increases by 5 people. In terms of elasticity, access to improved water service continues to increase by 0.2 percent of people irrespective of 1 percent decrease in nominal expenditure on infrastructure development. This may demonstrate the role of the private investments which fill the gap created by decreasing public investment or the effect of previous investments, besides the overriding effect by the recurrent expenditure.

Positive changes in nominal recurrent expenditure by 1 percent have positive effect on accessibility by 0.6 percent. The marginal product of nominal recurrent expenditure is 0.008, meaning an increase in nominal recurrent expenditure by 1000 shillings is associated with increased access to improved water source by 8 people (table 4.2). Contrary, access to improved water is negatively correlated with real recurrent expenditure with marginal product of 0.002. This means that irrespective of sustained decline in real recurrent expenditure by KES.1000, access to improved water still increases by 2 people. Decline in real recurrent expenditure by 1 percent is associated with sustained increase in access to water by 2.5 percent.

The resilience of the water sector to decreases in infrastructure expenditure can also be explained by policy lags or effect of previous investments. It takes 1 to 2 years for investment in infrastructure to increase the population accessing improved water sources (table 6.3). This can be explained by the fact that it takes construction time for water infrastructure to be completed and handed over for use.

Water Investment and Population Growth

Growth in water investments should match up with the projected growth in population in order to keep pace on access to water. Population is always on an increasing trend, unless there is a catastrophe. Contrary to the population accessing improved water sources, overall population has positive relationship with investment in water

infrastructure and negative with recurrent expenditure in nominal values. This demonstrates that planning for water infrastructure is responsive to population growth but implementation does not yield the desired results. Increasing infrastructure expenditure by 1 percent is associated with increase in population by 0.5 percent (table 4.2). However, the marginal product of development expenditure is 0.004, but in negative coefficient, meaning that irrespective of KES.1000 declines in infrastructure investments, the population keeps on growing by 4 more people who would require access to improved water.

However, in real terms increase in allocations for the water infrastructure by 1 percent targets increment in population to access improved water by 0.3 percent, with marginal product of 0.001 (table 4.2). The marginal products show that every additional 1000 spent on water infrastructure should enable at least 1 more person to access improved water source. Though the population is projected to increase, there seems to be a sustained relative reduction in real recurrent expenditure in the water sector. Reduction in real recurrent expenditure by 1 percent, is still associated with additional 0.5 percent of population expected to be enabled to access improved water source. It is expected that additional 1 person is still feasible with reduction in real recurrent expenditure by KES. 100, given that the marginal product of 0.01.

In terms of time lags, it takes 3-4 years for both development and recurrent expenditure in real and nominal terms to have to have significant increases due to population growth (table 6.4). This coincides with the medium-term expenditure framework which takes 3 years.

Water Investment and Food Security

The development expenditure on water infrastructure has significant effect on the output from agriculture even though the recurrent expenditure is negatively linked to tonnage of agricultural output due to irrigation. Changes in

development expenditure on water infrastructure bring about positive changes on the number of tonnes of output from irrigation. Change in water infrastructure investments by 1 percent is positively associated with increase in tonnes of irrigation output by 0.6 percent (table 4.2). The tonnage from irrigation increases by 6 tonnes for an increase in water infrastructure investments by KES. 100,000 in nominal terms. Despite decline in nominal recurrent expenditure on water sector by 1 percent irrigation tonnage still increases by about 0.6 percent. Though not significantly correlated with variations in irrigation tonnage a decline in recurrent expenditure by about KES. 100,000, is associated with sustained growth in tonnage by 4 tonnes.

In real expenditure, increasing water infrastructure investments by 1 percent increases the tonnage from irrigation by 0.7 percent. This is associated with increasing expenditure by KES.1 million for additional 4 tonnes. The recurrent expenditure declines by 1 percent, but the sector still sustains growth in tonnage by 1 percent. The recurrent expenditure may decrease by KES. 100,000 but the sector still maintains an increase in tonnage by 2 tonnes.Changes in sector investments seem to have immediate results in irrigation output, a lag of a year only (table 6.5). This shows that there is planning proximity between investments and irrigation output.

In summary, the four preceding analyses (on the economic growth, water coverage, population growth and irrigation) indicate that in Kenya the water sector requires an annual increment of over 10 percent in real development expenditure to yield 10 percent growth in contribution of the sector to real GDP. This will also ensure 10 percent and 14 percent increase in number of people accessing improved water sources and the tonnage from irrigation respectively. This is derived from the elasticity of real GDP (1.1), access (1.0), population (0.3) and tonnage (0.7). However, the effect of nominal development expenditure is inconsistent especially with respect to water coverage which stresses the need for prudent realignment of the expenditures with more focus on water coverage. The elasticity to nominal development expenditure are; real GDP (0.6), access (-0.2), population (0.5) and tonnage (0.6). The marginal products of development expenditure on water investments, in reference to nominal and real values respectively, are GDP (-2.4 and 0.8), access (-0.0005 and 0.003), population (-0.004 and 0.001), and tonnage (0.00007 and 0.000004). Synthesis of these findings leads to a conclusion that in Kenya KES.1 million of development expenditure in the water sector can each trigger KES.3 million in contribution to GDP, increased water coverage by 500 people or increased irrigation output by 70 tonnes. This is linked with investment forecasting on growth of population by 4,000 people, which implies 3,500 remained outside the investment plan. The implication of these analyses is that development expenditure needs to increase by seven times more. Recurrent expenditure may need judicious synchronization, optimal mix and utilization to prevent adverse effect on productivity in the outputs, since they have negative coefficient of elasticity and marginal product.

The time lag taken by the water investments to yield significant relationship with dependent variables was estimated at 3 to 4 years, thus signalling as probable period investments take to show desired outcomes. This relatively coincides with planning cycles of the country with respect to medium-term plans (MTP), whose major policy shifts in sector allocations are expected periodically. In this regard, a combination of threshold increment in allocations for development expenditure and policy time lags shows that with sustained 10 percent annual increment in water development expenditures, Kenya will need about 5 MTP cycles to realize universal access to water and sustainable 10 percent growth in real GDP and food security.

Challenges Faced in Maximizing Water Investments Potentials
A meta-review of water sector reports shows that inconsistencies in the effect of water investments to the sector outputs can be attributed a number of investment challenges (table 4.3). Insufficient funding arises from financial gaps emanating from expected expenditure and actual receipts, which is attributable to weak resource mobilization strategies in the sector or its inability to attract partnership with rivate sector. Delayed disbursements from both the government and development partners affect delivery of water project. It is also noted that some projects and institutions do not exhaust the funds advanced to them, this results in low absorption of funds leading to limited negotiation power and increased likelihood in revision of budget allocation downwards in subsequent year.

Capacity gaps have been cited especially in technical and financial skills which have negative effect of efficiency of the sector. The sector investment planning and coordination is weak, and this affects integration and alignment of the investments towards maximized output and expansion. This has also been complicated especially in the transition period which was to entrench devolution in the sector since water service delivery is a function of devolved governments. The sector needs a negotiated and well-structured coordination framework to ensure that the synergies between the national and county governments are harnessed in execution of their functions. The

monitoring and evaluation framework is inadequate, and this exposes the water investments to various risks which curtails attainment of the outputs and outcomes of the programmes and projects. Lack of a clear monitoring and evaluation framework is a weakness with respect to the principles of good governance and public finance management.

Table 4.3:-Challenges Using Water Investments Effectively

Sector Challenges on Productivity	Sector Reports					
	2009	2011	2012	2013	2014	2015
Insufficient funds	✓	✓	✓	✓	✓	✓
Disbursement of funds	✓	✓	✓	✓	✓	✓
Absorption of funds			✓	✓		
Capacity in technical and financial skills	✓	✓	✓	✓	✓	✓
Investment planning and coordination,	✓	✓	✓	✓	✓	✓
Monitoring and Evaluation Framework	✓	✓	✓	✓	✓	✓

Source of Data: MEWNR (2012, 2013) and MWI (2009, 2014 and 2015).

The sector needs to address these challenges to boost productivity of investments. These challenges are largely about capacity building. They fall under sector support and strengthening where the support is aligned to financing while strengthening is associated with principles of governance and management especially those touching on planning, coordination, monitoring and evaluation, and accountability.

Conclusion and Recommendations:-
The paper has interrogated the need for and means of enhancing financing and boosting investment productivity of the water sector in Kenya. Water sector investments have mixed effects on the economy with respect to the role of development expenditure and recurrent expenditure. This shows that there exist investments distortions which limit the investments from registering desired impact. Some of the reasons attributed to such distortions are delayed disbursement, low absorption rate,absence of harmonised sector national investment plan and weak coordination, monitoring and evaluation framework. However, these factors need further research to ascertain their nature, intensity and effect.

The growth in real GDP, access to water and irrigation output is more dependent on development expenditure (infrastructure investments) than the recurrent expenditure. There has been consistent policy in controlling disproportionate increase in recurrent expenditure,with emphasis being dedicated on development expenditure. This is partly due to the nature of the sector which is capital-intensive. However, without optimal mix of recurrent and

development expenditure the sector can stagnate andrecord lower growth rates than its full potential. Nevertheless, the sector has shown resilience to the policy on capping recurrent expenditure, by registering growth. The resilience on reducing recurrent expenditure can be attributed to cumulative effect of investments over the previous period, necessitated by policy lags in investments to register desired impact.

An optimal balance between recurrent and development spending is critical in building synergies between the two expenditures. The outcome inconsistencies with water financing are attributed to inadequate coordination of investment plans, delayed disbursement, low absorption and limited monitoring and evaluation framework. Lack of integrated investment plan exposes the sector to dis-jointed investments thus limiting synergies that can foster accelerated progress made by Kenya in the water sector. Whereas, the sector depends on multi-stakeholder participation, meaningful progress can only be achieved with well-coordinated investment planning, which is missing in Kenya. Therefore, a national investment plan is inevitable.

It is reiterated that sector financial investments and support in Kenya should be urgently scaled up and hinged on strengthening investment productivity if desired targets are to be achieved effectively and efficiently. The central call to the sector financing partners is to emphasize on value for money from the recipients of the water sector finances. The caution is that failure to take heed, Kenya will continue to experience delays in achieving the sector objectives on universal water coverage and food security, derailing the sector from meeting Vision 2030. It is also recommended that outcome-based financing is used as opposed to output based or input based. This will instil the culture of productive investments and focus more on end results. Further area for research is an extension the scope

of this paper to include a comparative analysis for Africa on sector sensitivity to water investments. It will also be of great significance to carry out a survey on the various water programs with a view of ascertaining their impact and situational analysis.

The analysis has estimated multiplier effect of infrastructure investment in the water sector. It has also reviewed challenges the sector faces with respect to realizing full potential of investments. On this basis the following recommendations are made;

1. Development expenditure needs sustained annual increment of 10 percent to yield 10 percent growth in real GDP contribution of the sector. This will also enable 10 percent and 14 percent increase in water coverage and irrigation tonnagerespectively.In order to achieve and sustain universal access to improved water source by 2030, development expenditure need to increase by approximately seven times more in the initialshiftthen followed by sustained growth by 10 percent annually.
2. In order to achieve higher level of investment productivity to desirable impact on water coverage, development expenditure will require prudent realignment. This is because the relationship was contrary to the expected results and also showed inconsistencies.
3. The changes in recurrent expenditure need to be synchronized in the sector so that they do not have adverse effect on productivity in the outputs of the sector. This is because of the negative relationships and lack of significance in the effects of the recurrent expenditure on the sector outputs.
4. The sector can record higher productivity of investments with improvedmanagement with respect to investment planning and monitoring framework which can guarantee value for money and investment efficiency. Therefore, there is need to develop an investment plan with a clear coordination, monitoring and evaluation framework.

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Appendix
Table 6.1:-Unit Root Test

Variables	Unit root Test - ADF						Order of Integration					
	Lags	Estimate	Trend (p-value)	1% Critical	5% Critical	10% Critical	I (d)	Lags	Estimate	1% Critical	5% Critical	10% Critical
Nominal												
NGDP	1	0.604	0.089	-4.288	-3.560	-3.216	1	1	-4.080	-4.297	-3.564	-3.218
NDEV	3	6.815	-	-3.696	-2.978	-2.620	1	2	-5.747	-4.306	-3.568	-3.221
NREC	1	-2.331	0.033	-4.288	-3.560	-3.216	1	0	-5.551	-3.682	-2.972	-2.618
WACS	2	-2.226	0.065	-4.297	-3.564	-3.218	2	0	-3.540	-3.689	-2.975	-2.619
TON	2	-1.326	0.039	-4.297	-3.564	-3.218	1	0	-6.480	-3.682	-2.972	-2.618
LNGDP	1	-2.257	0.028	-4.288	-3.560	-3.216	1	0	-6.070	-3.682	-2.972	-2.618
LNDEV	1	-2.363	0.023	-4.288	-3.560	-3.216	1	0	-5.078	-4.288	-3.560	-3.216
LNREC	1	-2.524	0.038	-4.288	-3.560	-3.216	1	0	-5.265	-3.682	-2.972	-2.618
LWACS	1	-1.385	-	-3.682	-2.972	-2.618	1	0	-3.682	-2.972	-2.618	-3.682
LTON	1	-2.463	0.016	-4.288	-3.560	-3.216	1	2	-5.156	-4.306	-3.568	-3.221
Real												
RGDP	1	-1.137	0.032	-4.288	-3.560	-3.216	1	0	-5.542	-3.682	-2.972	-2.618
RDEV	2	-1.541	0.025	-4.297	-3.564	-3.218	2	4	-5.895	*-3.716*	*-2.986*	*-2.624*
RREC	1	-2.035	-	-3.682	-2.972	-2.618	1	0	-6.176	-3.682	-2.972	-2.618
LRGDP	1	-1.744	0.053	-4.288	-3.560	-3.216	1	0	-5.260	-4.288	-3.560	-3.216
LRDEV	1	-1.210	-	-3.682	-2.972	-2.618	1	0	-5.202	-3.682	-2.972	-2.618
LRREC	1	-2.132	-	-3.682	-2.972	-2.618	1	0	-5.973	-3.682	-2.972	-2.618

Table 6.2:-Time Lag in Water Investments Effect on Economic Growth

LGDP	Coef.	P>z	LRGDP	Coef.	P>z
L1.LGDP	.9012271	0.000	L1.LRGDP	1.141938	0.000
L2.LGDP	.0833221	0.598	L2.LRGDP	-.1019069	0.589
L1.LDEV	-.3815726	0.005*	L1.LRDEV	-.3673392	0.043*
L2.LDEV	.2470117	0.077*	L2.LRDEV	.310221	0.070*
L1. LREC	.2237081	0.254	L1. LRREC	.1680433	0.549
L2. LREC	-.0058289	0.978	L2. LRREC	-.1293892	0.652
_cons	-1.089256	0.105	_cons	-.413534	0.938
GDP	Coef.	P>z	RGDP	Coef.	P>z
L1. GDP	.6149441	0.000	L1. RGDP	.887504	0.000
L2. GDP	-.0554654	0.697	L2. RGDP	-.0274114	0.878
L3. GDP	.6600249	0.002			
L4. GDP	-.3246123	0.176			
L1. DEV	.05666	0.654	L1. RDEV	.1345246	0.349
L2. DEV	-.2113746	0.366	L2. RDEV	.0754254	0.602

L3. DEV	1.234708	0.000*			
L4. DEV	-1.163222	0.000*			
L1. REC	-.0049189	0.994	L1. RREC	-.8287495	0.206
L2. REC	.6131265	0.437	L2. RREC	-.0266102	0.969
L3. REC	-2.76289	0.000*			
L4. REC	3.94427	0.000*			
_cons	-5.06e+08	0.132	_cons	2.55e+09	0.240

Table 6.3:-Time Lag in Water Investment Effect on Access to Improved Water

LWACS	Coef.	P>z	LWACS	Coef.	P>z
L1. LWACS	.9783193	0.000	L1. LWACS	1.004039	0.000
L1. LDEV	-.0084491	0.020*	L1. LRDEV	-.0108522	0.009*
L1. LREC	.0176539	0.003*	L1. LRREC	.0177136	0.067*
_cons	.2127016	0.075	_cons	-.1664192	0.443
WACS			WACS		
L1.WACS	1.518623	0.000	L1.WACS	2.170377	0.000
L2.WACS	-.5367943	0.042	L2.WACS	-1.175283	0.000
L1.DEV	-.0000394	0.001	L1.RDEV	-.0000106	0.493
L2.DEV	.0000136	0.178*	L2.RDEV	-3.87e-07	0.978
L1.REC	.0001313	0.020*	L1.RREC	-8.89e-06	0.901
L2.REC	.0001473	0.012*	L2.RREC	.000105	0.123*
_cons	267124.4	0.003	_cons	-251732.1	0.363

Table 6-4:-Time Lag in Water Investment Effect on Population Growth

LPOP	Coef.	P>z	LPOP	Coef.	P>z
L1. LPOP	3.52697	0.000	L1. LPOP	3.494504	0.000
L2. LPOP	-4.668711	.	L2. LPOP	-4.602112	.
L3. LPOP	2.757433	.	L3. LPOP	2.672958	.
L4. LPOP	-.6169087	0.000	L4. LPOP	-.565811	0.000
L1. LNDEV	-.0001611	0.064	L1. LRDEV	-.0001153	0.187
L2. LNDEV	.000113	0.108	L2. LRDEV	.0001215	0.098
L3. LNDEV	.0001259	0.087*	L3. LRDEV	.0001278	0.102*
L4. LNDEV	-.0002491	0.001	L4. LRDEV	-.0001714	0.033
L1. LNREC	.0001728	0.092	L1. LRREC	.0002297	0.041
L2. LNREC	.0000444	0.680	L2. LRREC	.0000267	0.814
L3. LNREC	-.0000561	0.634	L3. LRREC	-.0000334	0.800
L4. LNREC	.000411	0.000*	L4. LRREC	.0003105	0.019*
_cons	.0125429	0.085	_cons	-.0015529	0.868
POP	Coef.	P>z	POP	Coef.	P>z
L1. POP	3.437644	0.000	L1. POP	3.42558	0.000
L2. POP	-4.388965	0.000	L2. POP	-4.353007	0.000
L3. POP	2.466488	0.000	L3. POP	2.400743	.
L4. POP	-.5162838	0.000	L4. POP	-.4720115	0.000
L1. LRDEV	-1.04e-06	0.004	L1. RDEV	-8.38e-07	0.000
L2. LRDEV	-1.08e-07	0.837	L2. RDEV	2.87e-08	0.911
L3. LRDEV	1.93e-07	0.734	L3. RDEV	2.58e-07	0.332
L4. LRDEV	-9.05e-07	0.055	L4. RDEV	-6.00e-07	0.011
L1. LRREC	2.91e-06	0.009	L1. RREC	3.12e-06	0.001*
L2. LRREC	1.66e-06	0.163	L2. RREC	1.92e-06	0.033*
L3. LRREC	4.62e-06	0.014*	L3. RREC	1.30e-06	0.191
L4. LRREC	6.59e-06	0.001*	L4. RREC	3.99e-06	0.000*
_cons	15898.97	0.076	_cons	-35857	0.000

Table 6.5:-Policy Lags on Water Investment and Irrigation

LTON	Coef.	P>z	LTON	Coef.	P>z
L1. LTON	.2614744	0.099	L1. LTON	.2692833	0.132
L1. LNDEV	.4266421	0.001*	L1. LRDEV	.5520102	0.000*
L1. LNREC	-.3232005	0.030*	L1. LRREC	-.7425149	0.005*
_cons	5.308538	0.001	_cons	11.43633	0.016
TON	Coef.	P>z	TON	Coef.	P>z
L1. TON	.4157589	0.031	L1. TON	.3328411	0.081
L2. TON	-.2202277	0.297	L2. TON	-.1290477	0.547
L3. TON	-.0701089	0.761	L3. TON	-.0957969	0.658
L4. TON	.0371867	0.875	L4. TON	.2211923	0.292
L1. NDEV	3.65e-07	0.709	L1. RDEV	1.86e-06	0.055*
L2. NDEV	3.50e-07	0.836	L2. RDEV	6.84e-07	0.588
L3. NDEV	-1.39e-06	0.624	L3. RDEV	-7.31e-07	0.622
L4. NDEV	2.36e-06	0.292	L4. RDEV	1.75e-06	0.191*
L1. NREC	4.93e-06	0.298	L1. RREC	-6.30e-06	0.154
L2. NREC	-3.05e-06	0.549	L2. RREC	-3.30e-06	0.498
L3. NREC	7.30e-06	0.225	L3. RREC	3.60e-06	0.499
L4. NREC	-6.95e-06	0.368	L4. RREC	-.00001	0.058*
_cons	23913.69	0.028	_cons	53033.59	0.006

Table 6.6:-Correlations

	NGDPW	RGDPW	WACS	POP	TON
NDEV	0.9333	NA	0.8737	0.8372	0.8894
NREC	0.8147	NA	0.9204	0.9081	0.7697
RDEV	NA	0.7310	0.6516	0.5339	0.7604
RREC	NA	-0.3775	-0.4549	-0.4523	-0.3382