Auditing Water Management to Achieve Sustainable Development in Supply Chain

Dr. Khawla Hussein Hamdan[1]
[1] *Post Graduate Institute for Accounting and Financial Studies, University of Baghdad, Iraq*
[1]Dr.kawla@pgiafs.uobaghdad.edu.iq

***Abstract*- The research aims at auditing water management to identify the extent to which water management contributes to the achievement of 2030 sustainable development in supply chain goal no.6. Statistical reports and time series were used to estimate percentages to some indicators. The research aims at utilizing indicators within SD (economic, social, environmental and institutional) dimensions to know how water management contributes to the achievement of SD. The researcher has concluded a set of conclusions the most important of which are the following: water reserves are not being maintained, efficient use of water has not been achieved due to high rates of water withdrawn from surface water, non-provision of safe drinking water and appropriate sanitation, inequality of water provision between country and urban population, low rate of wastewater treatment, most wastes of various activities are disposed of by being dumped in rivers untreated and high rate of morbidity resulting from water pollution. Despite the efforts exerted either by projects and plans or water related conventions, no effect has been seen on water management reality to achieve SD. Hence, water management has not achieved targets of goal 6 of 2030 development Agenda.**

***Keywords*-** *water management, sustainable development, supply chain, Audit, Iraq.*

1. Introduction

The study of sustainable development in the supply chain is a novel one and it is essentially related to environmental changes faced by the world. This concept has been tackled in many studies namely the one conducted by [1]. That paper provides discussion of ways in which an interdisciplinary approach can be taken to produce an integrated assessment of water stress and scarcity, linking physical estimates of water availability with socioeconomic variables that reflect poverty, i.e., a Water Poverty Index poor households often suffer from poor water provision, and this results in a significant loss of time and effort, especially for women. By linking the physical and social sciences to address this issue, a more equitable solution for water allocation may be found. Poverty index will introduce a comprehensive tool to contribute to water management, namely producing a direct contribution to eliminate Poverty in poor countries. As for the study conducted by [2] it discusses the empirical analysis of the issue of how far sustainable development in the supply chain can be achieved through stakeholder relation management SRM. It describes the SD- SRM perspective that is called the distinctive research approach and it pinpoints how it is related to the wider stakeholder theory. The study of [3] focuses on the multi-indicator approach of the environmental audit of public programs of water management. The environmental condition of Wuli Lake in China was assessed by using the international indicators developed by SD committee and four additional indicators that are proposed by the author: water quality, pollution loading, water system condition and sediments of the lake. Various hydrological, chemical, biological and environmental factors were used to estimate the values of indicators so as to assess the environmental condition of the lake building on historical data series for 20 years. It is concluded that the suggested indicators can be used to meet the needs of a special assessment of water conservation programs. Thus, evaluating the performance of national environmental conservation programs and providing environment auditors with technical support. Multi indicators need to be used along with socioeconomic assessment indicators so as to come up with a reliable and objective audit The study recommends that the cooperation between environment auditors, ecologists and consultants is essential for the identification of audit indicators and criteria, audit data gathering, and analysis of project effectiveness as well as drawing audit conclusions. Whereas [4] study suggests adopting and spreading SD through developing curricula in universities .the study concludes that integrating the concept of SD in all economic, social and environmental fields of specialty can help graduates to contribute better to create more sustainable societies.

The study of [5] investigates the use of water auditing techniques to examine water flows within a petroleum refinery, concurrently identifying practical ways for achieving water conservation. The study demonstrates that many opportunities existed to improve water conservation through the use of alternate water sources such as rainwater runoff, reuse of water within process units, and the introduction of an overarching company policy to minimize water use and effluent discharge. Water auditing was shown to be a method for identifying the weakness in water management and for conducting technical and behavior improvements including the alignment of the company strategy with water management goals. There are many chances available to conserve water in the site thus, contributing reaching zero liquid discharge ZLD. The study of [6], investigates water auditing .water flows were identified by using historical data .two major water conservation measures were identified which could reduce inputs and outputs by 40 %. These were the reuse of rainwater falling throughout the plant's boundaries and the improvement of the efficiency of one of the cooling towers.

The study conducted by [7]. Concludes that sustainable water management of urban, agricultural, and environmental systems is integral to continued development. Lots of models and metrics exist for evaluating sustainable management practices. These methods should focus on the interconnectedness of social and physical systems using quantitative metrics. Urban water management in developing regions face challenges, especially with the rapid urban population growth. Sustainable management plans should focus on continued improvements in stakeholder involvement and infrastructure in developing regions, and on water reclamation and reuse in developed regions. Water reuse will reduce stress during drought periods, though technology adoption cost and risks are still barriers in both developing and developed nations. Improvements to crop water productivity can benefit all sectors of water users by reducing competition between the agricultural sector and urban and environmental users. Crop water production in irrigated areas can be improved with the adoption of efficient irrigation and on-farm technologies. Long-term economic development is clearly linked to environmental system health, evidenced by the developed country focus on protection of water resources. Sustainable water management varies with geography and economic capabilities, though all regions can manage water resources in a way that supports sustainable social, economic, and environmental development.

The study of [8] discusses the impact of Higher education on meeting the SD requirements .the research comes up with a number of conclusions most important of which is that the availability of lab devices, modern data show systems and audiovisuals in time of delivering lectures, financial allocations that are necessary to make research and develop and update curricula can contribute to enhancing higher education quality and achieving sustainable development in the supply chain. The problem of research that the Effective water management includes policies, procedures and programs to secure safe drinking water, suitable sanitation for all, efficient and sustainable use of water in all sectors, trans boundary international cooperation to protect human health and living organisms and securing the needs of current and future generations. Thus, the research problem is the lack of an audit report on water resources management that discloses the contribution of water management to the achievement of SDG 6 of post 2015 development Agenda as per SD (economic, social, environmental and institutional)dimensions. The research derives its importance through the following:

1. The research stems from that of developing a report on water audit results based on SD (economic, social, environmental and institutional) dimensions.
2. The report is to disclose water related issues and problems that hinder the achievement of SDG 6 of post 2015 development Agenda. Water related entities can develop policies to maintain water sustainability and eventually meet the needs of current and future generations.

Research hypothesis: The research is based on a hypothesis that water management audit report helps to determine the extent to which water management contributes to the achievement of 2030 SD Goal 6 so as to meet present and future generation's needs.

Research tools: Statistical reports ,the research subject matter related studies and historical time series of some indicators have been used to identify the extent to which 2030 SD Agenda can be achieved.

2. Theoretical framework

2.1. Sustainable Water Management (SWM)

Millions of people suffer from the intolerable scourge of diseases due to lack of access to safe drinking water supply. Major contaminants on the global level are: garbage, foodstuffs, toxic metals and industrial and agricultural chemicals. In developing countries, untreated water constitutes the highest risk to public health. It causes the death of about 25000 people per day. While waterborne diseases in developed countries were eradicated, cholera and other digestive system diseases are still seen with high awful frequency in developing countries. About 450 km3 of wastewater is estimated as being poured into rivers each year. To move dirt away and to dilute wastewater, 6000 km3 of water are needed. Global wastes removal needs a quantity of water that is equal to the surface flow. Water management according to [9] consists of 10 processes: planning and design, construction, operation and maintenance, irrigated agriculture, performance audit, rehabilitation and modernization, catchments water harvesting pollution, reuse, groundwater reservoirs management, fishing, and wildlife. Water management as defined by [10] is "the process by which water is treated and used for producing food and fibers". They liken management in its simple form to people organization to attain set goals by means of a method developed as per a specific plan. This definition means that management is an engagement to achieve certain goals through people by taking decisions concerning the most efficient utilization of resources.

Rio de Janeiro conference1990 came up with an action plan called Agenda 21. Chapter 18 was about freshwater. The Agenda considers integrated water resources management and development as a main method to achieve world sustainable drinking water resources management. The [11] principles that were globally supported must be followed by means of integrated water resources management. The principles include (Global water partnership)

Principle 1: Fresh water is a finite and vulnerable resource, essential to sustain life, development, and the environment. This principle acknowledges all hydrologic cycle properties and their interaction with natural resources and other ecosystems.

The Statement acknowledges that water is needed for many uses, functions and various services. Accordingly, overall management needs to consider demands for resources and the threats that are being faced.

Principle 2: Water development and management should be based on a participatory approach, involving users, planners, and policymakers at all levels.

Water is the subject in which everybody is a stakeholder. Real participation is realized only when stakeholders are part of the decision making process.

Principle 3: Women play a central part in the provision, management and safeguarding of water.

It is widely known that women play a pivotal role in collecting and safeguarding water for domestic and often agricultural uses. Yet, their effect is less than that of men in terms of management, problem analysis and water resources related decisions.

Principle 4: Water is a public good and has a social and economic value in all its competing uses.

SWM is a critical component of SD. Agenda 21provides for the goal to ensure adequate supplies of good quality water that are made available for the entire population while preserving the hydrological, biological and chemical functions of ecosystems, adapting human activities within the capacity limits of nature and to combat water-related diseases." Figure (1) shows the water related agreements as per their subjects.

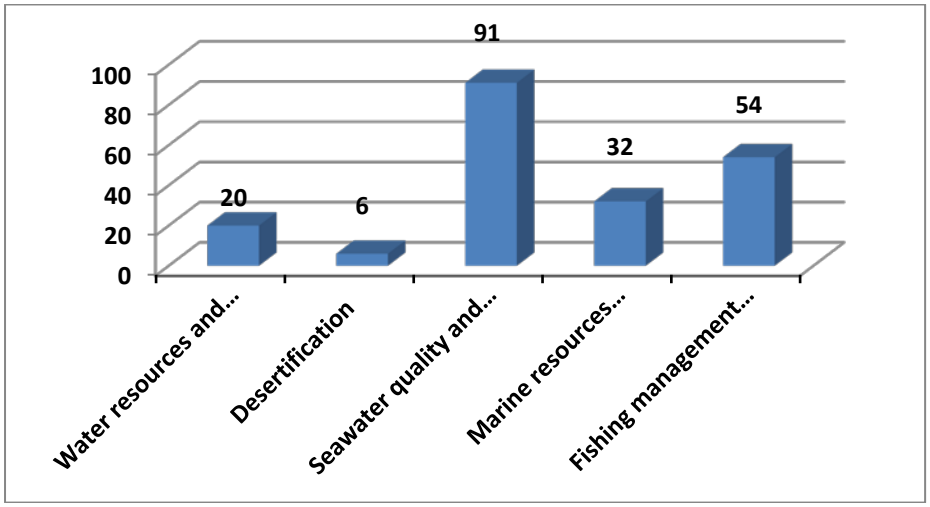

Figure (1) shows the water related agreements as per their subjects

[11] Has been one of the central themes of the Working Group Since 1996 INTOSAI Working Group on Environmental Auditing" Auditing Water Issues 2004, p 29.

2.2. Sustainable Development in supply chain

UN Stockholm Conference on environment is the first conference that was convened that dealt with environmental issues in coherent systemic approach. A strategy was proposed to establish a sustainable community "Earth Summit", and was published in 1991 by the international union for nature conservation in collaboration with UNPE and WWF. SD is the concept describing the relationship between economic growth and environment. The term was used for the first time in 1987 by world commission on environment and development also known as Brundtland commission after its chairperson, Gro Harlem Bruntland in its report" our common future' the sustainable development in supply chain as the development that meets the needs of the present without compromising the ability of future generations to meet their own needs".

[13] defined sustainable development in supply chain as a socially constructed and contested concept that reflects the interest of those involved and that sustainability is the key discourse for discussing the economic, environmental and social future in the region and through which environment is protected. [14] defined sustainable development in the supply chain as the process of improving the economy and the social aspect to meet and evaluate the benefits while maintaining the future choices, natural resources and diversity.

2.3. Sustainable Development in supply chain Dimensions

2.3.1. The Economic Dimension

An economically sustainable system must be capable of producing goods and services on a continuing basis to maintain manageable levels of the government and external debt and avoid extreme sectoral imbalances that damage agriculture or industrial production

2.3.2. The Environmental Dimension

The environmentally sustainable system should maintain a stable resources base and avoid overexploitation of renewable resources systems and depletion of non-renewable maintaining biodiversity, atmospheric stability and other ecosystem functions not always looked upon as economic resources

2.3.3. The Social Dimension:

The socially sustainable system should achieve fairness in distribution with adequate provision of social services such as health, education gender equality, accountability and participation.

2.3.4. Institutional Dimension

Policies are being taken care of and implemented to promote Sustainable Development in the supply chain. They include legislation, national strategy, agreements and expenditure on Research and Development in addition to economic losses.

2.3.5. Water related Sustainable Development in supply chain Goals

SDGs are based on measurable indicators that have international nature and applicable to all states while taking into account capabilities, development levels and national priorities. The SDGs integrate economic, social and environmental Goal 6 of post 2015 sustainable development in supply chain Agenda ensures the adequacy of water and sanitation for all and that it is sustainably managed. They are as follows:

- By 2030, achieve access to water, sanitation and sustainable use for all.
- By 2030, achieve access to safe and affordable drinking water for all.
- By 2030, make sanitation available and women and girls are met.
- By 2030, reduce pollution by eliminating hazardous materials, increasing the treatment of wastewater and increasing recycling and safe reuse.
- By 2030, implement integrated water resources management at all levels, including through Trans boundary cooperation.
- By 2030, increase water-use efficiency across all sectors and ensure sustainable withdrawals and supply of freshwater.
- By 2030, decrease mortality rate and disasters resulting from water.
- By 2030, expand international cooperation in water- and sanitation-related activities, including water harvesting, desalination, wastewater treatment, recycling and reuse.

3. Literature Review

3.1. Water Management Audit:

The general purpose of water audit is to evaluate whether internal controls on water are sufficient and effective to check the availability of water conservation activities and to reduce environmental risks. The water audit is an effective management tool for reducing losses, achieving the utmost benefit from the various uses thus, enabling water conservation at a large extent. Water audit consists of the preparation of layout of water sources, distribution network, and service/ delivery points to water users and return flow of waste or excess water. The layout should include locations and capacities of flow measurement devices installed at key points, dimensions of pipes and fittings in the water supply system, locations and particulars of flow control devices and history sheets of all measuring and control devices including pipes and fittings. Water quality of the distribution system needs to be monitored regularly at strategic points to find out the level and nature of contaminants present in the supplied water.

A water audit report may contain:

(a) Amount of water earmarked/made available to the service.

(b) Amount of water utilized, both through metered and unmetered supplies.

(c) Water loss and efficiency of the system along with reasons for such water losses.

An effective water audit report may be purposeful in the detection of the leak in the distribution system, taking timely action for reducing conveyance losses of water and improving the efficiency of the system. The water audit of the system should be undertaken at regular interval of time, at least on an annual basis (General Guidelines for water Audit and Water conservation central Water Commission Evaluation of Water Utilization Directorate December 2005 New Delhi).

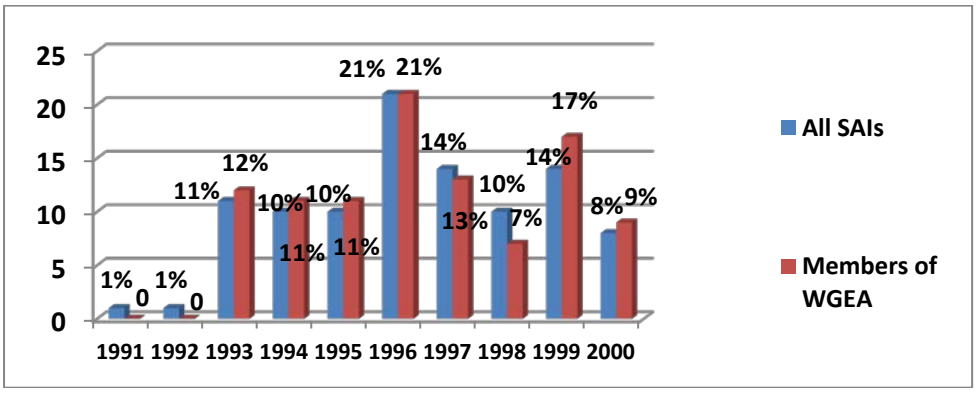

Figure 2 depicts the percentage of water audit report

[15] Freshwater has been one of the central themes of the Working Group Since 1996 INTOSAI Working Group on Environmental Auditing" Auditing Water Issues Experiences of Supreme Audit Institutions, p42

Performance audit is broader than regularity audit when it comes to water audit issues but they are often used together as shown in figure (3)

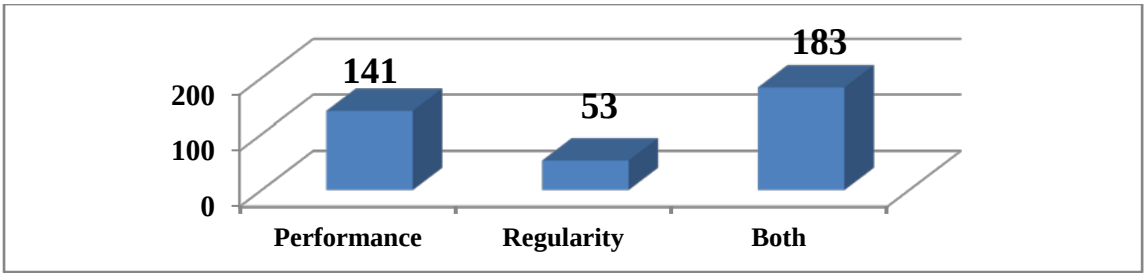

Figure (3) Type of water audits

[16] Freshwater has been one of the central themes of the Working Group Since 1996 INTOSAI Working Group on Environmental Auditing" Auditing Water Issues Experiences of Supreme Audit Institutions, p40

As for Arab SAIs ,8 SAIs (47.1%)use performance audit indicators in environment audit on water .Most Arab SAIs(14 SAIs (82.4%) do not carry out audits on environmental issues in the field of international environmental agreements. whereas 3 Arab SAIs carry out independent audits (unilaterally) on environmental agreements. These SAIs are The Sudan, Algeria Oman. 11 SAIs (76.5%) need training in the field of water audit .8 SAIs (Egypt, Tunisia, Libya, Qatar, Yemen, Jordan, Saudi Arabia and the UAE) suggest preparing cooperative audit reports.

3.2. SAIs 'Experiences in The Field of Water Audit

3.2.1. Bolivia

SAI of Bolivia conducted an audit on the pollution of the Pirai River. The report shows the relevance of water quality measurements as one of the audit methods. The analyses included the physical and chemical water properties as well as the presence of bacteria. The water quality analysis considered non-treated water (from the source) that belongs to the Piraí River catchment area, polluted by industries and some other commercial activities that discharge their treated and untreated waste water. The SAI concluded that the monitoring duties carried out by the Environmental Authority were not effective concerning the control of the Piraí River water quality and some other small rivers that discharge their water to the Piraí River.

3.2.2. USA

The SAI of USA conducted several types of audits on drinking water .most of these audit types concentrated on environment conservation while other kinds of audit focused in general on funds dispersed by the States.

3.2.3. The United Kingdom

In 2000, the SAI of the United Kingdom published an audit report on leakage and water efficiency. The SAI examined how the Office of Water Services (OFWAT) are carrying out their responsibilities for regulating the way water companies manage leakage and promote the efficient use of water. The SAI also examined what progress has been made in reducing leakage. Main conclusions of the audit are that the OFWAT have sought to reduce the amount of water lost through leakage by means of the introduction of mandatory or self-proclaimed targets for the water companies. The water companies have responded to these targets and the leakage has been reduced to around 21 percent in 1999-2000. This produced benefits, although the costs incurred are not clear.

3.2.4. Korea

Between the years 1993-2000 and despite the fact that the Korean government spent $15 billion on improving the water quality of four major rivers, no concrete improvements were seen. In 2001, an audit was conducted to identify the reasons behind non improvement. Based on audit findings and conclusions, the ministry of environment conducted a project and established a system for feedback, they adjust the size of sanitation system treatment stations and their focus was no longer confined to the treatment of wastewater for the stock to the production of organic fertilizers. The audit and its recommendation caused water quality to improve.

4. Data and method

4.1. Auditing water resources to achieve sustainable development in supply chain in Iraq environment

4.1.1. A brief description of the Water Resources Ministry

The ministry was established when Act Number 50 was legislated on 17/11/2008. Section 2 of this act includes the ministry's aims which are:

- Planning to invest water resources in Iraq and exploiting surface water and groundwater to achieve a perfect usage of water resources.
- Developing and sustaining water resources and identifying its sources and usage.
- Protecting Iraq rights of shared international water and communicating and exchanging information with neighboring countries and the countries that surround rivers to ensure reaching fair agreements to divide the amount and the quality of water that enters Iraq.
- Protecting surface water and groundwater from pollution and giving priority to the environment aspect and reviving and sustaining marshes and other water surfaces.

4.1.2. Water sector issues in Iraq

- a-The decrease in water revenues as a result of constructing dams and water storages by the countries that have the origin of water (Turkey, Iran and Syria)
- b- The pipes that transfer water are becoming old and digging up roads as a result of roadwork increases the number of broken pipes which results in more loss in water.
- c. Water desalination stations, water parks and projects stop working as a result of power cut.
- d- The irresponsible use of water
- e- Lack of rain and when there is heavy rain, they do not take advantage of it.
- f- The increasing number of plants that consume a lot of water such as Nile flower and Shamblan.
- g- The increasing amount of grass which obstructs water flow.
- h- Lands were prone to desertification.
- Encroaching incidents on water pipes caused by public members.
- j- Encroachment on water shares between provinces.

4.2. Water management audit to achieve sustainable development in supply chain goals

4.2.1. The Economic Dimension

- **Comparing the ratio of government expenditure to GDP on Education and Health sectors with that on water sector**.

First -Based on the comparison made, we noticed that while the expenditure on education and health was low, that on water sector was much lower as shown in table (1).

Table (1) Ratio of government expenditure to GDP on education, health and water sectors.

Year	Ratio of government expenditure on education sector to GDP	Ratio of government expenditure on health sector to GDP	Ratio of government expenditure on water sector to GDP
2010	0.03	0.03	0.006
2011	0.03	0.02	0.005
2012	0.03	0.04	0.005
2013	0.27	0.02	0.004

Preparation of the researcher depending on the Ministry of Finance, the final accounts of the Republic of Iraq & (2010-2013)، Unified Arab Economic Report, 2014.

Second: the proportion of spending on water in Iraq was low compared to the average rate in the Arab countries of 0.7 for 2010.

b- Water uses -Water uses for agriculture, irrigation, industry and domestic usage

The indicator is the total annual volume of (surface and underground) water that is used in the agricultural, domestic and industrial areas. The purpose of the indicator is to manage water resources and identify the sector with the highest consumption of water taking into consideration the benefit gained from that consumption.

The agricultural sector contribution to GDP

Table 3 depicts water uses and the contribution of agricultural sector to GDP water years (from 2011-2012 to 2013-2014). The table shows that the agricultural sector is the highest in terms of water use but its contribution to GDP low.

Table (2) Water uses and contribution of agricultural sector to GDP % Agricultural use, industrial use, domestic use and water year.

water year	domestic use	industrial use	Agricultural use	contribution of agricultural sector to GDP%
2009- 2010	1.2	2.0	34.8	6.1
2010-2011	1.2	2.0	35	5.6
2011-2012	1.4	2.3	38.7	4.8
2012-2013	1.4	2.2	38.7	5.5
2013-2014	1.3	2.1	36.6	5.6
2014- 2015	1.11	1.86	31.95	5.1
2015- 2016	1.23	2.05	35.27	5.5

The researcher developed the table based on the Central Statistics Organization for the years 2010-2016, Unified Arab Economic Report 2014 p.407

(2). Irrigation efficiency

Table 4 shows a comparison of the agriculture share of total withdrawals, irrigation needs, agricultural water withdrawals and irrigation efficiency in Iraq with that of some Arab countries for the year 2011.

The following was obtained:

- The agriculture share of total withdrawals in Iraq was low as compared with that in some selected Arab countries save Jordan and it was below the average of Arab countries in general.
- Water withdrawal was low when compared with that in the selected Arab countries and below the average of Arab countries in general.
- Irrigation water use efficiency percentage in Iraq for the year 2011 was 28.9%. It is considered low when compared with that of the selected Arab countries and below the world average (56%) and the average of the Arab countries (51.1%).this is because modern irrigation methods are not being used in Iraq (sprinkler and drip irrigation). These methods were proved to be economical in terms of water use.

Table (3) a comparison of actual renewable water resources and percentage of irrigation efficiency with that of some Arab countries for the year 2011

Agricultural water withdrawals(million m3 /year),%	Agricultural water withdrawals(million m3 /year),	Irrigation water needs (million m3 /year)	Agriculture share of total withdrawals %	Country
28.9	52	15023.9	78.8	IRAQ
49.3	611.0	301.0	65	JORDN
48.6	14670.0	7123.0	87.5	SYRIA
55.7	20830	11599	88	KSA
52.9	11010.0	5823.0	87.3	EGYPT
30.7	26153.0	8025.0	94.8	SUDAN
51.1	20525.0	104786.0	84.5	Average of Arab Countries

The table is developed by the researcher based on the Unified Arab Economic Report 2014 p.409

(3)-**Agricultural imports and exports**

Figure 4 depicts the size of Iraq's agricultural imports and exports. Agricultural imports exceed the exports due to non-meeting of the agricultural needs for water withdrawals and lack of efficient irrigation. This, in turn, will affect the Balance of Payment.

Source: developed by the researcher based on the Unified Arab Economic Report.2015.

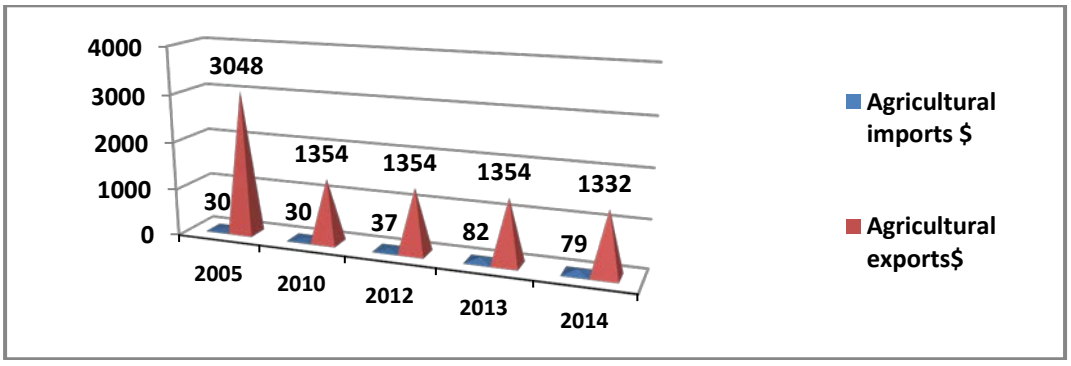

Figure (4) Iraq's agricultural imports and exports for the years 2005-2014

Second - produced hydroelectric power

Table (4) depicts the production and hydroelectric power rate from total produced power excluding KGR

Table (4) Production and hydroelectric power rate from total produced power excluding KGR

year	Number of plants		Ratio of hydroelectric power to total number of(gas, steam, diesel and mobile)hydroelectric plants	Production (mwh)hydro electric plants	Hydroelectric power rate produced out of total power	The actual contribution to production - hydroelectric plants 100%,
	hydroelectric	Total plants				
2012	6	52	12%	4392150	10%	6.9
2013	8	59	14%	4756787	7%	8.2
2014	8	60	13%	2930797	4%	4.3

Source: Central Statistics organization, environmental statistics, 2014)

Percentage of actual contribution to production .The highest percentage was recorded in 2013 (8.2%). The security conditions have a significant impact on the amount of power produced as the breakdown of electric transmission lines leads to the failure to distribute the power produced in the plants thus production decreases despite the availability of the capacity to produce. The hydroelectric power produced from the total power produced has decreased because of the security conditions and ISIS occupation in 2014 in some of the provinces that have dams that produce hydroelectric power (Mosul Dam, Samarra dam and Diyala dam).

It is necessary to maintain hydroelectric plants and to take precautionary measures in case dams stop producing energy for any reason by operating dams that are located in safe provinces.

c. WATER inflow and reserve

First -The percentage of water withdrawn from surface water and groundwater that can be withdrawn is (1billion cubic meters)

The percentage of water withdrawn from surface water was (80.2 - 91.6) from the water year 2009-2010 to the water year 2012-2013. It was so high that it resulted in the non-retention of water reserve. The amount of water withdrawn from the surface water (billion cubic meters) for the water year 2013-2014 exceeded the inflowing quantity (billion cubic meters) due to the use of water reserve as shown in Table (5)

Table (5) Percentage of water withdrawn from surface water (billion cubic meters)

water year	Quantity of inflowing surface water (Billion cubic meters).	Quantity of surface water withdrawn from surface water (billion cubic meters	percentage of water withdrawn from surface water (billion cubic meters)	Groundwater that can be withdrawn (billion cubic meters)
2009-2010	50.1	40.4	80.6	7
2010-2011	47.6	40.7	85.5	4
2011-2012	49.11	45	91.6	4
2012-2013	56.02	44.9	80.2	4
2013-2014	37.3	42.5	114	4
2019- 2020	51.46	41.02	80	5.8
2021- 2030	49.74	41.86	84.2	5.2

Source: (Central Statistics Organization 2014)

Second. The plan of the Ministry of Water Resources for the years 2010-2014 included increasing the volume of water reserve by about 33 billion m3 as a result of the implementation of (9) large dams during the period of the plan for the years 2010-2012, including Bakhma Dam, which would take three years after the plan to be implemented. The storage capacity of Bakhma dam is 14.4 billion cubic meters. The water reserve of the Tigris and the Euphrates have decreased from 74.2 in 2007 to be 55.81 billion cubic meters in 2014 without achieving the target of the plan i.e. Increasing water reserve to be 33 m3. For the following reasons:

1. Due to the construction of dams and reservoirs by Turkey and Iran, levels of water flowing into Iraq has decreased as the sources of water flowing into Iraq from these countries constitute the largest proportion of inland water resources (71%) from Turkey and 6% from Iran.
2. High evaporation rate of water from reservoirs and dams due to non-meeting of technical specifications when constructing the reservoirs and dams.
3. Low amount of rain and in case available, it is not treated to be made use of in agriculture.
4. Water Hyacinth (Echhomiacrassipes) covers the rive which causes the consumption of water and draining dissolved oxygen. It constitutes an obstacle to water flow leading to the destruction of water wealth and the hindering irrigation thus on badly affecting agriculture.

From the previous indicators of the economic dimension, we conclude the following: water reserve is not maintained and water efficiency, whether in agriculture, irrigation and generation of hydroelectric power, has not been achieved. There has neither been an expenditure on investment projects nor control on such expenditure. This led to not achieving

target 5 of the sustainable development in supply chain Goal 6 which provides for the efficient use of water in all sectors by using time series to estimate water withdrawals rates for 2020 and 2030.we noticed that that adequate reserve of water could not be maintained ,therefore, sustainable supply is affected .Hence target 5 of SDG that include making water withdrawal conform to sustainable supply is not achieved.

4.2.2. Social Dimension

a. Continuous water development index:

This indicator takes into account demand for water against the amount available to find out how to meet the needs of future generations for their share of water.

The negative result of this indicator means that it is not possible to achieve the continuous development of water and if it is positive, and also compares the positive result with the previous years, the higher the index, it is the better.

Table (6) shows that the value of the indicator has declined in 2013 and 2014 as the quantity does not cover the available quantity. When estimating the quantity available and required, it is noticed that the value of the indicator increases to be 16% in 2020 while it drops to 4% in 2030.

Table (6) Continuous water development index

Continuous water development index	Average need for available water per capita m^3/year	Per capita share of available water m^3/year	Population million	needed quantity of water for the coming period to meet needs 1000m/day	Available Quantity of Water 1000m^3/day	year
40	301	341	33	9917	11250	2011
51	318	369	34	10799	12561	2012
67	435	381	35	15224	13333	2013
60	448	388	36	16129	13981	2014
59	299	358	32	9558.10	11436.5	2020
15	359	374	33	11864.20	12333	2030

As depicted in the table above, we notice that the index in 2013 and 2014 shows no continuous development .Also, the index value is positive for the years 2020 and 2030 though low in 2030.

b. Percentage of population with access to safe drinking water.

It is the percentage of the population that has access to a sufficient amount of safe drinking water in the residential area either from the permanent water supply inside the house or from the close area. This indicator is used to find out whether the population has access to safe drinking water and the ability to do so. The purpose behind is to lessen the risk of the dangerous diseases and epidemics that spread through contaminated drinking water and water that is not properly stored. It is worth mentioning that a person needs a minimum of 20 liters per day to meet all his/her needs.

Table (7) shows the percentage of population of urban and rural areas with access to safe drinking water.

The following is noticed:

First. When comparing the percentage of the population in urban and rural areas with access to safe drinking water in Iraq with that of Jordan and the UAE for years (2010, 2015), we find out that it is a low percentage. Moreover, the percentage of the urban and rural population in Iraq with access to safe drinking water in 2015was below the average of Arab countries in terms of urban, rural and total (94.30%, 88%, and 93%) respectively.

Second. No equality is seen between urban and rural areas in providing safe water to the population of Iraq for, the percentage of the urban population with access to safe drinking water is higher than that of the rural population.

Table (7) Percentage of population with access to safe drinking water

Country	2010			2015		
	Urban	Rural	Total	Urban	Rural	Total
IRAQ	91%	56%	79%	94%	70%	87%
JORDAN	98%	92%	97%	97.80%	92.30%	96.30%
UAE	100%	100%	100%	99.60%	99.60%	99.60%
Average of Arab Countries				94.30%	88%	93%

Source: The table is prepared by the researcher based on the Unified Arab Economic report for the years 2011, 2016)

d. Water price:

Water supply tariff is governed by regulations no. 16 (2000). The tariff structure is an increasing block rate tariff to recover costs for providing water to residential units and public facilities. It starts from ID 2 (Iraqi dinar) for 1-30 $m^3$of water per month and ends with ID 20 for 91-120 M^3 of water per month. As for public and mixed sector, the tariff is ID 20 for 1 m^3 of water per month while the tariff for private industrial and commercial sector, is ID 30 for 1

$m^3$of water per month [16]. This means the price is right for everyone.

d. The percentage of urban and rural population benefiting from adequate sanitation.

First. Table 8 shows the percentage of urban and rural population benefiting from sanitation.

The following is noticed:

When comparing the percentage of population that have access to adequate sanitation in Iraq with that of Jordan and the UAE for years (2010, 2015), we noticed that the percentage is lower than that of Jordan and the UAE. Moreover it is below the average of Arab countries in terms of urban, rural and total.

No equality is seen between urban and rural population in Iraq as the percentage of urban population with access to sanitation is greater than that of rural population.

Table (8) Percentage of population benefiting from adequate sanitation

Country	2010			2015		
	Urban	Rural	Total	Urban	Rural	Total
IRAQ	76%	67%	73%	86%	84%	59%
JORDAN	98%	98%	98%	99%	99%	99%
UAE	98%	95%	100%	98.00%	9520.00%	97.60%
Average of Arab Countries				92.7%	87.0%	91.0%

Source: The table is prepared by the researcher based on (the Unified Arab Economic Report for the year 2011

- The target of the National Development Plan (2010-2014), which includes increasing the percentage o of people benefiting from adequate sanitation to be 100%., has not been achieved.

Second. Estimating the percentage of the population benefiting from safe drinking water and adequate sanitation for the years 2020-2030:

Table (9) shows the inability to achieve equality between urban and rural residents in terms of the provision of safe drinking water and adequate sanitation in addition to the fact that safe drinking water and sanitation are not being provided to all population.

Table (9): Estimating the percentage of population benefiting from safe drinking water and adequate sanitation

Data	2010		2011		2012		2015		2030	
	Urban	Rural	Urban	Rural	Urban	Rural	Urban	Rural	Urban	Rural
Safe drinking water	91%	56%	94%	67%	94%	69%	94%	70%	93%	63%
Adequate sanitation	76%	67%	86%	80%	86%	82%	86%	84%	82%	76%

Source: The table prepared by the researcher is based on the Unified Arab Economic Report for the year 2011, 2016

Third. Most women in the southern provinces of Iraq bear the burden of transferring water from the source to their houses causing them to suffer from stress and fatigue.

From previous indicators of the social dimension, we infer the following:

The inability to achieve equality between the urban and rural population in terms of provision of safe drinking water and adequate sanitation. They have not been provided for all either now or in the future. Additionally, women are still responsible for fetching water. As a result , Sustainable development in supply chain Goal 6 - targets 1, 2 and 3 (provision of water, safe drinking water and adequate sanitation, sustainable use and meeting the needs of women by 2030) are yet to be achieved.

4.2.3. Environmental Dimension

a. Treated Wastewater

Treated the wastewater is the water that flows from wastewater treatment plant after being properly treated according to the standard quality specifications of treated wastewater as per the purpose of its use or is disposed of.

Figure (4) shows the percentage of treated wastewater for the year (2006) and the estimated treated wastewater for the years 2020 and 2030.

The figure shows that the highest percentage of treated water was recorded in 2006. It ranged between low and high from the year 2007 to 2013. This percentage for all years is below that of 2006.By using the time series, the results are deemed to be good in 2020 and moderate in 2030.

Source: The figure is developed by the researcher based on the report of the Central Statistics Organization 2006-2013 and results of the application of the time series 2020, 2030

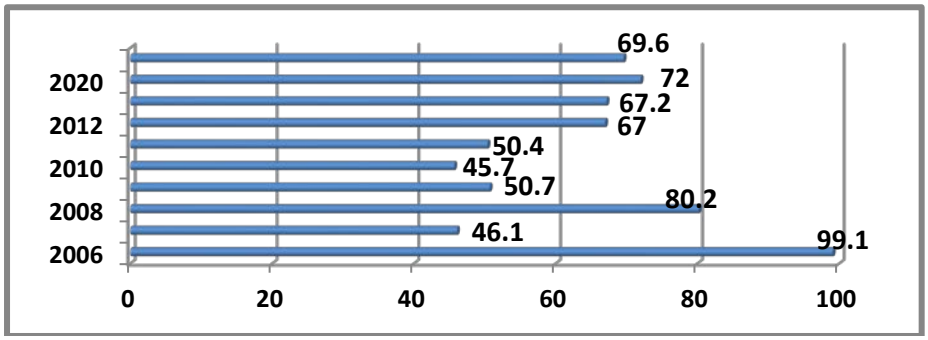

Figure (5) Percentage of treated water

a. Focus (BOD) in water

BOD is used as an indicator of the degree of organic pollution of water. Biochemical Oxygen Demand is the amount of dissolved Oxygen needed by aerobic biological organisms to break down organic material in water. BOD is measured during 5 days of incubation at 20 C.

figure (5) shows that BOD amount in treated water flowing from treatment plants is 36.2 mg/l (one part of 1000000) for all provinces and it exceeds the local typical value (10mg/l) and the global typical value (5mg/l) (one part of 10000000).This leads to draining the oxygen and the death of organisms living in water namely fish in addition to the resulting toxic gases that are released when organic materials are broken down.

Source Preparation researcher of the researcher based on the (Republic of Iraq, Ministry of Planning Central statistical organization IRAQ, Priority Indicators for Environment and Sustainable Development in supply chain in Iraq, 2012)

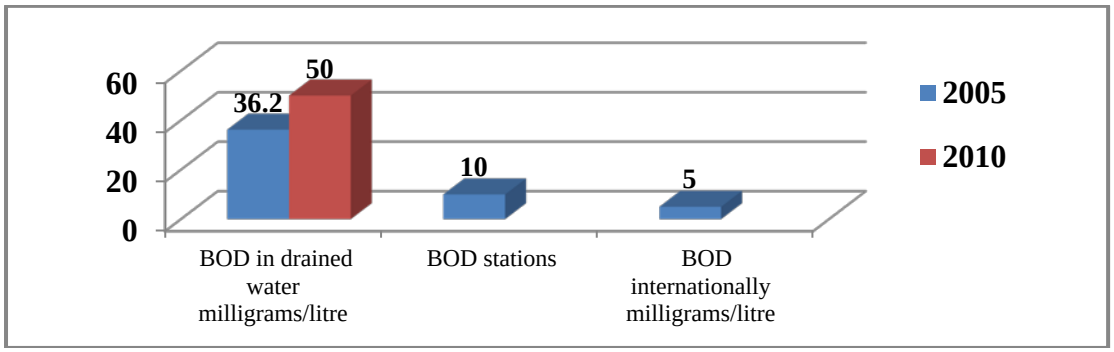

Figure (6) Focus (BOD) in water

b. waterborne diseases

Hepatitis types A and E, Diarrhea

Table (10) depicts the deaths caused by water pollution .The following is noticed:

High rates of morbidity and mortality among children under five due to water pollution, failure to achieve the goal to reduce morbidity and mortality rates among children under five .Number of cases with hepatitis types A and E has increased therefore the goal to eliminate and control the disease by 100% has not been achieved.

The number of cases with hepatitis types (A and E) has increased. Karbala governorate has the highest number of cases with hepatitis in 2012 (714) and Nineveh has the highest number of cases with diarrheal (322474), and in 2013 Baghdad /Rusafa recorded the highest number of cases with hepatitis type A (2508).In 2013 Nineveh has the highest number of cases with diarrheal (210798) while in 2014 the highest number of hepatitis type (A) was recorded in Baghdad /Rusafa (1428) and the highest number of cases with diarrheal (110952).

Table (10) morbidity and mortality caused by water pollution

Year	Diarrhea age group (under 5)		Hepatitis (by type)			
			A		E	
	morbidity	mortality (excluding KGR)	morbidity	mortality (excluding KGR)	morbidity	mortality (excluding KGR)
2012	1188510	195	5364	3	289	8
2013	1057097	163	10845	12	336	3
2014	708800 excluding KGR		4723 (excluding Nineveh Salah Uddin, Anbar)	7	199)excluding Nineveh ,Salahuddin,Anbar	7

Prepared by the researcher based on Central Statistics Organization 2012-2014

As for cholera, no cases was recorded during 2009-2011 .However ,there were cases that were recorded in 2007 and 2008.In 2012 ,588 cases with cholera were recorded in Suleimaniya and Kirkuk according to MOH report of the year 2012 .Cholera was controlled .In 2015 it is (375) confirmed cases with cholera were recorded .

c. Domestic and industrial pollutants:

Most industrial and agricultural establishments, hospitals and other activities dump their wastes into rivers untreated. If treated, it wouldn't be according to the set standards due to lack of efficient treatment units. No statistics are found for industrial pollutants and the damage they cause to water and life. Additionally," polluters pay "principle is not adopted.

d. Water recycling or reusing:

Some industries that use water in their operations recycle the water they use. However no statistics are found in this concern. As for reuse of agricultural drainage water, Water and Agriculture Organization's report based on the global Survey on water and agriculture for 2008 states that the reused agricultural drainage water in Iraq, Syria and Lebanon amounts to 1500, 2246 and 165 million cubic meters respectively [17]. Other sectors do not have data available.

Accordingly, authorities concerned should take the necessary measures to achieve the development Goal of 2030, which includes the provision of potable water and wastewater system for all, and the recycling and reuse of recycled water in the various sectors to achieve target (4) of goal (6) i.e. pollution reduction and wastewater treatment as well as increasing water recycling and reuse.

4.2.4. Institutional dimension

4.2.4.1. Integrated water management:

The report issued by the Ministry of Planning and the Central Statistics Organization of Iraq depicted that integrated management of water resources in Iraq scored 25.1 degrees out of 100. A degree which is below the acceptable level leading to non-achievement of the target (5) i.e. Integrated water management.

4.2.4.2. Iraq's efforts in projects, plans and cooperation on Tran's boundary water basins:

The following are Chronology of major events in the Euphrates-Tigris Basin:

- 1914 Al-Hindiya dam on the Euphrates River in Iraq for flood control and irrigation purposes.
- 1951 Ramadi and Habbaniyah Dam on the Euphrates in Iraq for flood control and irrigation purposes.
- 1960s start of construction of the "Third River" in Iraq 565-kilometer canal between the Tigris and the Euphrates (completed in 1992).
- 1970s construction of several canals in Iraq for linking lakeThartharto the Euphrates and connecting the lake with the Tigris.
- 1975 filling of Tapqadam conflict - Syria and Iraq (Saudi Arabia and possibly USSR mediated) Major sources of conflict between Syrians and Iraqis addressed. Finally the Syrian Arab Republic released more water from the dam to Iraq
- 1983 Establishment of the Joint Technical Committee for regional water - Turkey, Iraq and the Syrian - Dealing with water issues between the basin riparian countries, to ensure principles of consultation and notification as required by international law. This group disintegrated after 1993 without any progress having been made.
- 1984 Turkey proposes a "Three-staged plan" - Turkey (indirectly Syrian and Iraq) - For optimal, equitable and reasonable utilization of the Trans boundary watercourses of the Euphrates-Tigris basin. In the application of the principle of equitable utilization [18], [19].
- 1985 Haditha dam on the Euphrates - Iraq- to generate electricity.
- 1990 Agreement between the Syrian Arab Republic and Iraq to share of water of Euphrates- Iraq - The Syrian Arab Republic agrees to share the Euphrates' water with Iraq on a 58 percent (Iraq) and 42 percent (the Syrian Arab Republic) basis. It corresponds to a flow of 9 km^3/year.
- 2002 Bilateral agreement on the installation of a Syrian pumping station on the Tigris River for irrigation purposes.
- 2008 Cooperation on water issues by establishing a water institute- Turkey, Syria and Iraq - 18 water experts from each country to work toward the resolution of water-related problems.

4.2.4.3. International Agreements

Iraq has signed the following international agreements:

- The Ramsar Convention on Wetlands in Iran on 2nd February 1971, that was amended by a Protocol on 03/02/1984 and the amendments made on 28/05/1987. Iraq acceded to this Convention on 22nd January 2007.

- The Basel Convention on the Control of Tran boundary Movements of Hazardous Wastes and Their Disposal which entered into force on 5th May, 1992 and was acceded to by Iraq on 31st January, 2011.

Neighboring countries have not complied with the agreements on the sharing of water, including Turkey and Iran. They have built a number of dams and reservoirs which affected the amount of water flowing into Iraq. Accordingly; the Iraqi government has resorted to diplomatic measures to settle the issue of water with neighboring countries in a way that ensures the rights of all to have their shares of water resources.

Despite the efforts made through projects and plans and Iraq's accession to a number of water related agreements, no effect has been seen on the reality of water management to achieve sustainable development in supply chain.

4.2.4.4. Economic losses of water

Iraq's registered in 2010 losses in terms of inadequacy of water supplies and sanitation are 2.3%, among the 19 countries representing the Middle East and North Africa (MENA) region. Egypt and Saudi Arabia losses are below 0.08% and Jordan's losses are 0.05% [20], [21].

From the institutional dimension, we conclude that:

Target 6 "to ensure integrated water resource management at all levels and trans boundary cooperation", could not be achieved. Target 7 "reducing mortality and water-related disasters could not be achieved.

5. Conclusions

a. Non achievement of the SD economic dimension objectives of water management in the Iraqi environment. A water reserve has not been maintained and water efficiency has not been achieved. The percentages of water withdrawn from surface water estimated for the years 2020 and 2030 prove the inability to maintain an adequate reserve of water thus, impacting sustainable supply, therefore, target (5) of Goal (6) "water –use efficiency across all sectors and making water withdrawal compatible with sustainable supply" is not achieved.

b. Non achievement of the social dimension objectives. Iraq's rate in terms of the provision of water supply, safe drinking water and adequate sanitation are below that of both Jordan and UAE and below the average of Arab countries. Similarly, the urban and rural populations are not equally provided with safe drinking water and adequate sanitation and women still carry water. This, in turn led to the non-achievement of targets 1, 2 and 3 of goal (6)" the provision of safe water, adequate sanitation, sustainable use for all, and meeting women's needs by 2030.

c. The non-achievement of the objectives of the environmental dimension because the rate of wastewater treatment is low because of the lack of technology in the treatment of wastewater, and the BOD amount was higher than the global value, which affects the aquatic life. Additionally, most of the wastes of various activities are disposed of by being dumped in rivers untreated. No statistics are found for the reused water to save the agricultural drainage water. Cases with Hepatitis type) A & E) and diarrheal disease were higher than before, therefore, it was not possible to achieve targets (4) of Goal (6) "the treatment of wastewater and recycling and re use of water in different sectors.

d. Non- achievement of the objectives of the institutional dimension. Target (6), which ensures integrated water resources management of at all levels and Tran's boundary cooperation, has not been achieved. Target (7) " reducing water related mortality and disasters has not been achieved either [22], [23], [24].

Reference

[1] Abde magd Isam, M. "*Integrated water resources management"*, Scientific Research and Foreign Affairs Center T chinal paper series, No. 5, P. 55, 2015.

[2] Al Jawarein, A.F. "*Sustainable Development in Iraq Reality and Challenges"*, IRAQI Economists Network, p. 7, www.iraqieconomists.net.

[3] Arabosai W. *"Minutes of the third meeting held in the SAI Tunisia 11-15 April"*, 2012.

[4] *Audit division audit report Water and environmental protection operations in unamid United Nations office of international services*, audit report, 2011.

[5] Barrington, D.J., and Ho, G. *"Towards zero liquid discharge: the use of water auditing to identify water conservation measures"*, Journal of cleaner production, Vol 66, pp. 571-576, 2014.

[6] Barrington, D.J., Prior, A., and Ho, G. *"The role of water auditing in achieving water conservation in the process industry"*, Journal of cleaner production, 52, pp. 356-361, 2013.

[7] Bramwel, B. *"Coastal Mass Tourism, Diversification and Sustainable Development in Southern Europe"*, USA, 2004.

[8] Caroline, S. *"Calculating a Water Poverty Index Centre for Ecology and Hydrology, Wallingford, UK World Development"*, Elsevier Science Ltd, Vol 30, No. 7, pp. 1195–1210, 2002, All rights reserved Printed in Great Britain 0305-750X/02/$ - see front matter PII: S0305-750X(02)00035-9 www.elsevier.com/locate/worl.

[9] Farghaly A.H. *"Sustainable Development Knowledge Framework and Accounting Evaluation"*, Center for the Development of Graduate Studies and Research Cairo University, p. 27, 2007.

[10] Fatoumata Ndiaye& Gurpur Kumar& Eleanor T. Burns: INTERNAL

[11] HE, G.Z., LU, Y.L., Hua, M.A., and WANG, X.L. *"Multi-indicator assessment of water environment in government environmental auditing"*, Journal of Environmental Sciences, Vol 19, No. 4, pp. 494-501, 2007.

[12] Jonathan M.H." Global development and environment institute working paper 00-04 Basic Principles of Sustainable Development", 2000.

[13] Dashkin R. "*Determinations of Investment Activity of Russian Companies"*, Astra Salvensis, Supplement No. 2, p. 397, 2017.

[15] Martinuzzi, A. "*Corporations, Stakeholders and Sustainable Development I: A Theoretical Exploration*

of Business–Society Relations", Journal of Business Ethics, Vol 61, pp. 263-281, 2005.

[16] Ministry of Planning Central statistical organization IRAQ, Priority Indicators for Environment and Sustainable Development in Iraq.

[17] Mohamed, A. *"Contemporary Economic Issues"*, Egypt, Alexandria University Faculty of Commerce, 2005.

[18] Mreza, M.D., Bachay, I.R. and Flayyih, H.H. *"The Role Higher Education Quality in Achieving Sustainable development: Field Study from the perspective of Iraqi Universities Instructors"*, the annual second conference, 2018.

[19] Park, CH. *"the Environment: Principles and Applications"*, Rout ledge, Taylor and Francis Group, Ed (second) London: Rout ledge, 2011.

[20] Russo, T., Alfredo, K., & Fisher, J. *"Sustainable Water Management in Urban, Agricultural, and Natural Systems"*, Journal Water, Vol *6*, No. 12, pp. 3934–3956, 2014, https://doi.org/10.3390/w6123934.

[21] Sheila, F., and Johanne, G. "*Freshwater has been one of the central themes of the Working Group Since 1996 Intosai Working Group on Environmental Auditing"*, Auditing Water Issues Experiences of Supreme Audit Institutions, 2004.

[22] Galeeva G., Aktasheva A. "*Forecasting the Dynamics of Foreign Direct Investment in the Russian Economy"*, Astra Salvensis, Supplement No. 2, p. 137, 2017.

[23] Oelze, N., Hoejmose, S.U., Habisch, A., and Millington, A. *"Sustainable development in supply chain management: The role of organizational learning for policy implementation"*, Business Strategy and the Environment, Vol 25, No. 4, pp. 241- 260, 2016.

[24] Sajjad, A., Eweje, G., and Tappin, D. "*Sustainable supply chain management: motivators and barriers"*, Business Strategy and the Environment, Vol 24, No. 7, pp. 643- 655, 2015.