

Sustainable Development of Groundwater in the Middle Euphrates Region

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Abstract:

Groundwater represents the strategic water reserve in the world and Iraq, as many studies have indicated that its quantities fluctuate from year to year and from place to place, and this matter demonstrates the need for future and sustainable visions to maintain that resource and preserve it from depletion and misuse, to meet The increasing requirements of usable water in all sectors and directions.

This research focuses on the sustainable development of that important resource in the central Euphrates region, which abounds with various activities (agricultural, industrial, tourism and service), and that there are treatments that are consistent with the requirements for the application of sustainable development indicators called for by the United Nations, and the most important conclusions reached by the research are The abundance of groundwater in the study area, but it is not usable in some activities due to its physical and chemical properties and its geographical distribution in the study area.

التنمية المستدامة للمياه الجوفية في منطقة الفرات الاوسط

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الملخص:

تمثل المياه الجوفية المخزون الاستراتيجي للمياه في العالم والعراق ، اذ اشارت الكثير من الدراسات الى ان كمياتها تذبذب من سنة الى اخرى ومن مكان الى اخر ، وهذا الامر يوضح مدى ضرورة ان تكون هناك رؤى مستقبلية ومستدامة لصيانة ذلك المورد والحفاظ عليه من الاستنزاف وسوء الاستعمال ، لتلبية المتطلبات المتزايدة من المياه الصالحة للاستعمال في كل القطاعات والاتجاهات .

يركز هذا البحث على التنمية المستدامة لذلك المورد المهم في اقليم الفرات الاوسط الذي يزخر بالنشاطات المختلفة (الزراعية والصناعية والسياحية والخدمية) ، و ان تكون هناك معالجات تتفق مع متطلبات تطبيق مؤشرات التنمية المستدامة التي دعت اليها الامم المتحدة ، اما اهم الاستنتاجات التي توصل اليها البحث فهي وفرة المياه الجوفية في منطقة الدراسة الا انها غير صالحة للاستعمال في بعض النشاطات بسبب خصائصها الفيزيائية والكيميائية وتوزيعها الجغرافي في منطقة الدراسة .

Introduction

Groundwater is of exceptional importance in the desert and semi-desert environments, and this importance has increased after the water scarcity in the Arab region, of which Iraq is a part, and because of the recent exposure to political bargains by the countries that own the sources of the rivers entering Iraq, and their failure to recognize the international law, which recognized that these Rivers are international and not cross-border, according to the last claim, so the search for new sources of water or the development of current resources, including groundwater, has become an urgent necessity, and there is no door left but to adopt the sustainable development of those waters with its known steps and mechanisms.

1- Research problem:

-How can the principles of sustainable development be applied to groundwater in the Middle Euphrates region, making it suitable for various human uses and preserving it?

2- Research hypothesis:

There are several principles and applications that have been relied upon to maintain and preserve this resource, but at the same time groundwater faces major problems, both natural and human, that negatively affect its quantity and quality. It was found that some remote areas that did not have access to water sources to drink and irrigate animals, were forced to use groundwater without studies and analyzes to determine its validity, which led to some animals being blinded or exposed to death, and this is a serious issue that requires official authorities to form an accurate database On groundwater and its suitability, and warning the population not to use it until after determining its suitability for drinking, irrigating animals or watering agricultural crops.

3- The importance of the research:

The importance emerges through two important aspects, the first aspect is to stop the continuous depletion of this vital resource through a series of measures that should be taken urgently and quickly, while the second aspect is the development of this resource in a sustainable and continuous manner to preserve it from the abuses that occur.

4- Objectives of the research:

There are a set of objectives that this research seeks to achieve, namely:

- ✓ Reducing pollution in groundwater reservoirs, whose percentage has increased in recent years.
- ✓ Rationalizing the use of groundwater, especially in desert and remote areas.
- ✓ Monitoring changes in its various levels and characteristics.
- ✓ Renewing the sources of nutrition, especially water harvesting.

5- Research Methodology:

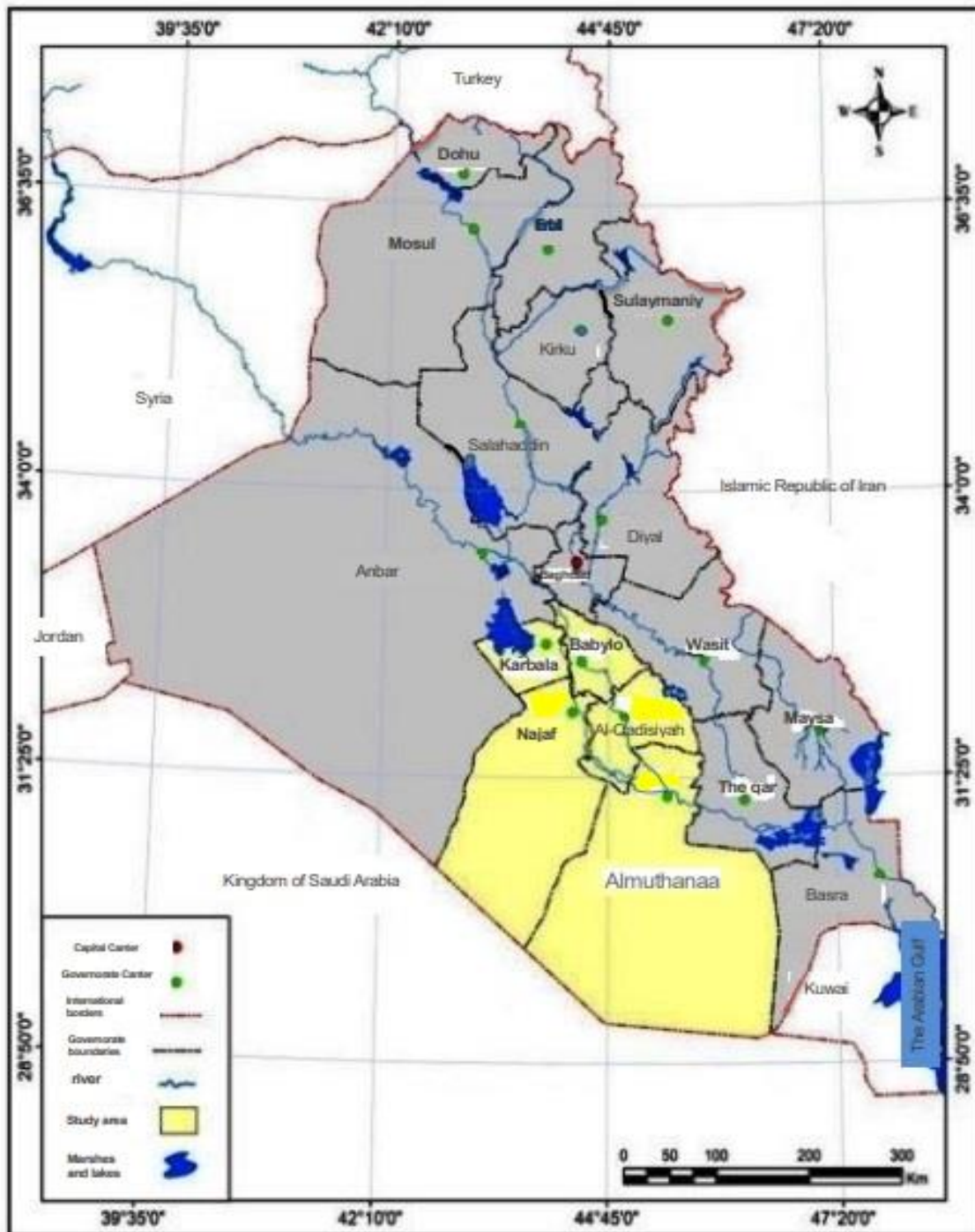
The research relied on the analytical and deductive approach in its writing, and the most important topics that are consistent with the geographical data of the study area were used, which contribute to drawing the appropriate strategy for the sustainable development of groundwater.

6- Spatial and temporal limits of the research:

The spatial boundaries are represented by the borders of the middle Euphrates region, which is located astronomically between two latitudes ($4^{\circ} 29' - 3^{\circ} 33' \text{ N}$) and longitudes ($43^{\circ} - 56^{\circ} 46' \text{ E}$), and is geographically determined within the five governorates (Babylon, Karbala, Najaf and Qadisiyah Al-Muthanna), Map (1), the region extends in the western plateau and to the central sedimentary plain, which takes a geographical extension (northwest - southeast), and it is located within the hot semi-tropical region, which is reflected in the presence of a dry and semi-arid climate in most days of the year. The rise in temperatures and the rise in the annual total of evaporation significantly, especially in central and southern Iraq, and its area reaches about (98,874) km², which constitutes more than (22%) of the total area of Iraq, that is, about one-fifth of its area. As for the temporal limits, it is the study of the reality of water Underground currents in light of the available studies and research on this subject.

Map(١)

The Central Euphrates region in relation to Iraq



Source: General Authority for Survey, Administrative Map of Iraq, at a scale of 1:2000000, Baghdad, 2024.

1- Sustainable groundwater management

The water supply in arid and semi-arid regions is highly dependent on the availability of groundwater, rivers and rainwater, and in order to achieve sustainable water management it is necessary to protect these sources from depletion, thus knowing the amount of available water recharged to these sources is essential in order to maintain levels Minimum water level.

Effective and sustainable water management is a complex process that requires significant contributions and efforts that will improve water in countries facing current and potential water scarcity, and lead to sustainable development that takes into account the policies and agreements adopted at the international level, and the strategy will not achieve success unless it takes into account the interests of all parties actors, and to ensure all Member States more benefits, taking into account their greater needs for the effective management of water resources. Water resources are under increasing pressure for many reasons, including:

Water limitation

Increased demands

Lack of resources due to pollution and climate change

Water management means the process of managing supply and demand. Supply management includes all activities necessary to identify, develop and invest new resources. As for demand management, it represents all that is required to achieve the best levels and patterns of water use, and the planning process is based on integrating these two sections into one process to provide the necessary analytical basis for selecting alternative mechanisms. The concept of water resources management is framed by legislation and future plans for its development, as well as by a set of procedures, preparation of personnel, water research, organization of information and data necessary for short or long-term preparation. A plan for the development of water resources based on a number of scientific approaches (1)

The sustainability of water resources is achieved through the concept of integrated management through the perspective of comprehensive and coordinated management and the perspective of integration across all sectors of water use. Organizational rules and the use of economic and social means to rationalize use and resolve disputes. The

integration should be done by linking the different available water resources in terms of quantity and quality, in time and space, and between water resources and other related natural systems, and it is possible to deal with the integrated management of the various elements mentioned. Through two systems, the natural system and the human system (2)

It is vital for the integrated management of groundwater as a public good by monitoring natural recharge rates and as such. These resources can continue to support their independent ecosystems and contribution to sustainable development.

2- Objectives of Integrated Water Resources Management

Integrated water management aims to achieve the following things (3)

- Securing sufficient and clean water for all segments of civil and rural society.
- Securing water to meet food needs under the global trade system.
- Securing water to meet the requirements of social and economic development.
- Flexible and comprehensive dealing with water resources variables in time and place within the formulation and implementation of policies and strategies.
- Achieving cooperation, coordination and integration between and across sectors, institutions and society.
- Improving water risk management to address the problems of pollution, floods, droughts, conflict and terrorism.
- Activating the role of political will to give priority to the role of water in all development activities.
- Strengthening the role of water awareness and popular participation in water management.
- Strengthening the role of cooperation in resolving water disputes.

Water resource management issues have become more pressing and discussed in the world, to the point that the World Economic Forum has described water as one of its biggest challenges for two consecutive years (2013 and 2014), and in light of this changing physical and socio-economic landscape, previous water practices are no longer appropriate; Countries cannot achieve sustainable growth or enhance their resilience to changes without the need for smart water resource management Taking into account decreasing water availability, deteriorating water quality and the need for an informed allocation based on social, environmental and economic needs. Integrated water resources management is a systematic path of sustainable

development, in order to translate the dimensions of sustainability through the basic principles (4)

3- The necessity of dealing with water as an economic, social and environmental good.

Water policies should focus on managing water in an integrated manner and not just providing it. The role of the government in facilitating and paving the way for the sustainable development of groundwater through integrated water policies, regulatory and legal frameworks and legislation that ensure the application of the principles of integrated management of water resources, especially groundwater resources. Groundwater faces a number of multiple problems and risks, reinforced by various strategic reports and studies issued by international organizations and bodies. The problem of pollution and depletion is one of the biggest problems these resources face, especially with the expansion of industrial and agricultural activities that require huge amounts of water, in addition to its secretions. The environment is often polluted, and the demographic growth that the world is witnessing is one of these pressures facing water resources, and it usually leads to the emergence of conflicts and disputes between countries to obtain these resources, in addition to these problems, water resources often suffer from the problem of mismanagement that negatively affects on quantity and quality.

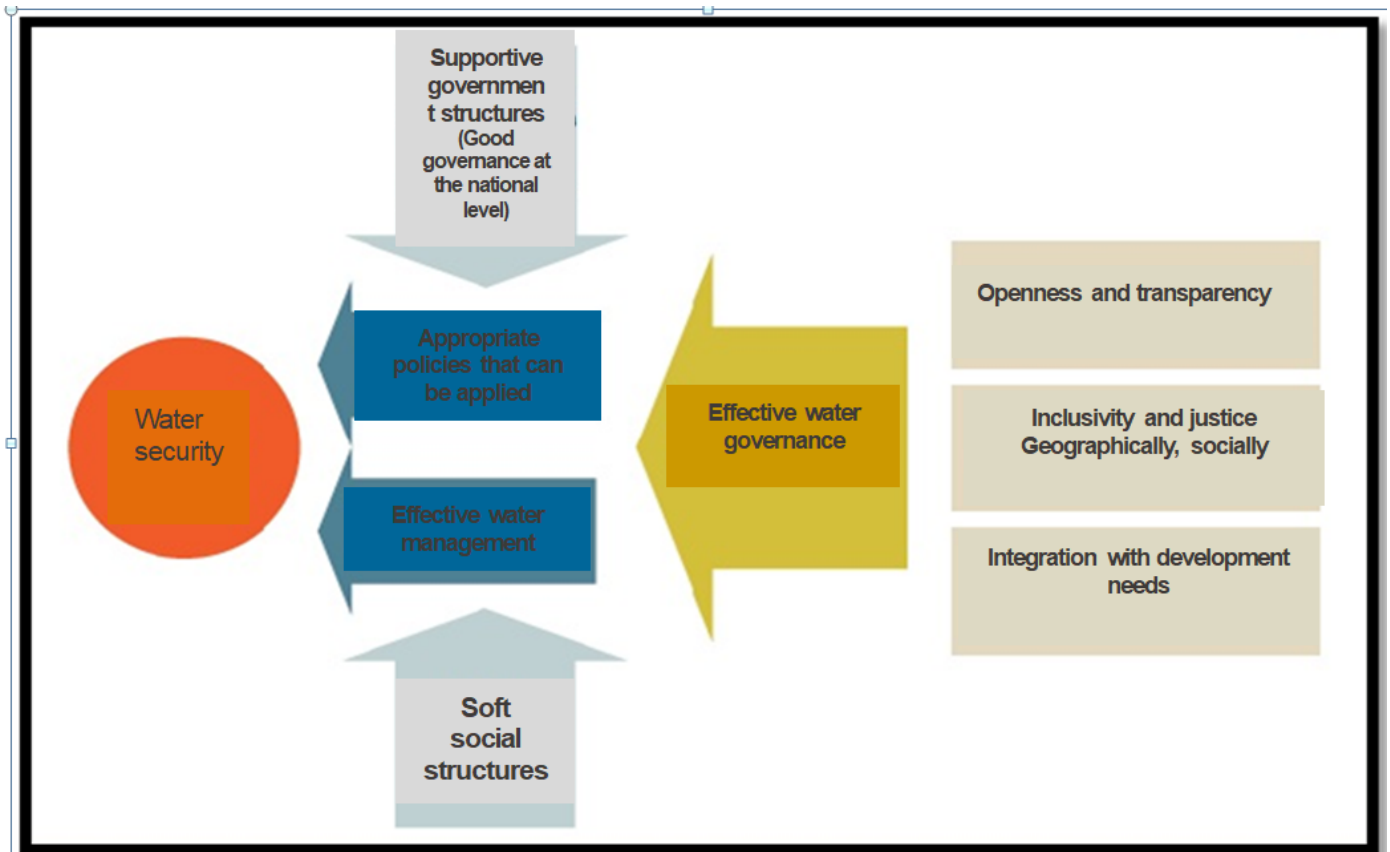
4-Groundwater management :

Sustainable and effective water management deals with the water sector as part of a larger framework that pursues social, political and economic development and thus affects and is affected by other sectors. Groundwater management is the process by which these resources are managed and the basic elements of this process are (responsibility, participation, availability, transparency, information, observance of customs and rule of law), so it is the art of coordinating administrative actions and taking administrative actions. Correct decisions between different levels (5), or in other words, good management of water resources. Quantitatively and qualitatively, to avoid and treat any problem facing water sources, especially groundwater, because they are more sensitive and affected by other sources. Any pollution in the sources of precipitation or in surface water is directly reflected on the quality and quantity of groundwater, and based on this definition it can be said that groundwater management is translated in the form of a set of policies or decisions that have an

impact on the use and protection of water. Therefore, groundwater management has become relevant to the decisions of pesticide use, waste management...etc and these decisions are taken on a daily basis through the water services. Hundreds of millions of users and planning managers. Pillars of effective water management include water policy reorientation, enforcement of legislation and regulations, adequate financing of the water sector, development of regulatory capacity, monitoring and evaluation programmes, information and data management, and coordination of regional and international cooperation. Pay attention to education and awareness, support stakeholder participation and empowerment, ensure realization of water rights and social justice, increase water use efficiency and improve linkages. Between research and management (6), Figure (1), groundwater management is closely related to the state of the aquifer, which means that local actions directly affect the uses of the aquifer and the movement of shallow polluted groundwater. Since then, it is no longer difficult to achieve sustainable use of groundwater for many widely exploited aquifers; moreover, surface water quality can also deteriorate significantly, so the interaction between surface water and groundwater must be taken into account (7).

Figure (١)

Comprehensive System for Effective Water Governance



Source: United Nations Development Program, Regional Office for Arab States, Water Management in the Arab Region, Lebanon, 2014, p. 120.

Some aspects of governance relate to site-specific extraction, but others relate to the recharge and management of large tracts of land and aquifers. These aspects relate to a different set of actors whose interests may overlap, including individual farmers, municipalities, and public services. Identify the participant in the topic of protecting the aquifer in his head.

5-Improving the principles of groundwater management

It is difficult to implement an effective groundwater management strategy in light of the endogenous nature of groundwater, which includes the conditions and challenges to achieve sustainable management of groundwater resources. It can be said that attempts to make dozens of individual decisions did not bring the expected results,

because these decisions were not sufficiently studied. Previous attempts to organize and manage groundwater and other natural resources did not provide any lessons or indicators, and some of the points required in the environmental assessment reports lead to talk about the state of groundwater and the economic, social and environmental risks resulting from the weakness of groundwater however, in order to focus on groundwater when treating Water management, groundwater management can be said to be directed by investments focused on surface water (8)

Perhaps the abundance of surface water historically and the exit of tens of billions of cubic meters of water to the Arabian Gulf before (1980 AD), and the indifference of official authorities to the future and the expected problems that may face Iraqi water resources. Such as pollution and geopolitical problems with countries, especially Turkey, and the unexpected decline such as climatic changes that led to water revenues in the basin of the Tigris and Euphrates rivers by about (1/3), as well as the mismanagement of water resources in Iraq (9), and the problem of drought may be exacerbated by climate change and the frequency of drought And rising temperatures since 1990, which greatly affect the groundwater recharge in the western plateau and the Middle Euphrates provinces in particular. Al-Razzaza Lake dried up, its area deteriorated, and salts were concentrated in it, as is the case with Sawa Lake in Muthanna Governorate, which suffers from a lack of salt. In the process of groundwater recharge transferred from the western plateau. The basic principles of water management are responsibility, transparency, user participation, and the need to integrate assessments and operationalize management, but there is a need to adapt these principles to make them more applicable to groundwater. Moreover, it is possible to develop specific principles of groundwater management as follows:

6- Sustainable use of groundwater

Dealing with sustainable water management with the water sector as part of a larger framework that seeks to achieve social, political and economic development and thus impact on other sectors and is influenced by the context. This concept includes the following five points (10)

- Protecting groundwater resources from depletion.
- Maintaining the quality of groundwater by protecting it from pollution.
- Preserving the survival and continuity of existing ecosystems.
- Achieving social and economic well-being.

- Apply the principles of good governance.

7-Transparency

More can be done to disseminate information about groundwater, its dynamics, and everything related to recharge and extraction. Among what should be noted in this aspect is the lack of information, studies and research in the past, but in the past decade with the intensification of the water problem and its effects, many researchers began to study groundwater in Iraq, most of them there are wonderful and excellent university theses and doctoral theses, but unfortunately the official authorities responsible for managing Water resources are far from it and do not use it. Therefore, when we review for information on groundwater, the answer is (the water is invalid and little and we have no information about it). Therefore, when the inhabitants have to search for water for drinking, for watering animals or for irrigation, the efforts are self-sufficient and the water is used without tests to determine its suitability. That is why after a while animals begin to perish or go blind.

8-Participation

Involve all groundwater users in the management of the aquifer at the local level, and there is a need to deal with users throughout the aquifer, for example monitoring and agreeing on acceptable limits for pollution, in addition to a clear presentation of information related to groundwater at the local level and collective follow-up to agree on levels Acceptable groundwater quality and this does not exist, which exposes the population to the risk of using groundwater without knowing its suitability and the seriousness of its effects.

9-Responsibility

That is, balancing the economic benefits and the effects of using groundwater. More efforts could be made to focus on the social and economic benefits of governance, in conjunction with assessing the costs or consequences of groundwater use—including the effects of unclear rules and standards for drilling wells and who is responsible for polluting groundwater, even if they are. Don't use it and acknowledge the 'polluter pays' principle, it can work well for all water users.

10-Merger

It is the way in which all actors in groundwater interact, where groundwater management must integrate the management of surface water and its distribution as well as wastewater through the creation of new tools such as payment for environmental services, reuse of treated water and cooperation with various actors in all water sectors (11)

11-Assessment of the potential natural hazards of groundwater

The trace elements (1%) represent only the dissolved components naturally present in groundwater, but they can make this water unsuitable or unacceptable for consumption of all kinds, Figure (2), and at the same time, many of these elements are essential to human and animal health And the plant. But in small quantities it can be obtained from eating food or drinking good water, and in any case, the desired concentration of these elements may be little, some are dangerous and become harmful at higher levels, and some are always harmful to health even at very high levels. Low concentrations. Especially toxic elements (cadmium, lead, copper).

Figure (٢)

Dissolved elements in groundwater and their impact on human health

		العناصر الشحيحة (µg/l)				العناصر الرئيسية (mg/l)		
		القياسات تتطلب أجهزة عالية				القياس بسيط ورخيص بشكل رئيسي		
		0.1-1	1-10	10-100	100-1000	1,-10	10-100	> 100
As	زئبق	V *	Li *	P *	Sr *	Mg *	Na *	HCO ₃ *
Ba	باريوم	Se *	Ba *	B	F *	K *	Ca *	
Br	بروميد	As	Cu *	Br		Si *	SO ₄ *	
Ca	كالكسيوم	Cd	Mn *	Fe *			Cl *	
Cd	كادميوم	Co *	U	Zn *			NO ₃ *	
Cl	كلوريد	Ni *	I *					
Co	كوبالت	Cr *						
Cr	معدن كروم	Pb						
Cu	نحاس	Al						
F	فلوريد							
Fe	حديد							
HCO ₃	بيكربونات							
I	اليود							
K	بوتاسيوم							
Li	ليثيوم							
Mg	مغنيسيوم							
Mn	منجنيز							
Na	صوديوم							
Ni	نيكل							
NO ₃	نترات							
P	فسفور							
Pb	رصاص							
Se	سيلينيوم							
Si	سيليكات							
SO ₄	كبريتات							
Sr	سترونشيوم							
U	يورانيوم							
V	فاناديوم							
Zn	خارصين							
Al	ألومنيوم							

* من المحتمل أن يكون أساسيا لصحة الإنسان/ الحيوان
 As سام أو غير مرغوب فيه بكميات مفرطة (من المحتمل
 أيضاً أن يكون أساسيا حينما يشار إليه)
 B عناصر أخرى

Source: World Bank, 2014.

There are specific elements such as (As, F, Mn) that represent known problems in groundwater and other elements, especially (Ni, U, Al) that deserve more attention and deserve study under some circumstances, and the concentration of some of these components may also increase as a result of polluting activities on It is important for management purposes to distinguish the effects of human activities from those of natural events, and this in turn requires investment in monitoring and detailed examination of groundwater.

Therefore, in order to ensure that, the philosophy of the so-called United Nations (contract) for health care and water supply was linked to the reality of water cleaning and follow-up of water-borne diseases, and then the priorities were:

- Quick access to a reliable water source in terms of quantity
- The microbiological quality of the supply is improved but not necessarily zero

The beginnings of the twenty-first century are witnessing a major problem in water quality control, especially in the developing world, as a result of the spread of waterborne diseases that cause disease, as a result of drinking water pollution and the natural presence of high drinking water. Concentrations of some elements in some groundwater supplies are at levels above WHO guidelines. That these problems occur in some aquifers as a result of their mineral nature, the slow flow of groundwater and only partial washing of the aquifer (12), it is possible to monitor the contamination of groundwater supplies with a set of simple measures. If there are no fissures or fissures that could allow contaminants to move quickly to the source, groundwater in confined or deep aquifers is generally free of pathogenic microorganisms, and wells should be lined to a reasonable depth and sealed to seal wellheads to prevent entry Contaminated Surface Water or Shallow Aquifer: Groundwater from confined depths and aquifers is usually germ-free and chemically stable in the absence of direct contamination, however shallow or unconfined aquifers can be subject to wastewater contamination and leaching associated with practices Agricultural waste (pathogens and nitrates) and waste. Industrial hazards and related accidents, which can affect the watershed, which should be taken into account as part of the risk assessment, include:

- Rapid changes in raw water quality.
- Sewage and sewage system.
- Industrial waste disposal.

- The use of chemicals in water harvesting areas, such as the use of fertilizers and agricultural pesticides.
- Various human activities.
- Live cattle grazing wild life.

There are other risks and situations that may affect water storage tanks and where they are withdrawn, and they must be taken into account, including (13)

- Human intervention and the lack of places to repel or purify water.
- Failure to manage the water tank and depletion of the water stock.
- Lack of selective withdrawal and the absence of alternative water sources.
- Insufficient intake sites or alignment of water bearing layers.
- Inadequate monitoring equipment and warning systems or the spread of pathogenic bacteria.

There is a range of measures and procedures to control these risks, including:

- Develop and implement a water complex management plan that includes risk control measures to protect groundwater resources.
- Ensure that planning regulations include the protection of groundwater resources (land use planning and water area management) from activities that may harm or pollute water sources.
- Increasing societal awareness of the impact of human activity on the quality and quantity of water.

The most prominent examples of risk control measures to provide protection for groundwater sources are:

- Determining and defining the uses and registering the chemicals used in those uses and setting certain conditions for protection such as (containment) in relation to the chemical industries or refueling stations.
- Mixing water in the underground tank to reduce bacterial growth or lack of oxygen in the lower layers and from the decomposition of manganese and iron deposits, and adjust the pH of the tank water.
- Human monitoring inside the water pools, monitoring of waste water flow, and regular inspection of those pools.
- Land use planning procedures and the use of planning and environment systems to organize development activities that may pollute water.
- Diverting the flow of torrential rains and torrents and blocking surface runoff.

- Other security measures to prevent tampering with the area and existing wells (14).

12-Groundwater development

In the absence of joint agreements on the sustainable management of shared groundwater, unplanned development has caused high rates of depletion, increased pumping costs, and deteriorated water quality as a result of mixing water between multiple aquifers and reversing flow in some locations and across the world. Groundwater development will meet the demand. The increased demand for water leads to the withdrawal of more of the shared water reserves, which can lead to conflicts between regions or countries. Most of the reserves of these basins are employed mainly in the processes of agricultural expansion and random development and lead to an accelerated depletion of groundwater, and as a result of the great advantages of groundwater in providing water supply, including:

- The water must be of good chemical and microbiological quality, as it avoids the additional financial burden and logistical complexity of the water treatment method.
- They have natural storage and are easy to adapt to drought, eliminating the need to build expensive surface water storage facilities.
- It has a wide distribution that facilitates a phased development process close to the location of the demand, which reduces the size of the infrastructure needed for distribution with the least investment requirements it includes (15)

For these reasons, groundwater development is often the only cheap and sustainable way to ensure better access to drinking water in remote and rural areas. When discussing and illustrating the advantages and costs of groundwater development, groundwater economy is likely to be more than that. Essential to defend groundwater management and consider the social and environmental impacts of development, including external factors associated with groundwater extraction and pollution. Groundwater in Iraq has been subjected to misuse and lack of serious attention to this important resource. In addition, aquifers have lost the compressive (pressure) property of water confined to the ground, which was previously one of the main reasons for raising the water level in wells and springs. The reasons can be traced back to the reasons that go back to (16)

- Digging deep wells that penetrated the aquifers without taking into account the protection and separation of these layers with cement or iron insulators, and protection was limited to the upper parts of the well.
- Failure to study the amount of piezometric pressure and productivity in the groundwater formations that will be penetrated.
- Not to bury unproductive tube wells in a scientific and correct manner, which makes them an outlet for the loss of the piezometric pressure property between the layers.
- Neglecting the maintenance and protection of concrete and steel insulators, which leads to corrosion over time and becomes an outlet for pressure loss within the layer.
- Drilling large numbers of tube wells in one layer of the aquifer, which affects its pressure as a result of the great depletion, and not taking into account the distribution of wells over the layers in a scientifically studied manner.

As a result of the increase in water consumption from bearing formations, a decrease in water quality began to be observed due to the high concentration of salt due to continuous withdrawal, poor supply and compensation, especially of non-renewable formations. Water resources. In order to maintain the quantitative level of groundwater and reduce the stress of water reservoirs, the strategy of human and artificial recharge must be adopted, by injecting wells with water, either from surface water or by building dams on valleys and torrents to keep them in and then practicing the injection process in wells as well as water reserves In large valleys such as network depressions, where they lead to activation of natural nutrition as well, and injections can be practiced in sedimentary plain areas during rainy seasons in wet areas. The artificial recharge of groundwater has many importance and objectives, the most prominent of which are (17)

- Utilizing and regulating flood waters. In order to develop groundwater, it is necessary:
- Determine groundwater use problems.
- Set a goal to tackle each problem individually.
- Develop a number of scenario solutions.
- Evaluate different scenarios and determine the expected environmental impact.
- Choosing the best suitable scenarios for current and future conditions.
- Implement the best scenario.

Conclusion :

Iraq is governed by unstable conditions in terms of the abundance of arable water and other uses, especially after the severe decrease in the quantities of water coming from neighboring countries and the fluctuations in the amount of rain from year to year as a result of climatic changes in the whole world, which is due to the problem of global warming. The fact that Iraq is located in arid and semi-arid areas, and people have become accustomed to excessive consumption of water before these conditions, has complicated matters and made it suffer from severe water shortage, especially in the center and south with high salinity.

Accordingly, the trend towards all ways to invest water ideally, including groundwater, is an inevitable matter imposed by realistic and rational trends to lay the foundations of development, as providing water to these areas on the spot is more economic than transporting it from far places.

Through the study and analysis of studies related to the issue of groundwater and its development, it has been found that there is no shortage in the number of these studies inside Iraq as much as there is a lack of unification and coordination of these studies in one body specialized in providing advice and guidance quickly for those wishing to exploit those waters, especially the studies prepared by them. Academic authorities in the last two decades, which are mature and accurate studies, and adopted modern scientific methods and equipment in their preparation.

These studies, in general, took into account, the type of flow, whether it was flowing, artesian or normal, as well as the level of groundwater, the number of wells that could be drilled for the sustainability of water use and the expected drainage and the percentage of salts, and some of them gave guidelines on the type of crops to be cultivated, as studies indicate that the average consumption For some cities located on rivers, it exceeds (400 liters/ day), which means that there is an urgent need for water in quality and quantity, and the need for water is increasing as the population increases, the comprehensive development occurs and the higher the level of urbanization.

The issue of groundwater development should be inevitable in all fields, as the United Nations study prepared in the middle of the last century expected that the percentage of groundwater used in Iraq that is suitable for drinking and for domestic

purposes in the year (1995 AD) is about 22% of the water supplied to consumers. This was not achieved because of the compelling political circumstances that Iraq went through.

Another study in the year (1975 AD) showed that the water supply pipes would reach (95%) of the urban population and (80%) of the rural population within the year (2000 AD), if the groundwater was efficiently invested alongside the surface water, but this The matter also did not happen due to the exceptional circumstances that Iraq went through, accompanied by a high rate of consumption per capita in some areas where water reaches (330-460) liters/ day, and this amount was at the expense of other categories that water does not reach (18).

The development of groundwater for the purposes of drinking, domestic consumption and agriculture seems encouraging. Productivity is generally good, although some of it is deep and reaches more than 150 m, which increases the cost of extraction, which encourages the development of groundwater consumption, especially in the northern region and the ruggedness of the region and the difficulty of finding liquefaction systems It depends on rivers and tributaries that have begun to decline significantly, especially in the areas adjacent to the eastern borders of Iraq, as well as the low percentage of salts in the waters of the area suitable for human consumption, which is estimated at (1500 parts per million) (19).

The relative stability that prevailed in the northern region in general has encouraged the use of groundwater, as one study estimates that the number of wells drilled from the year (1990 AD) to the year (2000 AD) amounted to (4,000 wells), but this increase was not parallel to the development and growth of agriculture there. In the rest of the regions, the development of groundwater for the purpose of domestic consumption and drinking collides with the issue of salinity, which exceeds the permissible limits for human consumption. On the other hand, it is the agricultural use of groundwater investment, which can only be overcome by solving the problem of salinity to some extent by planting resistant crops and using modern irrigation methods. In 2010, 1,345 wells were examined. In 2011, about 1,000 wells were drilled and 844 wells were examined (20), which indicates that there is a positive movement in this area, and these matters are imposed by the steady increase in population and the high prices of agricultural crops all over the world.

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