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Full Length Research Paper

A comparative analysis on irrigation governance in Ethiopia and China

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Abstract

The purpose of the paper is to analyze the effective governance of irrigation, and to make strong linkage between China and Ethiopia with irrigation systems governing. The paper clarifies the irrigation governance services into four, including the comparison of farmland water conservancy policies service, examination of farmland water conservancy construction service, analysis of farmland water conservancy management and protection systems service and facilitation of farmers participation in the overall activities service. Then, based on the status analysis of irrigation governance services in China and Ethiopia and data collected from the relevant sources, we highlighted the similarities and differences of irrigation governance. Systematically, the actual services of irrigation governance if effected at the end will ensure food security, especially at the global level of population growth. In this sense, irrigation has been taken as the warmly implemented tool to stabilize the growing population with food security demand. It needs a good governance system to support irrigation schemes and institutions associated with agriculture. Based on empirical findings from research and national statistics institutions, the study examines the status of irrigation governance in both nations. Our study addressed and compared the irrigation and entire farmland water conservancy policies, examine the efficiency of a farmland water conservancy construction with cooperative management and protection strategies and ensure active participation of farmers. The findings of this study can address the problem-oriented and solution-based which will play a significant role in effective improvement in irrigation schemes and upgrade capacity of governance.

Keywords: Irrigation, Governance, Analysis, Ethiopia, China.

INTRODUCTION

Generally, an irrigation process is influenced by infrastructure design, management system, socioeconomic settings, climatic condition and task of relating performance [Molden et al. (1998)]. Meanwhile, irrigation can be considered as one of the tools that will increase the availability and accessibility of agricultural products [Abraham Gebrehiwot & Yihdego A A (2015)]. For instance, in 1995, the existing irrigated area was 29 million ha, meanwhile the total installed capacity of water-lifting machines for irrigation and drainage were 68, 240 MW consumed [Oksenberg (1969)]. In fact, there is an extra effort needed to balance the growing population with food production, due to an increase in world population which is set to reach 9 billion by 2050. By now the total irrigated area of the world is estimated to be 299 million hectares and the annual irrigation water withdrawal is about 2672 km3 at continent level [FAO (2014)]. While, the water withdrawal will continue to increase irrigation productivity at global level with scarce water resources [Yimin Ding (2017)]. To be sure, many countries in the world have engaged in irrigation as an option for producing enough food to sustainability condition [Jing Liu (2014). This has been conducted at large, medium and small scale and based on the availability of land, water, labor, technology and capital resources [Abeyou W. Worqlul (2017)].

In this regards, it is also practiced at small-scale level in developing countries, with a small land size, limited capital and high population pressure [Shibeshi Assefa (2016)]. These constraints also prevent developing countries from highly practicing irrigation as

much as compared to the actual utilization [Berhane Grum (2016)]. Poor technology, indecorous agriculture extension service, inappropriate policy measures and lack of comprehensive education institutions make the irrigation practices challenging than expected [Solomon Mutambara (2016)]. Moreover, an increasing food demand and scarcity of natural resource as a result of increasing population and climatic change [D von Guntena (2015)]. So that an effective manipulation of irrigation management and governance are prior to utilizing water resources efficiently and effectively [Haoyang Sun (2017)]. Based on comparative theory, this paper come up with four objectives which includes:

1. Comparing the farmland water conservancy policies.
2. Examining the efficiency of farmland water conservancy construction.
3. Analyzing the farmland water conservancy management and protection systems/strategies.
4. Facilitating farmers participation in the overall farmland water conservancy system.

Historical views of irrigation, importance of irrigation Governance in Ethiopia and China

Irrigation Governance in Ethiopia

Ethiopia is located in Sub-Saharan Africa, covered by four ecological zones which are Wurchi (alpine), dega (highland of its altitude), woyna dega (medium of its altitude) and qola (lowland). It is important to:; develop self-support for agricultural production, land management and tenure system [Baye (2017)]. It contains drought-prone region area where the soil is fertile and availability of rain are for rain-fed agriculture; and the non-drought prone region areas are scarce rainfall for rain-fed agriculture [Asnake Mekuriaw & Andreas Heinimann (2018)]. And fortunately, there are 12 river basins with an annual runoff volume of around 122 billion m3, water, 2.6 billion m3 of groundwater potential were estimated, 112 million hectares (Mha) of cultivable land areas and approximately 30 to 70Mha are irrigated [Bekele (2010)].

Incidentally, since irrigation was practiced for the first time in Ethiopia [Sulas Federica (2009), some historical evidence indicated that irrigation was traditionally practiced as far back as several centuries [Bekele Yeshitela (2012)]. MoA, 2011s, reported that modern irrigation in Ethiopia was first practiced in the 1950s, when the imperial government of Ethiopia and Dutch companies together implemented the project in the upper Awash basin for industrial crops. In that decade, most agricultural productions were affected by improper irrigation water management, lack of farmland water storage construction and low status of irrigation construction [Degol Fissahaye Yohannes (2017)]. Irrigation is basically affected by various challenges with increasing lack of water management system and unrelative equivalent of water resources and soil [Mulubrehan Kifle T G (2017)]. Moreover, an arid area in Ethiopia has less irrigation water utilization and irrigation practice is effective because of scarce water resources in the particular place [Zhang W (2018)]. In fact, there are about 2.7 million hectare of arable land in Ethiopia [FAO (2005)]. However, only 5 percent of the total irrigation potential is actually irrigated [Hagos F (2009)]. It showed that the country has correspondingly high access land for irrigation, only a little manageable land is being utilized and the greatest number of the farming system is dependent on rain-fed agriculture [Johan Rockstro¨MA (2010)]. With soil erosion crisis leading to accumulation of sediments on the dam of irrigation and this problem is very common in different parts of the country; it causes the failure of irrigation projects (FAO, 2000). Hence, poor management, operation and maintenance of irrigation practice hinders sustainable irrigation productivity development in rural areas, deprived irrigation water management association and water scarcity; all of them are the major reason for under performance of most irrigation schemes [Degol Fissahaye Yohannes (2017)].

Irrigation Governance in China

Since 1949 in China, water resources and irrigation growth were explored and shown to pass into the modern system, when Chinese government was strongly involved and irrigation was automatically achieved incrementally. Since there were three phases of irrigation periods in China: which are from 1949 to 1980, 1981 to 1990 and 1991 to the current [Xiufang Zhu (2013)]. Thus, irrigation and drainage were vigorously developed, with an investment of irrigation and drainage between 1958 and 1985 [Spence (1999)]. It was focused on the government of China when an industrial development and irrigation infrastructure were contributing to the stagnation of grain production and insufficient surface water resources [Lohmar B (2003)]. Advancing China's food manufacturing was supported mainly by irrigation. However, irrigated agriculture has been influenced by enhancing water shortage [Jinxia Wang (2017)]. Regarding to 1978, the country has begun to implement the reform policy which led to an increasing of agricultural productivity and farmers are getting the chance to exercise control over their land [FAO (2018)]. Especially food security for the increasing population with unexpected climate change has in fact been a big challenge for China [Yimin Ding (2017)]. Since 1950s, climate change has continued to affect the scarcity of water resources on agricultural production, where the shortage of water was recently disturbing the stability and role of agricultural production with respect to the drying tendency [MO Xing-Guo (2017)]. Water scarcity has continued to be an issue since it is tied to a lot of economic duties. This shortage has been studied alongside with the problem of quality of production. Moreover, the World Bank 2007 says that

the water crisis in China has been reduced to about 2.3% per year, approximately half of it is impacted by pollution, for gross of water accounts for 76.1% or 225.0 billion m3 was consumed in agricultural sectors [Chang yi Liao (2018)]. According to [Yao Jiang (2015)] Irrigation is essential for agriculture in the middle Heihe River basin, Northwest China, due to water scarcity and dryness of climate. Meanwhile, Chinese government put various irrigation governance and farmland water conservancy policies that could be taken as a powerful tool to increase food security, household income and national prosperity accordingly [Risheng Dinga (2013)]. So that, food undernourishment density was changed from 11%. Only 10.9% of the people are considered undernourished [FAO (2018)].

MATERIALS AND METHODS

Data Source

This study was analyzed on descriptive statistics based on the findings from literature and global databases such as FAO, World Bank and Knoema. A series of literature was utilized to better examine the standard and evaluation of irrigation governance and development of farmland water conservancy in both nations. And also an analysis of Irrigation policy implementation, construction, management and protection and farmer's participation by holding farm lands in China and Ethiopia have been investigated in a number of studies. This were dependent on characteristics of existing irrigation potential of land and water, schemes of irrigation, implementation of technologies and scientific researches on irrigation and management systems behavior which are revealed in these studies and allow us to develop a vision on the future expansion pathways of irrigation in both countries.

Data processing

Which underpinning our analysis and study was conducted in descriptive/quantitative methods and also all data are empirically remarkable on analysis of irrigation governance and system management in China and Ethiopia. That is why, the above methods effectively defined all comparative analysis of irrigation governance and farmland water conservancy; the methods were widely including historical data and communicated in the forms of charts, table, dashboards and game theory. In order these methods are classifying the following analytic data which are defined as: descriptive, diagnostic, predictive, prescriptive & empirical. Therefore, our paper is tending to the following methods to face questions based on past data which are nearly defined as responses to the distribution of future events of irrigation construction, system governance and system management to satisfy food security and to fill a gap in the global level and especially, in Ethiopia and China.

RESULTS AND DISCUSSION

RESULT

In comparing the case studies, we have to take the point of start in the five questions that pointed to as importance for reminding the commons and the differences between them:

1.What are the characteristics of farmland water conservancy?
2.What is the historical and current background of the Irrigation policy?
3.Which views prefer irrigation construction in both countries?
4.How are the commons and differences seen at each level in different times?
5.Which property rights exist through time and how do they advance?

Asymmetric Management Effect and Farmland Water Conservancy Policy in Nations

Farmland water conservancy and governance policies directly or indirectly depend on rainfall of the specific area. Meanwhile, working on farmland water conservancy or irrigation systems are mainly seeking water management accordingly. So, analysis of rainfall is very important to predict and/ or decide a policy for farmland water conservancy and it might be to lead management systems in both nations, it was predicted the rate of rainfall in each months at (1901-2009), maximum rainfall were recorded in both nations, and it might be resulted high floods. For instance, Let's assume that at (Table 1) the average monthly rainfall reached 133. 25mm in August and 112.897mm in July in Ethiopia and China respectively. These empirical results are shown predicted value might be helpful to indicate a policy implementation on the farmland water conservancy operation in each nation to control floods. Perhaps, the pattern of rainfall signposted that it is hard to engaged in farm production throughout the year, one pointed farming is in a year witnessed i.e. rain fed hooked on agriculture. This is mainly merged to the incomes approach, people at the center of development and works to support people's efforts to achieve their own income goals. At practical level, the incomes approach can help us to address the questions raised by:

- in view of agro-ecological factors which support people's income decisions;
- stress the susceptibility of incomes to seasonality people's response to this vulnerability;

concentrating on the influence of different policy and usually it turns as, subsidiarity of decision-making and

Table 1. Average monthly rainfall in Ethiopia and China (1901-2009).

Categories	Average monthly rainfall (mm)	
Month	Ethiopia	China
Jan.	7.117	10.215
Feb.	12.779	14.995
Mar.	34.114	25.331
Apr.	78.932	40.469
May	90.385	61.583
Jun.	71.21	91.455
July	124.671	112.897
Aug.	133.245	101.455
Sept.	89.454	62.076
Oct.	59.657	32.413
Nov.	25.826	16.948
Dec.	8.478	9.503

Source: (World Bank, 2010).

financial resources for soil conservation to the local level may act as an encouragement for investment in SWC at an individual and societal level, though more research is required on farmland water conservation [https://www.odi.org]. Our study found the result is helping for asymmetric running policy act as incentive to soil water conservation, chain management system applied on rainfall effects and needed farmland water conservation. There was fluctuation rainfall and ecological effects which should be ecologically arid and semi-arid areas resulted. It needs actual policy to control or manage the place where it is highly affected by erosion, annually low rainfall and water scarcity.

It is directly or indirectly revealing irrigation governance and predict rainfall are the sustainable importance of irrigation for agricultural production. So it is willing to contribute to assuring irrigation water structure construction and its governance as well.

Farmland water conservancy and Irrigation application systems

As shown on (Table 2), the sorting of irrigation types in Ethiopia and China are based on the area of irrigation recommended farmland available in both nations. However, the size of the land in each category varied, due to their own policy outstanding and economical development to the area of land in each country. As shown that, it is important to define the size of land and how far required and departed it. Our study revealed that more inclined towards irrigation policy in which is actually persuaded to emergent strategy in Ethiopia, this means, strategies can be cautious or emergent or a stage in-between. There is a communal intent followed by its interpretation. Sometimes this bent on is not formally written down but emerges over time as part of the irrigating values. Whereas in China irrigation recommended land demo-gradation was depending on the capacity of economic development and standard of strategic attention.

In other hands, irrigation application is attentively revised as taking food undernourishment from 2000 and 2016 in both nations (Table 3). i.e. let's taken value from the 2000s Ethiopia and China, 52% and 15.9% respectively populations were starving and from the 2016s also 21.4% and 8.7% populations are undernourished respectively. Motive of this, most irrigation policies in Ethiopia pay is played more attention on food security and it is depending on small-scale irrigation rehearsal, but in China irrigation was fleeting and out of traditional standard. Almost all parts of irrigation in China have been practicing to a high standard and given giving attention on it. We have summarized on the simple equation as follows below to grade what irrigation practice has to contribute to food security and help to minimize food undernourishment in both nations. Which are shown as following:

Eth. undernourished Pop. in 2000=52%
China undernourished Pop. in 2000=15.9%
Dissimilarity=52%-15.9%=36.1% and in 2016
Eth. undernourished Pop. =21.4%
China undernourished Pop. =8.7%,

In terms of the above equation, one of food undernourishment is influenced by system problems of It

Table 2. Type of Irrigation based on land size in Ethiopia and China.

Scale	China	Ethiopia
Small-Scale irrigation	<667 ha	< 200 ha
Medium-Scale irrigation	667 - 20,000 ha	200 - 3000 ha
Large-Scale Irrigation	>20,000 ha	>3000 ha

Source: [Ethiopia M. o., 2002] & [China water and statistics, 2006].

Table 3. Shows the prevalence of undernourishment (% of population) in Ethiopia and China.

Year	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Ethiopia	52	49	46.7	44.2	42	39.7	38.5	37.2	35.6	33.7	32.1	30.7	29	26.9	24.7	22.8	21.4
China	15.9	15.8	15.7	15.7	15.5	15.2	14.8	14.1	13.4	12.6	11.8	11.1	10.4	9.7	9.1	8.8	8.7

Source: [World Bank, 2010 & http://documents.worldbank.org].

is indicated that the types of irrigation used for agricultural production within size of arable lands which is convenient to irrigation. As much as possible, it also can contribute to upgrading irrigation concerns.

It might be a subsidiary for irrigation governance at a time of gross development of agricultural production to sustainable food security in each country level, i.e the level of food undernourishment. So this table also helps to predict irrigation governance contributions to produce enough food for decreasing food undernourishment from each country. On the other hand, food undernourishment is directly or indirectly affecting irrigation governance and vice-versa. Farmland water conservancy and irrigation governance. In this regard, Ethiopia is more affected than China.

Farmland water conservation and Irrigation construction strategies

Table 4 showed that: The irrigation potential of China is estimated at 70,000,000 ha, which is very high relative to other Asian countries . 69,863,000 ha of land is currently irrigated i.e. 99.8% of the potential, showing that almost bursting utilization of the available water resources is under irrigated. Whereas, the irrigation potential of Ethiopia estimated 2700000 ha (Table 4) as compared to other east African countries and it has a high potential of irrigation. However, only 24.38% of the available potential is at the time (currently) utilized. There are plenty and complicated reasons for the under-utilization of the potential which will be explained in the discussion section of the article. As a simple calculation, we have three variables. Those are; Potential and Actual irrigation, Arable land and total land of each country. The total lands and arable lands of each nation have already known under (Table 4). But we can solve the following requirements: -

Required:

1.% of actual irrigation with relative to the potential irrigation

2.% of potential irrigation with relative to the total arable land.

3.% of actual irrigation with relative to total arable land.

Case of Ethiopia

1.% of Actual irrigation =(Actual/potential) %

= (658300/2,700,000)100 =24.38%

2.%of potential of irrigation=(potential/arable) % = (2700000/15,119,000) 100=17.85%

3.% of Actual irrigation= (actual/total arable) %= (658300/15119000)100=4.35%

Case of Chin

1.%actual irrigation=(actual/potential)100= (69,863,000/70,000,000)100=99.8%

2. % of potential irrigation= (potential/total arable)100= (70,000,000/106,318,000)100= 65.84%

3.% of actual irrigation= (actual/total arable)100= (69,863,000/106,318,000)100=65.711%

Our result revealed that there was the big farmland water conservancy and irrigation application problems between them. Even so, potential of irrigated land in Ethiopia is well-preserved and it has 27,000,000ha but actual % of current arable land covered or irrigated is 17.85 up to 2013. It is less achievement from China, that means China achieved 65.84% in the same decade (Table 4). Moreover, Irrigation policy practice in China is concentrated on more research, planning-acted angle and immediate implementation culture, but in Ethiopia is not like China. Moreover, there is no plenty of experience shared between them and they have less considered problems in Ethiopia act a China irrigation policy, somehow to implement good irrigation policy to solve irrigation governance problems, unsustainable farmland water conservancy procedure policies and to supply future development of the process. In this respect, the performance of irrigation construction in Ethiopia was chronicled from actual to potential irrigation is 24.38% and from potential irrigation to the total arable land is 17.85% [Table (4)], shown that Ethiopia consumes adequate irrigation and arable land

Table 4. Irrigation profile of Ethiopia and China in 2013.

Country	Potential of irrigated land (ha)	Area equipped for full control irrigation (ha)	Total area of arable land (ha)	% of actual to potential irrigation	%of potential irrigation to total arable land
Ethiopia	2700000	658300	15,119,000	24.38	17.85
China	70,000,000	69,863,000.00	106,318,000	99.8	65.84

Source: [https://knoema.com & ttps://www.statravel.com].

Table 5. Differences of Irrigation policy between China and Ethiopia.

TYPES OF STRATEGIES	IN CHINA	IN ETHIOPIA
STRATEGY 1	Research and development	Institutional Strategy
STRATEGY 2	Modernization of irrigation	Development strategy
STRATEGY 3	Institutional development	Promotion strategy
STRATEGY 4	Water transfer	Water use strategy

Source: [http://www.fao.org & http://www.fao.org/nr/water].

potential, nevertheless widely used. Study appraisals also find out that the irrigation status in China was noted from actual to potential irrigation is % of 99.8 and from potential to the total arable land is % of 65.84. The above statement clearly showed below as following and stated that as comparative between both nations; for example:

Assumed; Actual irrigation potential in China=99.8%,
Actual to irrigation potential in Ethiopia=24.38%
Vital; What is the actual irrigation potential difference between in China and Ethiopia?
Result; The actual irrigation potential difference=actual irrigation potential in China-actual irrigation potential in Ethiopia.
Therefore; Actual difference=99.8%-24.38%
=77.42%

Our study presented that there is a vast discrepancy, factor of irrigation construction was separated and policy implementation capacity was varied in the realms. It is briefly defined the irrigation features in each nation, i.e how much potential of irrigation and land recommend to irrigation in each country. So, these types of features are helping to assure irrigation governance and farmland water conservancy facilities there.

Farmland Water Management and Protection Strategies

Ambiguous, strategic management within water scarcity, they are led to affecting irrigation structures and schemes sustainability. This is directly related with skills of a man and strategic running on irrigation water management which are generating possible causes of locked planning under irrigation management and protection. Our study main to practiced management levels: in case of making body in irrigation fields which are:

Main level: facilities for water acquisition and conveyance-managed by irrigation agencies.
Off-farm level: facilities for water distribution at off-takes managed by a group of farmers or water users.
Field-level: facilities for application of water to the individual plots managed by the individual farmer or users.

As summarized as follows

Irrigation (1) agency Group (2) of farmers Individual (3) farmer

There is a flowchart running from 1-3. Among them it must be faced responsibility on irrigation management systems.
It is less defined in Ethiopia than China [Tables 6,7 & 8].
Our brief results indicate that: The procedures of irrigation water management as indicated as the
power distribution networks and the main purpose is broadly applicable to one and the other is how?
It is unlikely organized in Ethiopia rather than China. Our study is recognized with which is depending on well policy implementation producers in China.

Farmers participation on irrigation water management in Ethiopia and China

In Particular, in standing water scarcity there are barricades of agricultural lands and wastewater should be treated with recycling irrigation as bargaining power of supply of treatment [Dinar (1986)]. As invulnerable stated, arid and semi-arid areas the place where threat of water scarcity, its desirable to water management and spreading governance and occasionally, be able to playing effective game theory for conflicts handling and teamwork among users, temporarily, game theory can change a system into smooth running of farmland water conservation with management systems. A Previous scholar noted that two types of game theories were played among farmers and urban population the systems of water using [Marianthi V podimata & Panavotis

Table 6. The main control systems a project management and protection on.

Problems	Possible Causes	Potential Impacts	Recommended Action
*Lack of skills/ Missing skills	certain skills over locked during planning possible	* the managing process will not move as fast as in the skills needed	* arrange for a team member to be trained
Team member leaves	There are many causes why a team member might leave the work	Depends on the skills and knowledge that are lost with the person:	Remind having backups for actual skills
Team members are too friendly	Team members devote lot of time chatting and discussing their own problems.	Decreased Overall productivity of work.	Emphasize that social gatherings need to be planned after work hours
Inflexible team Members.	a team may believe that their way is the only right way.	Team members may not keep up the colleagues.	Indicate goals and expectations at the Start of the project.
Conflicts within team	Many potential causes, including differences work style, personalities areas of expertise	Conflict can affect the schedule of work, overall productivity, and team Cohesiveness.	Focus on project goals, not personal feelings. Be compassionate but fair, separate the underlying causes from the surface disturbances. Work on solutions, not blame

Source: [School (2002)].

Table 7. Irrigation policies implementation and their effects in Ethiopia.

Types of Strategies	**Effects of Strategies**
Research and development	- Research and implementation of water-saving - leading to reducing irrigation water -increasing irrigation water productivity
Research and development	- Research and implementation of water-saving - leading to reducing irrigation water -increasing irrigation water productivity
Modernization of irrigation	-The large and medium-size schemes claim top priority for state investment -The improvement of which is extremely important both for water saving and food security. - irrigation water efficiency
Institutional development	-Improve irrigation water management to increase irrigation efficiency -Improve water productivity -Improve income of farmers -Find incentives for farmers to protect the irrigation facilities -improve irrigation water management on farm level -High-level policy support to provide incentives for research -Dissemination of new technologies -Funding policy –priority is given to those with wider adoption of WSI practices
Water transfer	- China needs more water savings from the irrigation sector because the total water supply is limited -There is an urgent need to increase water and land productivity -Immediate implemented projects were studied and designed

Source:[64http://www.fao.org/docrep].

C Yonnopouls (2015)]. Briefly as shown under [Figure 1] they are contributing for expectation of agood decision making, a systematic management is well-being, applicable to avoiding users' decision problems and are kept individual agreement. But these game theories have their own shorthand and side problems: such that fixed decisions were practiced, highly economic, probable decisions are expected and aerially limited. We explained at [Figure 1] farmers are plausibly participating in irrigation water which depends on right of usage till to reach equilibrium of their cooperation accomplished at normal condition. It is like

Table 5. Differences of Irrigation policy between China and Ethiopia.

Source: [http://www.fao.org & http://www.fao.org/nr/water].

It is shown the difference of irrigation policies and their functions in each country. These policies are important

Table 8. Irrigation policies implementation and its effects in China.

TYPES OF STRATEGIES	EFFECTS OF STRATEGIES
Institutional Strategy	Sub-sector and end productions oriented
Development strategy	Enhancement of small-scale irrigated agriculture -Grazing lands for food self-sufficiency -Enhancement of small, medium and large- scale irrigated agriculture for food security -Food self-sufficiency at national level
Promotion strategy	-Study -Planning -Implementing
Water use strategy	-Control wastage -Protection of irrigation structures -Confirmed drainage systems -Ensuring irrigation potential

Source: [http://www.fao.org/docrep].

Figure 1. Pumping groundwater in strategic.

Farmer2				
PRL			**PRH**	
Farmer1	**PRL**	**3**	**1**	**4**
		3		
	PRH	**4**	**2**	**2**
		1		
2 Nash equilibrium				

Adopted from: [Marianthi V podimata & Panayotis C Yonnopoulos (2015); PRL, pumping at lower rate and PRH, pumping at higher rate.

to allocating how to play a significant role on the governing of irrigation.

It is indicated that a trends sharing, i.e how irrigation governance is received and techniques from the methodology of project management when it is important on time of an irrigation construction undergoing.

It is defined as an implementation of irrigation policies throughout an irrigation going to work, i.e it can show how much policies are important to produce significant outputs and governance status in Ethiopia.

It is defined as an implementation of irrigation policies throughout an irrigation going to work, i.e it can show how much policies are important to produce significant outputs and governance status in China.

It shows the method of water used with controlling a conflict among urban population and farmers during water pumping. It also contributed to solving the problem of governance of water using systems.‘ an open door’, it is exposed to conflicts because demands interest is not going under equal sway. From the above expression we can get a mathematical opinion. So that the summation of different game theories contributed to the resolution of problems of water users and it is widely important to avoiding conflicts and making sustainable decisions. However, it should be contributed for water harvesting and farmland management cooperatively with strong participation of farmers and urban population. So, these theories are an important business for a conservation of irrigation water in both nations. Chinese Farmers have participated in farmland water conservation and management from the beginning of irrigation study to construction of it. Accurately, Chinese farmers have better opportunities to participate in farmland water management due to economic development in the country, this wisely supports them to involve in it and again they are interested in irrigated production as much as possible in higher ranks and making them a part of the institution. They actively participate in different projects, operational social-economic survey for each of the fields, on village meetings, supply in information dissemination and consultation, land resources mapping for the hydraulic borders with existing multilaterally/ village irrigation management and they are initiating to take irrigation

projects management [World Bank Database]. It has been observed that farmers in China were interested in participation of farmland management and conservation to come to the grade of high irrigated production. Whereas, farmers participate in Ethiopia agricultural water management and water conservation most of time they can involve: small-scale irrigation, highly participating on hilly areas management, committee making, small water harvesting, cleaning canals and giving information to operation and maintenance of irrigation. In general, almost all farmers are involved in the profitability of outcomes of irrigated production and they are concentrated on small-scale irrigation, due to economic development of the country. From the total production, about 97 percent of Ethiopia's food crops are produced by rain-fed agriculture, whereas only 3% is from irrigated agriculture [Temesgen Hirko (2018)]. Our study found that irrigated production is directly proportional to farmland water conservation and managements, by involving farmer's to highly participate, then irrigated production becomes high and at same time farmland conservancy also in our supervision was seen from web-site, irrigated production yields are higher than in Ethiopia. That is not a matter of our research but we want to find out the farmers participation on farmland water conservation varieties [**http://www.fao.org/nr/water/aquastat/**]

DISCUSSION

What are the characteristics of farmland water conservancy?

Our results reveal that, there are some common shares and separate at some difference's conditions between China and Ethiopia. So, the title covers farmland water conservancy technique and includes irrigation farming practice which mainly improves yield production and decreases the inputs of labor or anything else leading towards improved land husbandry, which expresses the base of good soil conservation. Many conservation programs have failed, due to the technology being inappropriately applied or they did not receive responsibility for the social aspects. An approval looks and improving irrigation technology are widely useful for water conservation in farmland water, which cannot be able to irrigate lands in Ethiopia [S Multsch (2017)]. At 1960s the rate of irrigated areas was covered 1% in per year at world level and from 1972 to 1975s by 2.3% the rate was increased at annually, but the rate of expansion where decreased less than 1% rate the year after in 1975s, due to population growth rate high, the rate of expansion become low level [WM Rose grant & M Svendsen (1993)]. On the other hand, irrigation by itself is a wide risk and the result of its expansion is declining, because it is influenced by: cost and time, high run, poor management, awareness of all, planned usage, health and environment, social-economic transmission among farmers and policy implementation. So on [Biswas (1990)]. We revealed that, irrigation has its own historical event and the beginning sense is harmful to practice then it is need policy implementation within strategic management as shown in [**http://www.fao.org**]

Comparative analysis of farmland water conservancy governance in Ethiopia and China

Nine thousand years before, an ancient agricultural system in China mainly depended on rain-fed and dry land agriculture [Li Lingling (2014)]. In addition, the climatic condition of China differs from northern to southern parts of the country. The northeastern part of the country is hot and dry and winters are very cold. The middle and northern part have continued rain with hot summers and cold winters. The southeast region is a place with plenty of rainfall, semi-tropical summers and cool winters. In the central, southern and western regions flooding frequently occurred [**https://www.statravel.com**]. This showed that the areas have; access to irrigation and its desirable system governance, because of a fluctuating climatic condition throughout the year, then our study suggested that it needs strategic governance of climatic areas. Besides, China was recognizing water saving irrigation technology used to water for yield production wisely without reduction and sequence, control losses to farmers [Wang (2013)]. Even so, southern and western regions flooding frequently occurred [**https://www.statravel.com**]. The reason of all, China's water policies mainly have depended on the construction of huge water conservancy projects in the form of dams, reservoirs, water transfer projects and irrigation infrastructure, which are facilities have contributed tremendous
economic and social importance but also burden on the socioeconomic environments and with less quantity of water [JunguoLiu (2013)].Because of food production in China highly depends on irrigation which is affected by increasing water scarcity [Jinxia Wang (2017)]. At the near middle decade time, soil conservation has its historical event, but in the early 20th century officially was implemented, due to while severe droughts and ecological difficulties emerged [Julian Dumanski (2015)]. At [Table1] showed that most parts of the country had low rainfall: for example, in Dec. & Jan. was recorded 9.503 & 10.215mm respectively. so that, there is water scarcity overall country and the problem is serious and harmful in arid areas. So, Water scarcity has been a crucial issue for sustainable irrigated agriculture in arid regions [Huang (2016)]. Water conserving from improved irrigation technology will not be able to contact the substantial needs of planned areas [S Multsch (2017)]. Con-temporarily, the construction of water conservancy is the inferior condition of current agriculture, irreplaceable foundation of social- economic development, and the security system of ecological environment [Chuntang Wang, Deming song (2011)]. And uniquely, China had undergone the irrigation with

treated water method [Xiufang Zhu (2013)].

Future Guidelines in Water Administration Policy in China

- National water politics are ever-changing from projects to policies
- Water may develop a test-bed for economic reform
- Water may become a test-bed for liberalization
- The water sub-sector will be less dominated by irrigation
- At the level of the irrigation scheme, the process of water policy invention, assessment and appraisal needs to include more open groups that are representative of political, technical, managerial and water user associations.
- Policy groups would be consulted before policy selection
- The policy groups would identify options consistent with the national policy framework, as opposed to measures to protect and satisfy special irrigation interests.
- The goal is to identify a broader range of water policy options
- Successful irrigation is a crucial determinant of the world's future development

Source:[**http://www.fao.org/docrep**]

Similarities and Differences of Farmland Water Conservancy and Irrigation System Policy in China and Ethiopia

Irrigation is the common meaning as a common language but the process of practice in each country are different, now our study demonstrated that both nations have similar senses of both nations. They have some common tools of strategy that were implemented by developmental strategy [Table 7&8]. Irrigation is categorized as small-scale, medium-scale and large-scale [Table 2] and this all about revealed the end target of irrigation to solve food security problems, which is located under the [Table 7&8] in strategy of development in Ethiopia and modernization in China.

It is inevitable for raising the question of food security from individual to global level, since food security is a social, political and environmental aspect of humanity. Nonetheless, food security scholars and experts suggested various tools of food security enhancement, irrigation provide an invaluable role to eradicate the challenge of accessibility and availability of food with the increasing population and alarming climate change. Moreover, irrigation has a major role in ensuring and sustaining food security and an increasing income generating for most of the world's population and improved economic growth and development, it can alleviate problems related to ensuring sufficient, safe and nutritious food for those who are food insecure [Table3]. This is all about the common sense in both nations. Whereas

Ethiopia and China have been experiencing diversified problems to achieve food security. However, China reduces food undernourishment at an increasingly descending rate. Even though there is a decreasing population of undernourishment in Ethiopia, the rate is very slow. As indicated in [Table3], 52% of Ethiopian population and 15.9% of the population of China was undernourished in 2000. This number decreased to 21.4% and 8.7% in Ethiopia and China, respectively in 2016, showing that there is still a huge amount of population in undernourished Ethiopia than China as compared to the national total population. Especially since 1978, China induced the systematic governance and development of the irrigation agriculture sector by essential policy and reform input. As a case policy implementation China changed traditional irrigation into modernization to succeed her food security [Table 8].

Case1: China;

strategy1: more concentrated on research and implementation policy, lead to water saving, increasing irrigation productivity.

Strategy2: mainly depend on irrigation application building then above medium-scale irrigation try to act supply to investment, improvement of water saving efficiency to use as a tool of food security.

Strategy3: acts as to improve water management, generating income of irrigation farmers to develop facilitating increasing incentive rate, funding incentives for research and policy.

Strategy4: provide more water supply from irrigation water saving to solve water limitation, fast implementation was designed and studied and attention to an urgent increase in land and water productivity. In here, strategy may be imposed on the irrigation organization, So that, irrigation policy in China did not fix at recent item implication and it will be allocated to future view, i.e. Policy groups would be consulted before policy selection, Successful irrigation is a crucial determinant of the world's future development, National water politics are shifting from projects to policies and soon [**http://www.fao.org/docrep**]

In general, Irrigation policies in China have been implemented as a strategic target, on research and development of water-saving irrigation, leading to reducing irrigation water and increasing irrigation water productivity without any identified reduction of crop yields. China irrigation policy acts as modernization of the system which is modernized from small-scale to large and medium size schemes claim high priority for state investment [Table 8]. Whereas,

Case 2: Ethiopia;

Strategy 1:as define as sense of office implementation and end productions oriented

strategy 2: more involved that small-scale irrigation to agriculture to self-reliance of food demand at national levels and to applying irrigation from small-scale to large

one to food security purposes
Strategy 3: to announce irrigation planning, study and implementing.
Strategy 4: it is shown that as control water wastage, controlling of irrigation schemes and ensuring irrigation potential. Overall, irrigation policy in Ethiopia has been formulating and implementing various policy measures and institutional restructuring to improve irrigation governance to achieve food security. However, the status of food security, poverty and agriculture production system witnessed how less impacts have the policy measures on irrigation development [Table7].

Comparison of The Construction of Irrigation in Ethiopia and China

Case statement to: Ethiopia

Warmly, from the East region of Africa, Ethiopia is the most water housing country [Makombe (2007)]. And Ethiopia has abundant endorsed irrigation land, a little bit fraction of its potential land is applicable [Abeyou W Worqlul (2017)]. For illustration, currently 5-6% of the 4.25 million hectares of irrigable land is irrigated by small-scale, medium-scale and large-scale irrigation schemes [Awulachew (2007)]. On the other hand, Chinese irrigation construction trend is historically established by the "Dujiangyan irrigation system", it is ancient, dam less and unique in China [Rao Fu (2018)]. Subsequently, from 1979-81 the run of irrigated areas covered 45 million ha but this figure rapidly changed into 61.7 million ha in 2011[Lei Zhang NH (2013)]. This dynamic alteration is the result of the top up reform policy in 1978 [FAO (2018)]. Our results revealed that at the period of 2013, 99.7% of irrigation water had applied from the irrigation potential [Table3].

Comparison of Irrigation Management and Protection in Ethiopia and China

Case statement: Ethiopia

Over the biosphere levels, semi-arid areas are a place dominated by water scarcity, poor soil characteristics, poor farmland water conservation and irrigation management systems were practiced in it. This feature is crucial to affect Ethiopia [Mulubrehan Kifle T G (2017)]. We discovered that arid and semi-arid areas are the place subjugated by water scarcity and it is necessarily involving good strategic management. However, proper management and protection irrigation agricultural water and water scarcity both influenced irrigation schemes and farmland water conservancy in Ethiopia [**Degol** Fissahaye Yohannes (2017)]. Our study also suggested that it might be shown a specific direction to an irrigation project management system. Primarily, a project is defined as; the problems of the project, possible causes of the problems and potential impacts on it [Table 6]. Hang on this and above details, poor irrigation water management has not only influenced irrigation schemes and arid areas but also influenced the total leveling of the management system and it may have led to conflicting among employees. However, a strategic management system can perform good irrigation water management. A good irrigation water management is a properly water using application systems and an appropriately drainage implementation system. Drainage and irrigation water are mutually related. Our results show that, some problems the system has faced in Ethiopia, an overall looking system of water management and drainage are small practiced through it [Table 7].

Case statement: China

Irrigation management systems in China with object-oriented programs, using flex viewer framework bases on development platforms and these systems implements the functions of analyzing irrigation real-time data and makes the strategic decision to water allocation [Xie Fang (2011)]. And, irrigation management and protection revealed that corporations with clearly articulated tight culture were able to develop simple, decentralized, flexible and innovative forms of organization based on trust and participation. Collectively, ownership arrangement of the water management system in North China, being responsible for canal operation and maintenance, water distribution and fee collection [Lei Zhang NH (2013)].
We agreed on the review points above, so the system managements are involved as in site engineering and object-oriented direction in it. Assuring to this regard, the engineering and management were impacted by the agricultural water management in irrigation sectors [Haoyang Sun (2017)]. On the other hand, a poor management system of water and fertilizer application; faced with the difficulties of soil erosion and ground water table ascension [Yaohu Kang (2012)]. The irrigation practice has a bearing on the amount of water applied to the soil and rate at which it is removed. For example, poor water management practices result in excess being applied to the soil, just as heavy mechanical traffic results in a soil with poor drainage properties due to compaction. Matter of this view is needed for improving management capacity. Therefore, From 2012 to 2016 in China, world bank financed to undergone project which aimed to upgrade agricultural water management and ascending agriculture water efficiency in three China's specific water scarce province, because the project act as minimize evaporation-transpiration, and increase water productivity of yields, due to China is a water scarce country [Bank (2016)]. So, there is either shortage of rainfall or low capacity of groundwater in arid and semi-arid areas and it requires protection from disasters, in addition to any irrigation project or scheme in an arid climatic zone which requires a different drainage system than a humid climatic zone. An arid climatic zone is

characteristics of high-intensity, short-duration rainfall and high evaporation throughout a year. The core purpose of drainage is a balance of ecological varieties' effect and used to remove excess surface runoff, resulting from the high-intensity precipitation, and to control the water table so as to protect the accumulation of salts in the root zone, resulting from high evaporation-transpiration. A surface drainage system is most suitable. At [Table 5] shown that it is used as supporting of irrigation and farmland water conservation management systems and it is briefly expressed that a sense of irrigation projects;

In general, our research puts more emphasis on some specific problems of irrigation project questions which are answered under result.

-what kind of problems will happen in a project?

-What are the causes of problems?

-What are the impacts of problems on potential?

There are an applied managerial systems and disappointment between persons to persons, projects to persons and projects to persons.

Comparison of Farmers Participation in Irrigation in Ethiopia and China

Farmers participating in irrigation do not have primary experience with opportunities to practice on irrigation by their conditional watershed on highlands of the country [Berhanu B (2014)]. Contrary, farmers are participated in irrigation as the case of solution of water management and one of role play as reforms in the land and water management of country but farmers was not afforded to respond to emotional approaches to care for the soil, and i.e. the conservation measures have to visible short-term benefits to the farmers of Ethiopia [C Yonnopoulos (2015)]. Overhead appearance showed that, the access of participation is a limited number of irrigation farmers who participated in Ethiopia and there was a gap among farmers and less access to participation practices. The most important things are farmers can participate in smallholder irrigation technologies which leads to enhancing profit but a large-scale scheme has increasingly faced economical loss and ecological problems related to improper management, worse leading finance, poor drainage, water over-logging and salinity [Yaro (2004)]. Our study was defined as a case of care for looking duty. So that, negligible number of farmers were participated on specific irrigation and they could not involvement on water, land and irrigation structure conservation programs, in this attention they had lost a good economical income, water and soil saving.In other hand, farmers wouldn't be able to get technical and governmental support and can't participate on large scale irrigation. Accustomed to, small holder's farmers in Ethiopia the awhile information and suitable idea that is associated among others with undermine planning and implementation, bad leading function to input and output markets and the lack of farmers knowledge to use systems wisely [Girma Moges (2011)]. There is no adequately given attention to Ethiopia irrigation water users. But China, given attention is admirably, i.e. ordinary irrigation water management systems are increasingly substituted by irrigation water users, participatory management pass through water users' associations with aim to promotion, economically assurance, ecologically importance, water harvesting and properly farm income generating.

According to the above review, it Might be acted to encourage farmers to participate and construct some irrigation schemes on their own interest, with government technical and material support and they should be effective when organizing and applying good management systems through making accurate water users association or committees. This statement has shown that allocate to future view, but the view of past was documented with a good effective result. It leads to keeping advanced managerial water users. And also, they should be supported by controlling conflicts and decision making over their works. In this regard, game theories are very important too as [Figure 1]. We have mentioned in details as follows:

Game theory (GT) is a mathematical method of problem analysis and decision making in strategic interaction and adopted from [Marianthi V podimata & Panayotis C Yonnopoulos (2015)].

Each game consists of:

a set of players N= {1, 2, i-1, i+1..., n}

a set of strategies for each player individually, I player has Si= $\{S_1, S_2..., S_k\}$ strategies, and

a set payoff of each player for each set of strategies Ui= $\{U_1, U_2..., U_k\}$

The process of setting up a game model includes defining players' options and preferences. The aim of each player is to reach its expectations. Classic example games this sub-section illustrates the basic concepts of GT, by presenting simple and figurative games of competition and cooperation in irrigation. These games depict how strategic interactions among players result in non-predictable situations with respect to the preferences of the players.

Assume that:

*Pumping groundwater game: This game was introduced into water resources literature by Madani (2010) and follows the concept of prisoner's dilemma game.

Water rights game: This was represented by Galaz (2004) and raises the question of cooperation or defection when the balance of water use is modified. In this game there are two players (a) a group of farmers and (b) an urban water company. At status quo the two water users have an agreement about the consumption of existing water resources. The game analyses what happens when one player (for example, the urban company) breaks this agreement. The other player can either accept the violation or not. The answer on this problem depends on the preference order of both players.

[Figure1] showed that, as solution actions which take time to define the real conflicts, controlling is a critical solution among the water users. Too often, in the desire to get something done release a new idea or deliver a solution to a perceived conflict. Without understanding the real underlying conflicts, you go to the embarrassment of killing time, money by using simplistic, too complicated, too late, or that does not make what the users need it to do. The two game players are participating in the game of water using mechanization, controlling methods, avoiding protruding, and simultaneously provide smooth relation-ship among each other and they might be working any tasks in cooperation mode and games lead as to do the same contribution on farmland water conservation mechanization.

CONCLUSION AND RECOMMENDATION

CONCLUSION

In generally, irrigation and farmland water management have a major role in ensuring sustainable food security and increasing an income generating for the most of the world's population and improved economic growth and development, it can alleviate problems related to ensuring sufficient, safe and simplest food for those who facing food insecure especially, in developing countries and vulnerable populations in society, dependence on rain-fed for food production and water scarcity areas. As we have seen from the result data and literature's farmland water management and irrigation governance in Ethiopia has been achieved a gradual and slow down governing systems for Irrigation sector, impacts of this irrigation has't play a role in ensuring and sustaining food security in country level and it will be wanted give attention to the sectors. Occasionally, Ethiopia has the opportunities of manpower, excess potential of both irrigation agricultural water, farmlands or arable lands and good political situation.

Whereas, in China: Farmland water management and Irrigation Governance has been achieved a highly and speedup governing systems for Irrigation sectors. Impacts of this, irrigation has somehow played a role in ensuring and sustaining food security in country level and also it grew up towards mechanization to the level of worldwide and to fulfill a controlling farmland water conservation and strategic management. Regarding this, China has access to manpower, has excess of scientific and technological irrigation, agricultural water management, and a good political situation.

Research offers insight into the problems leading to poor and good achievement of the irrigation sectors in both nations. Irrigation governance is a major leading to poor on-site productivity and increased administrative performance around the world. The research analyzed communication problems on irrigation governance in countries. From the results of a data analysis to Irrigation governance, study identified and briefly explained the effect of a comparative analysis of irrigation governance between China and Ethiopia and also indicated the 'luscious administrative system on the irrigation sector. It emphasized that unless governance issues are addressed the irrigation sector is likely to be operated poorly. This study is a preferential attention to determine suggestions and amend irrigation governance and shares one of its good irrigation governance experiences in the particular countries. However, while the findings of the study are important to irrigation governance parts in both nations and elsewhere, research concludes that; more diversity of management and allocations is required to confirm the results presented here.

By analyzing data in the literature on con-current governance types dealing with irrigation, we think that there is a lion share of allocated topics regarding the system of governance to irrigation and decision making on conflict among irrigation water users, cost allocation on targets of irrigation construction, management and protection, water-saving and policy action. This regard demonstrates the importance of irrigation governance and shows the huge chance of irrigation governance experiences to fix unlimited risks from irrigation water governance and food security.

Our findings further indicate the increasing gap of irrigation water management systems, institutional organizing ways, policies implementing methods and water saving and/or conserving mechanization in Ethiopia. In Ethiopia these kinds of shorthand occurred which delay to reach the target.

In our study, the comparative analysis of irrigation governance in Ethiopia and China do not play an important major role in arranging settlement irrigation between two. This is not appreciating because of the following cause:

Firstly, skilled laborers can easily move because the two countries have a good diplomatic relationship as a real supervision.

Second, the potential of irrigation in both nations have almost the same standard and this helps easily share knowledge transmission. Moreover, the quality of irrigation governance in China is much better than in Ethiopia. Especially since the 1980s, China put more focus on increasing the grain productivity through integrating the available natural and human resources. Moreover, the modernization administration of irrigation in China is growing relatively faster than Ethiopia.

As compared to Ethiopia, the advancement of irrigation practice is much better in China. Since 1978,

irrigation governance in China has provided a valuable contribution for food security management in the nation, we found that irrigation governance has progressed step by step but there were disasters appearing through time of different decades in both nations.

RECOMMENDATION

1. Irrigation water users and farmland water conservancy

technicians, should be required capacity building training from experts of water and soil science, also they should have shared experience from partners and field tours from conducted areas that have good practiced water and soil conservation.

2. Irrigation governance should be led by professional, intellectual and commitment persons and be allocated from higher offices to user's coordinators and connected within network systems in Ethiopia.

3. Office of irrigation or institutional organization should be organized in an independent way and assigning positions are in the logic of "a right person for a right place'' and most correlating with a need for good policy in Ethiopia.

4. Ethiopia should learn from China and vice-verse to China about irrigation policy implementation, and how to undergo policies on farmers funding and insurance. Their knowledge sharing process, fund raising or coverage should be covered from both governments, World bank. so on.

5. Irrigation finance must be secured and kept from corruption, by Increasing managerial awareness of each and every implementing irrigation and farmland water conservancy projects and any payment should be undergone mainly depends on actual results and agreements, why because most of time which is exposed to corruption and it could be affected easily.

6. Facilitating risk managers should be involved in irrigation water user's association and within some urban companies, which is defined as not preferences of users but give attention to specific water using games theory because it helps to minimizing risks and controlling decision making.

7. It should be supported for policy makers, show direction to the government to allocate strategic plan implementation on tasks, to undertake evaluation in each country and to assure farmland water conservancy policy.

8. Acting as an early warning system on a crucial water scarcity areas for both nations and especially China, through updating water managing policy, highly harvesting rain water, implementing flexible and commitment governance systems

9. It should be combined with strong governance policies with flexible management systems and helps to set worked together for further opportunities.

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REFERENCES

[Baye, 2017. Poverty, peasantry and agriculture in Ethiopia. Annals of Agrarian Science. 15 ,420e430.

Abeyou W. Worqlul, 2017.Assessing potential land suitable for surface irrigation using groundwater in Ethiopia. Applied Geography 85,1e13.

Abraham Gebrehiwot Yihdego A. A., 2015. The Impact of Small – Scale Irrigation on Income of Rural Farm Households: Evidence from Ahferom Woreda in Tigray, Ethiopia. International Journal of Business and Economics Research, 4(4), 217-228.

Asnake Mekuriaw & andreas heinimann, 2018.Hans Hurni,2018. Factors influencing the adoption of physical soil and water conservation practices in the Ethiopian highlands. International Soil and Water Conservation Research 6,23-30.

Awulachew, 2007.Water Resources and Irrigation Development in Ethiopia. Working. International Water Management Institute Paper 123.

Bank, (2016). Empowering farmers and Implementing Modern Irrigation Helps China Reduce Water Consumption.

Bekele Yeshitela, 2012. Preliminary Study on the Impact of Water Quality and Irrigation Practices on Soil Salinity and Crop Production, Gergera Watershed, Atsbi-Wonberta, Tigray, Northern Ethiopia. MEJS, 4 (1), 29-46.

Bekele, 2010. Irrigation potential in Ethiopia constraints and opportunities for enhancing the system. International water management Institute 1.

Berhane Grum, 2016.A decision support approach for the selection and implementation of water harvesting techniques in arid and semi-arid regions. Agricultural Water Management. 173,35–47.

Berhanu B., 2014. Surface Water and Ground Water Resources of Ethiopia: Potentials and Challenges of Water Resource Development. Nile River Basin. Springer, Cham, 97-117.

Biswas, 1990.Monitoring and Evaluation of irrigation projects. Irrigation and Drainage Engineering 116(2):227-242.

C.Yonnopoulos, 2015. The Effects of Irrigation and Drainage on Rural and Urban Landscapes, Patras, Greece: Evolution of Game Theory Application in Irrigation Systems. Agriculture and Agricultural Science procedia 4,271-281.

Chang yi Liao, 2018. The impacts of interprovincial agricultural trade on water resources in China: From perspective of grey water footprint. Energy Procedia 152, 253–258

Chuntang Wang & Deming song, 2011. Strengthen Water conservancy construction, Use Water Resources Scientifically and Develop Modern Agriculture, Procedia. Environmental Sciences 10,2011,1595-1600.

D. von Guntena, 2015 .Estimating climate-change effects on a Mediterranean catchment under various irrigation conditions. Journal of Hydrology: Regional Studies, 4, 550–570

Degol FissahayeYohannes, 2017. Department of irrigation water management: Farmers practices, perceptions and adaptations at Gumselassa irrigation scheme, North Ethiopia. Agricultural Water Management 191,16-28.

Dinar, 1986. 'Treatment Optimization of Municipal wastewater and Reuse for Regional Irrigation', Water Resources Research 22, 331-38.

Ethiopia M. o., 2002. Water Resources of Ethiopia; The National and International Perspective, Awareness creation Program prepared for Public Relation officials, Addis Ababa, Ethiopia.

FAO 2., 2004.The State of Food Insecurity in the World.

FAO 2., 2005. Geography, climate and population.

FAO 2., 2014. Food and Agriculture Organization of the United Nations.

FAO 2., 2018. Food Security & Nutrition around the World.

Girma Moges, 2011. Review and quantitative assessment of existing household rainwater harvesting systems in Ethiopia. Agricultural Water Management.98,1215-1227.

Hagos F., 2009. Colombo, Sri Lanka: International Water Management Institute 37, 128.

Haoyang Sun, 2017. Improved Analytic Hierarchy Process Method for the evaluation of agricultural water management in irrigation districts of north China. Agricultural Water Management. 179,324-337

Huang X. W., 2008. Evaluation on the irrigation and fertilization management practices under application of treated sewage water in Beijing, China. Agricultural Water Management 95,1011-1027.

Huang, 2016. Optimizing regional irrigation water use by integrating a two-level optimization model and an agro-hydrological model. Agricultural water management .178,76-88.

Jing Liu, 2014. International trade buffers the impact of future irrigation shortfalls. Global Environmental Change.29, 22–31.

Jinxia Wang, 2017. Growing water scarcity, food security and government responses in China. Global Food Security 14,9–17.

Johan Rockstro¨ma, 2010. Managing water in rain fed agriculture: The need for a paradigm shift. Agricultural Water Management 97,543–550.

Julian Dumanski, 2015.Evolving concepts and opportunities in soil conservation. International Soil and Water Conservation Research 3,1-14.

JunguoLiu, 2013. Water conservancy projects in China: Achievements, challenges and way forward.Global E13 environmental Change.23, 633-643.

Lei Zhang N. H., 2013. Water users' associations and irrigation water productivity in Northern China. Ecological Economics 95 128-136

Li Lingling, 2014. Evolution of soil and water conservation in rain-fed areas of China. International Soil and Water Conservation Research 2,1,78-90.

Lohmar B., 2003. China's agricultural water policy reforms: increasing investment, resolving conflicts and revising incentives, Agricultural Information Bulletin, Economic Research Service, U.S. Department of Agriculture No.782.

Makombe, 2007. A comparative analysis of rainfed and irrigated agriculture production in Ethiopia. Irrigation Drainage Systems: Published online. 21,31-44.

Marianthi V.podimata and Panayotis C.Yonnopoulos, 2015.The Effects of Irrigation and Drainage on Rular and Urban Landscapes, Patras, Greece:Evolution of Game Theory Application in Irrigation Systems. Agriculture and Agricultural Science procedia 4,271-281.

MO Xing-Guo, 2017. Impacts of climate change on agricultural water resources and adaptation on, the North China Plain. Advances in climate change Research 8,93-98

Molden et al., 1998. Indicators for comparing performance of irrigated agricultural systems. IWMI. Sri Lanka

Mulubrehan Kifle T. G., 2017. Effect of surge flow and alternative irrigation on the irrigation efficiency and water productivity of onion in the semi-arid areas of North Ethiopia. Agricultural Water Management 187,69-76.

Oksenberg, 1969. Policy formulation in Communist China: the case of the mass irrigation campaign, 1957-58.

Rao Fu, 2018. Next-Generation Plant Metabolic Engineering, Inspired by an Ancient Chinese Irrigation System. Molecular Plant 11, 45-57.

Resource, 2006. China water and statistics

Risheng Dinga, 2013. Multiscale spectral analysis of temporal variability in evaporate-transpiration over irrigated cropland in an arid region. Agricultural Water Management.130, 79– 89.

S.Multsch, 2017.Improving Irrigation Efficiency will be insufficient to meet future water demand in the Nile Basin. Journal of Hydrology: Regional studies 12,3,15-330.

School, 2002. Project Management. Harvad Business School Publishing Corporation 658.4'04-dc21

Shibeshi Assefa, 2016. Rainwater harvesting for supplemental irrigation of onions in the southern dry lands of Ethiopia. Agricultural Water Management, 178, 325–334.

Solomon Mutambara, 2016. A comparative review of water management sustainability challenges in smallholder irrigation schemes in Africa and Asia. Agricultural Water Management 171, 63–72

Spence, 1999.Reports that during a three-month period between late 1957 and the end of January 1958, the State mobilized peasants to create a functioning irrigation system for 7.8 million hectares of land.

Sulas Federica, 2009. State formation and water resources management in the Horn of Africa: the Aksumite Kingdom of the northern Ethiopian highlands. World Archaeology, 41(1), 2-15.

Temesgen Hirko,2018.Participation in Small-Scale Irrigation Practice: The Case of Abay Chomen District of Oromia National Regional State, Ethiopia. International Journal of Agricultural Economics 2018; 3(6): 135-144

W.M. Rose Grant and M. Svendsen, 1993. Asian food production in the 1990s.Food Policy.18(2):13-32.

Wang, 2013. An input/output approach to evaluate the water footprint and virtual water trade of Beijing, China. J. Clean. Prod. 42,172-179.

World Bank Database, 2010.

Xiangping Wang and Guan hu Huang, 2008. Evaluation on the irrigation and fertilization management practices under application of treated sewage water in Beijing, China. Agriculture Water Management 95, 1011-1027.

Xie Fang, 2011. GIS-based irrigation Water Management System Construction and application, Water Saving Irrigation 3:68-71.

Xiufang Zhu, 2013. Agricultural irrigation in China. Soil and Water Conservation 68,6.

Yao Jiang, 2015.Assessment of irrigation performance and water productivity in irrigated areas of the middle Heihe River basin using a distributed Agro-hydrological model. Agricultural Water Management 147, 67–81.

Yaohu Kang, 2012. Effects of different water levels on cotton growth and water use through drip irrigation in an arid region with saline ground water of Northwest China. Agricultural Water Management .107,74-85.

Yaro, 2004. Loan management: National Special Program for food security, Room: FMARD and FAO

Yimin Ding, 2017.Modeling spatial and temporal variability of the impact of climate change on rice irrigation water requirements in the middle and lower reaches of the Yangtze River, China. Agricultural Water Management 193, 89–101

Zhang W, 2018. Construction of intelligent water saving irrigation control system based on water balance. IFAC Papers Online .51-17, 466–471.

http://www.fao.org/nr/waterhttp://www.fao.org/nr/water/aquastat/water_use_agr/Figure1.jpgchallenges**Burhttp://www.fao.org/nr/water/aquastat/water_use_agr/**Figure1.jpgke, 2000 FAO, 2016. Food and Agriculture Organization of /aquastat/sets/index

http://www.fao.org/docrep/003/t0800e/t0800e0d.htm

https://knoema.com/atlas/China

http://www.fao.org/nr/water/aquastat/sets/index.)

https://www.statravel.com/china-climate.htm).

http://documents.worldbank.org

http://www.fao.org/nr/water/aquastat/water_use_agr/Figure1.jpgchallenges (Burhttp://www.fao.org/nr/water/aquastat/water_use_agr/Figure1.jpgke.

https://www.statravel.com/china-climate.htmhttps://knoema.com/atlas/Ethiopia**and** https://knoema.com/atlas/China

https://www.odi.org/sites/odi.org.uk/files/odi-assets/publications-opinion-files/5124.pdf