ISSN:2336-2693 | E-ISSN:2336-4890

CLIMATE CHANGES EFFECT ON THE AREAS OF WATER BODIES CHANGE IN FRONT OF THE MAIN DAMS IN IRAQ DURING THE PERIOD 1988/1989-2020/2021

Mayada Talib Kadhum[1], Nasir Wali Ferah[2] and Ammar Abdul-Hussain[3]
[1] Wasit Governorate Education Directorate, Wasit, Iraq.
[2]College of Education for Human Sciences, Wasit University, Iraq.
[3]College of Education for Human Sciences, Basrah University, Iraq.
Email: jojomeme048@gmail.com, nasirwali@uowasit.edu.iq, Hussain@uobasrah.edu.iq

Abstract:
The study of the change in the areas of water bodies in front of the main dams in Iraq, it has clear climatic, hydrological and environmental significance and indications. It could be an indication of the amount of climatic changes resulting from the problem of global warming, which works on rising temperatures and increasing frequency of droughts and desertification, low water levels of the Tigris and Euphrates rivers and their tributaries inside Iraqi territory (1), its direct and indirect impact on the area of water bodies, because it shows the amount of water in the lake, this was related to the amount of water received (incoming) or the amount of water released (outgoing or withdrawn) from it for the purpose of various water installations, it also shows the amount of levels and areas covered by the water, their directions, and their spatial and temporal variation, detecting the causes of change in the surface area of the lake water, in order to find appropriate solutions to address the environmental impacts of these changes, raising the level of efficiency of dams and their water bodies, with the exacerbation of the problem of climate change and the accompanying scarcity and great water crisis throughout Iraq, also as a result of the international political problems with neighboring Turkey and Iran, especially Turkey, which controls a large part of Iraq's surface waters, it exerts great pressure with it by reducing its water imports by implementing the largest water projects in the world, represented by the Southeastern Anatolia Development Project (GAP), which includes (22) dams built on the Tigris and Lavrat rivers, and (19) electric power supply stations (2).
Keywords: Climate changes, the areas of water bodies, the main dams, Iraq.

Introduction:

Water resources are among the most important natural wealth and resources, it is one of the basic ingredients for the continuity of life and achieving sustainability and development in all areas of life. Water is a finite resource that is at risk of depletion and pollution, the Earth's surface is witnessing climate changes, especially in temperatures and the rise in their annual rates, this corresponds to a significant decrease in humidity and precipitation rates and an increase in evaporation rates, especially in arid and semi-arid regions such as Iraq, which suffers from a significant decrease in the amount of water coming into its rivers and an increase in the amount of water needs of the population (3).

First: Description of the water bodies in front of the main dams in Iraq

Water projects began in Iraq at the beginning of the twentieth century, the first water project was established in 1913, represented by the Al-Hindiya Dam on the Euphrates River. The main objective of water projects in Iraq was and still is to regulate the movement and flow of water, in order to prevent the risk of floods and to generate electricity and irrigation, but with the development of life and the increase in the need for water, with the accompanying clear climatic

ISSN:2336-2693 | E-ISSN:2336-4890

changes, Iraq had to keep pace with this change and development and work to provide water facilities, that would transcend and exceed the old goals and head towards large storage projects, with the great and important benefits achieved by large water projects (dams and reservoirs), however, it takes a hostile position with the environment, because it threatens water security, lead in the long run to the deterioration of the surrounding water and land resources, Iraq has different types of dams and reservoirs (4). Most of them were built in order to control the fluctuating behavior of the rivers built on them, stopping the risk of floods threatening nearby cities, the following is a review and description of the main natural dams and lakes in front of the dams:

1. Mosul Dam Lake: Its area is 417 km2, and its water storage capacity is 11.5 billion cubic meters.

2. Dukan Dam Lake: Its water area is 270 km2 in the flood season and 4 km2 during the dry season, and its water capacity is 6.8 billion cubic meters.

3. Darbandikhan Dam Lake: The process of storing water in the lake began in November 1961, to carry out the storage process with a storage capacity of 3 billion cubic meters, so that the area of the lake resulting from storage is 114 square kilometers.

4. Haditha Dam Lake: It has a storage capacity of 8.28 billion cubic meters. The project was completed in 1986, with an area of 500 square kilometers.

5. Tharthar Depression and Lake: It represents the largest water reservoir and the largest natural depression in Iraq, with an area of 2710 square kilometers, and a storage volume of 85 billion cubic meters.

Second: the impact of climate change on the area of water bodies in front of the main dams in Iraq

Previous studies have proven the changes that the climate of Iraq was exposed to during the period 1940-2000, among the most important of these changes is a noticeable rise in average temperatures during that period between (+0.2- +0.9°C). A decrease in the annual rates of precipitation witnessed by all stations in Iraq, these climatic stations also witnessed a decrease in the amount of solar radiation reaching the Earth's surface (5), these conditions were also accompanied by a significant decrease in relative humidity rates, in exchange for a sharp increase in evaporation rates (6), these changes had a clear impact and negative impact on the surface water resources in Iraq, especially since Iraq is located within the desert belt, which is already characterized by scarcity of rain and fluctuation in its quantities and its temporal and spatial distribution, therefore, the effects of climate change will be severe, as these changes led to a decrease in the volume of surface runoff and water revenues that reach Iraq through the Tigris and Euphrates rivers and their tributaries, which feed the dams and water reservoirs in it, which will significantly change the drainage and volumes of water bodies and thus their areas (7).

Third: Search results:

Table (1) and Figure (1) show the significant variation in the area of water bodies for the main dams in Iraq specified in the study during the period (1988/1989-20/2021 AD), Tharthar Lake dominated the largest area, followed by Haditha Dam Lake, then Mosul Dam Lake, then Hamrin Dam Lake, then Dukan Dam Lake. Darbandikhan Dam Lake represents the smallest area (1729, 320, 260, 168, 146, 52 km^2), as the annual average of the area of the lakes for each dam varied and differed during the different years between the expansion and contraction in the area according to the increase and decrease in the amount of water discharges for each dam, that is,

ISSN:2336-2693 | E-ISSN:2336-4890

according to the climatic conditions of the water year, whether it was wet, dry or medium. We find that the lowest area of the lakes reached during the dry water years (2018, 2009, 2001, 1991, 2018, 2020) by (181, 96, 35, 64, 140, 1575 km^2) recorded by each of the Mosul Dam Lake, Dokan Dam, Dam Darbandikhan, Hamrin Dam, Haditha Dam, and Samarra Dam for Tharthar Lake, respectively. It was natural for the surface area of the dam to shrink and retreat from its natural limits, as a result of the decrease in the amount of water coming into the rivers on which dams are built, thus, it was reflected in the amount of water coming into its lake, this was an obvious result of climate change and the rise in temperatures, along with the decrease in rain and snow rates in the upstream areas, also the high rates of surface evaporation from those water bodies, in addition to the significant impact of dams and projects established by countries that share rivers and tributaries with us in reducing the amount of imports and water supplies (8), this leads to an increase in water releases from the reservoirs to compensate for the decrease in the quantities of daytime water, its effect is reflected on the water level in the lake and its surface area shrinking. Corresponding to this is that the water bodies of the dams witnessed during the wet water years, especially in the first climatic cycle (1988-1999 AD), where the flood year 1988 AD greatly increased the area and breadth of the lakes, and the highest annual average of the surface area of the dams reached (335, 280, 72, 291, 501, 2155 km^2), for each of the Mosul Dam Lake, Dukan Dam, Darbandikhan Dam, Hamrin Dam, Haditha Dam, and Samarra Dam of Tharthar Lake, respectively, this expansion is attributed to the amount of water imports for the water surface and the river, in addition to the state's policy in controlling the amount of water in the lake, this expansion leads to the tyranny of the lake's waters outside the boundaries of its basin, especially if the lake is shallow.

Table (1) Annual rates of surface area (km^2) of dams and main reservoirs in Iraq.

Water year	Mosul Dam	Dukan Dam	Darbandikhan Dam	Hamrin Dam	Haditha Dam	Tharthar Lake
-1988 1989	335	280	66	291	501	2155
-1989 1990	233	132	45	190	450	1575
-1990 1991	236	124	53	152	350	1620
-1991 1992	242	96	36	64	164	1640
-1992 1993	235	126	48	134	162	1675
-1993 1994	238	124	45	158	155	1650
-1994 1995	285	198	65	178	204	1750
-1995 1996	226	152	69	160	410	1895
-1996 1997	291	112	41	150	355	1879

ISSN:2336-2693 | E-ISSN:2336-4890

-1997 1998	298	104	57	153	314	1701
-1998 1999	288	167	57	145	305	1811
-1999 2000	276	114	70	175	245	1719
-2000 2001	266	108	36	72	328	1620
-2001 2002	290	106	35	74	274	1620
-2002 2003	294	160	49	142	305	1630
-2003 2004	291	210	62	228	366	1770
-2004 2005	302	171	48	234	440	1950
-2005 2006	289	137	47	160	442	1920
-2006 2007	265	140	47	160	440	1860
-2007 2008	266	132	49	160	460	1885
-2008 2009	251	112	41	150	355	1875
-2009 2010	242	96	36	64	164	1640
-2010 2011	231	126	46	124	162	1675
-2011 2012	238	115	45	156	255	1650
-2012 2013	236	124	53	102	360	1620
-2013 2014	262	144	52	175	439	1715
-2014 2015	233	132	45	190	450	1685
-2015 2016	243	122	47	129	154	1600
-2016 2017	224	162	72	239	280	1640
-2017 2018	232	195	71	224	300	1605

 ISSN:2336-2693 | E-ISSN:2336-4890

-2018 2019	181	185	52	200	140	1590
-2019 2020	275	225	65	286	260	1850
-2020 2021	282	199	57	206	470	2065

Source: Depending on the Republic of Iraq, Ministry of Water Resources, Planning Department, Strategic Studies, National Center for Water Resources Management, unpublished data, 2021-2022 AD.

The annual rate of change of the annual average surface area of Mosul Dam, Dokan Dam, Darbandikhan Dam, Hamrin Dam, Haditha Dam, and Samarra Dam of Tharthar Lake was (-0.36, 0.28, 0.32, 0.94, -0.32, -0.28%), respectively, by a percentage change in the average surface area during the study period for each of those dams, respectively, by (-12, 9, 11, 31, -11, -9%), as for the coefficient of variation, which represents the extent of variation in the surface area rates of dams and reservoirs, through the percentage between the standard deviation and the arithmetic mean of the surface areas, to find out the amount of its variation and deviation from the average through the following equation (9):

$$CV = \left(\frac{SD}{Xbar}\right) * 100$$

whereas:

CV: Coefficient of Variance

SD: Standard Deviation

Xbar: Arithmetic Mean

The number 100 is to convert the result into a non-discriminatory percentage, in order not to be affected by the units in which the phenomenon is measured, applying the equation to the average surface areas of Mosul Dam, Dukan Dam, Darbandikhan Dam, Hamrin Dam, Haditha Dam, and Samarra Dam of Tharthar Lake. The amount of variation is shown by (21, 33, 27, 38, 39, 19%), respectively. Figure (1) and Table (2) indicate that the change in the surface area of the lakes in front of the dams, some of them tend to decrease in area with time, such as Mosul Dam Lake, Haditha Dam, and Tharthar Lake, and the other tends towards an increase in area with the progression of time during the study period, such as Dukan Dam Lake, Darbandikhan Dam, and Hamrin Dam.

Table (2) Trend of change in the area of water bodies of dams during the study period.

Water year	Mosul Dam	Dukan Dam	Darbandikhan Dam	Hamrin Dam	Haditha Dam	Tharthar Lake
Annual mean	209	125	43	139	266	1410
Years number	33	33	33	33	33	33
Minimum area	-12	0	0	1	-11	-9
Maximum area	335	280	72	291	501	2155
Standard deviation	108	69	20	83	161	727
Direction coefficient	-0.933	0.415	0.168	1.553	-1.028	-4.965
Change annual mean	-0.45	0.33	0.39	1.12	-0.39	-0.35
Change during the study period	-15	11	13	37	-13	-12

ISSN:2336-2693 | E-ISSN:2336-4890

Change coefficient	52	55	47	60	61	52

Source: Based on Table (1).

Mosul Dam surface area

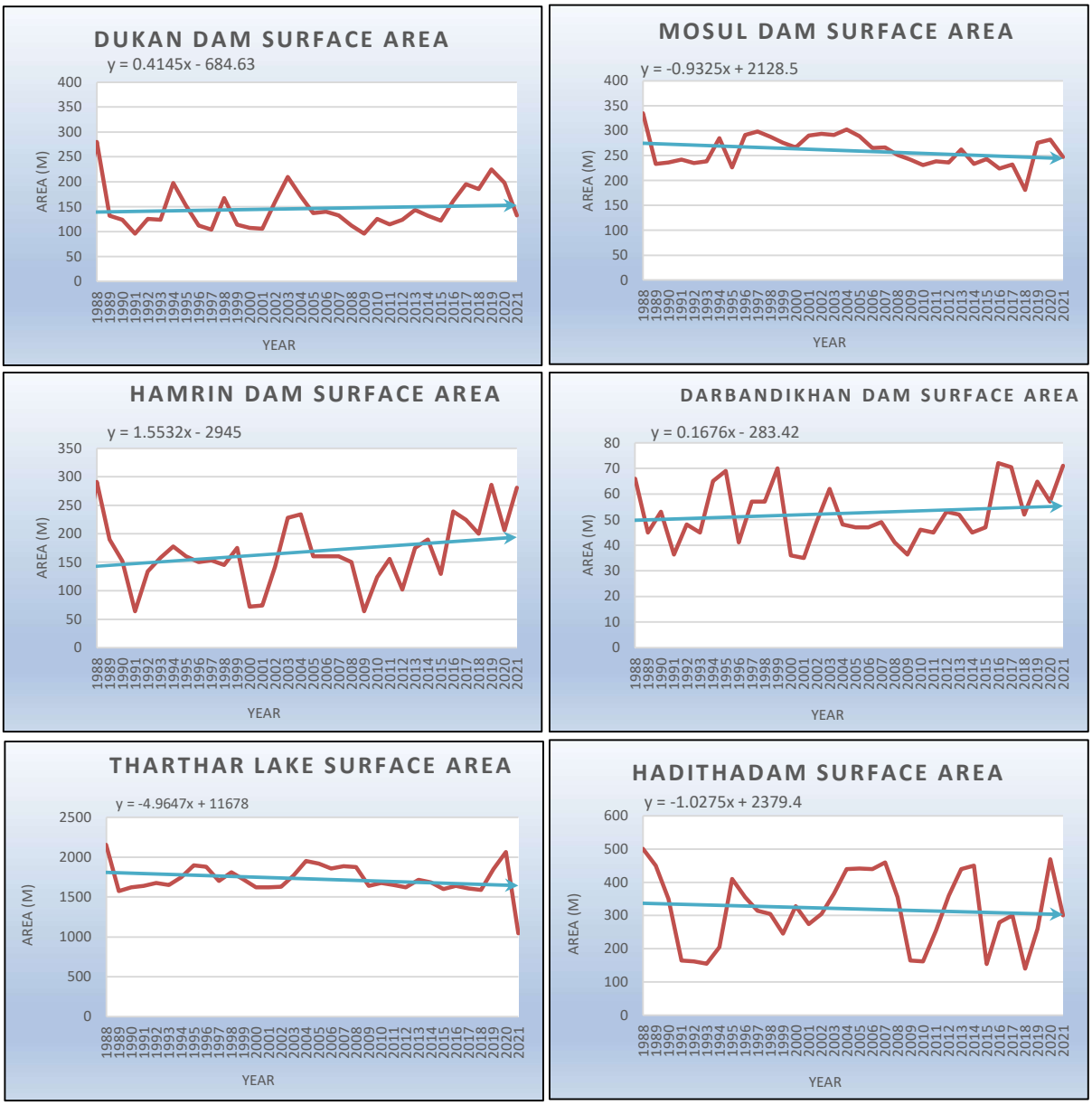

Figure (1) The direction of change in the annual rates of the surface area of the main dams and reservoirs in Iraq.
Source: Based on the data of Table (2).

Sources

(1) Ibrahim, Uday Khalil, The effect of global warming on the change of the maximum temperature in Iraq, 2019.
(2) Sophie, Madiha, the Turkish Gap project and its impact on water resources and the environmental reality in Iraq, 2010.

ISSN:2336-2693 | E-ISSN:2336-4890

(3) United Nations Organization, Comprehensive Assessment of Fresh Water Resources in the World, 1997.
(4) Al-Husseini, Adel Sharif, The Fund, Muhammad Ezz Al-Din, The Water Problem in Iraq, Causes and Proposed Solutions, University of Surrey / College of Engineering and Physical Sciences, September, 2009, pp. 1-14.
(5) Al-Asadi, Kazem Abdel-Wahhab, Yassin, Bushra Ramadan, Al-Nasser, Khadija Abdel-Zahra, the impact of global climate changes on the climate trends of Dhi Qar Governorate and its agricultural implications, Basra Arts Journal, Basra University / College of Arts, 2010, pp. 193-214.
(6) Al-Asadi, Kazem Abdel-Wahhab, Al-Nasser, Khadija Abdel-Zahra, The Impact of Environmental Changes on the Climate of Basra Governorate, Mesopotamia Journal of Marine Sciences, University of Basra, Volume 2, Issue 20, pp. 4-11, 2005.
(7) Al-Dazi, Salar Ali Khader, Climatic Drought in Iraq, Past and Present, 1st Edition, Dar Al-Adab for Printing and Publishing, Iraq, Baghdad, 2021.
(8) Muhanna, Wajeha, The Drought Crisis in the Syrian Region of Al-Jazeera, Al-Safir Al-Arabi Platform, Beirut, Issue 71, p. 3331, 11/27/2013.
(9) Al-Kinani, Ayed Karim Abd Aoun, Introduction to Statistics and Applications of SPSS, Dar Al-Yazroui for Printing and Publishing, 1st edition, 2014.