Study the Effect of Evaporation on Water Quality to the Iraq Reservoirs

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Abstract:

Water budget is a basic tool that can be used to evaluate the occurrence and movement of water through natural environment.A water budget provides a foundation for evaluating its use in relationship to other important influencing conditions such as other ecological systems and features, as well as social and economic components; how much water is being used by industry, residents, etc.

The main research methodology is to find area elevation curves of the reservoirs, monthly evaporation losses from the reservoirs with different conditions of storage, the amount of increase in the salinity of the water due to evaporation and its relationship with the volume of storage, the results analyzed and discussion.

The study presents an estimation of to the amount of water loss due to evaporation from some Iraqi reservoirs and its effect on the water quality. This paper studies the effect of storage in water losses due to evaporation of reservoirs, lakes and marshes in Iraq with different conditions of storage (minimum, average and maximum). Q-Basic program uses to find the results. Results show that losses caused by evaporation reaches about (22%) from storage volume at average condition, where the Total Dissolved Salts is increase to about 17% at the same condition.

Key word: water quality, Evaporation , Resevoirs, storage

الخلاصة:

الموازنة المائية هي الأداة الأساسية التي تستخدم لتقييم حدوث وحركات المياه خلال البيئة الطبيعية وهي التي تجهز كأساس لاستخدامها في علاقات مهمة اخرى كالنظم الايكولوجية والامكانيات بالإضافة الى المكونات الاجتماعية والاقتصادية مثل كمية الماء المستخدمة في الصناعة والاستخدامات السكانية الخ.

الموضوع الرئيسي للبحث هو العثور على منحنيات المساحة مع المنسوب، التبخر شهرية من الخزانات في الظروف المختلفة للتخزين، ومقدار الزيادة في ملوحة المياه بسبب التبخر وعلاقته مع حجم الخزان وتحليل و مناقشة النتائج.

درس هذا البحث تقدير كمية فقدان المياه بسبب التبخر من خزانات العراق، وتأثيرها على جودة المياه ويهتم هذا البحث تأثير الفقدان من المياه للتخزين بسبب التبخر من الخزانات والبحيرات والمستنقعات في العراق مع الظروف المختلفة للتخزين (اقل، متوسط، اعلى). تم استخدام برنامج (Q-Basic) لايجاد النتائج. وتشير النتائج إلى أن حجم الخسائر الناتجة من التبخر حوالي (22٪) من حجم التخزين في حالة متوسطة، كما بينت النتائج أن عملية التخزين تؤثر على جودة المياه للخزان والبحيرات والمستنقعات من خلال زيادة الأملاح الذائبة (T.D.S) إلى حوالي (17٪) من المتوسط.

الكلمات المفتاحية: نوعية المياه، التبخر، الخزانات، الخزن

Introduction:

The water scarcity is the lack of sufficient available water resources to meet the demands of water usage within a region. Scarcity in Iraq becomes a big problem, this is due to many reasons, especially due to building of many dams at the Euphrates and Tigris tributaries. Water shortage is a real problem in many parts of Iraq as a large part of the country is desert. But the existing networks also have been suffered from lack of maintenance or by being destroyed during the war, according to the Ministry of Water Resources, only 32 percent of the Iraqi population has access to clean drinking water, and only 19 percent has access to a good sewage system, and the proportion of rainfall in Kurdistan 600-1200 millimeters per year in the rest of Iraq is less than 200 millimeters per year, lack of rainfall in Kurdistan mountains which led to lack of water that feed groundwater and springs and artesian wells, Iraq consumes 90% of its water in agriculture. The number of tributaries of the Tigris, which stems from Iran, both seasonal ones and permanent are 30 tributaries; Iran has transferred tracks mostly into Iran.

Ihsan F. Hasan, 2013 was implement the (Linacre) mathematical Pilot Model

used for estimating evaporation from free water surface and testing the results accuracy of the mathematical evaporation model by comparing with values of the measured pan evaporation class (A) at the Mosul Dam Reservoir. Daily measured temperature data recorded in meteorological station at the Mosul Dam Reservoir for the period (2003 -2006)**.**

The study area: The water Resources in Iraq has made a tremendous wealth of Iraq and one of the richest countries in the world in this vital area which is sponsor of the refreshment of the country and achieves high levels of prosperity. Figure(1) shows Iraq Maps and location of Dams.

Haditha Dam: Haditha Dam is an earth-fill dam on the Euphrates north of Haditha (Iraq), creating Lake Qadisiyah (Buhayrat Al_Qadisiyah). The purpose of the dam is to generate hydroelectricity Regulate the flow of the Euphrates and provide water for irrigation .It is the second-largest hydroelectric contributor to the power system in Iraq behind the Musol Dam. Height of the Dam is 75m and 325m the width of the Dam , the width of crest is 20 m its level 154m.The operational level 147m , the area of reservoir at operational level is 500 km^2 and storage volume in the level is 8.25 billion m^3.The top level in flood 150.2m the area of reservoir at the level 567km^2 and storage volume 9.8 billion m^3.The area-elevation and storage curve of the Dam reservoir are as shown in Figure (2).

Derbendikhan Dam: The dam site is in the Sulaimaniyah at Diyala River and its an earth stone dam. The purpose of the dam is to protect against flooding, irrigation, electric power generation and for recreation. The dam height is 128m its width 500m, length of crest 445m and its width 17m at level 495m. Operational level is 485m and reservoir area at this level 114km2 and storage volume 3 billion m3. Top level in flood is 493.5 and reservoir area at this level 171km2 and storage volume 3.85 billion m3 .Total storage capacity 3 billion m3, dead storage capacity 0.47m3 and live storage capacity 2.53 billion m3. The area-elevation and storage curve of the dam reservoir are as shown in figure (3).

Mousel Dam: The Dam site in Ninawa on Tigris River and it is an earth dam with central earth core. Height of the dam is 100m its width 800m, length of crest 3652m including length of spillway 50m and width of crest is 10m, dam crest level 342.2m.The operational level 330m and reservoir area at this level is 380 km^2 and storage volume 11.11 billion m^3, top level in flood 339.4m and reservoir area at this level 446.5km^2 and storage volume 13.3 billion m^3, total storage capacity 11.11 billion m^3 and dead storage capacity 2.95 m^3 and live storage capacity 8.16m^3, max probable discharge to the gated spillway 13000m^3/sec and to the ungated 4000m^3/sec**.** The area-elevation and storage curve of the dam reservoir are as shown in figure (4).

Dokan Dam: The dam site in Sulaymania on the small Zab River of arch dam (140m radius).The purpose is protecting against the dangers of flooding, irrigation, electric power generation, development of fisheries and for recreation. Height of the dam 116.4m, width 65m, length of crest 350m and level 516m,operational level 511m, reservoir area at this level 370km^2 and storage volume 6.8m^3,top level in flood 515m and reservoir area at this level 446.5km^2. The total storage capacity 6.8billion m^3,dead storage capacity 0.79m^3,live storage capacity 6.01 billionm^3,number of gates is 3 and maximum probable discharge 11400m^3/sec in a level of 495.5m.Area-elevation curve of the reservoir is shown figure(5).

Al_Adhaim Dam: Dam is located at AL-Adhaim River in Diyala. The length of the dam is 3800m and width of the crest 12 m in a level 145.50 m above sea level, operational level is 131.5 m, volume of storage 1.5 billion m^3 and the reservoir area of 120 km^2 the highest level in the flood 142 m and volume of storage 3.9 billion m^3 and an area of 280km^2. Area elevation curve of the reservoir is shown in figure (6).

Tharthar Lake: The lake is Located 120 km northwest of Baghdad between Tigris and Euphrates Rivers. Its area is 2710 km^2 and has a higher level of storage 65m and its capacity 85.59 billion m^3,its dead storage 35.18 billion m^3 and lives storage 85.59 billion m^3.The area elevation curve of Tharthar Lake is shown in figure (7).

Hammar Lake: The lake is a saline lake in southeastern part of Iraq within the Marshes. It has an area of 600-1,350 km^2, water level in the lake fluctuates, with maximum depths varying from 1.8 meters (winter) to 3.0 meters (spring).The lake is an important wetland site for birds. The native inhabitants are Marsh Arabs, some of whom occupy villages on artificial, floating islands. The area elevation curve of Hammar Lake is shown in figure (8).

Habbania Lake: Habbaniya Lake is located southeast of Ramadi, the Anbar Governorate, and west of Baghdad. It is a large water reservoir constructed in 1982 and Evans (1994) included it in the original list of Important Bird Areas. It receives excess floodwaters from the Euphrates in the summer through a small canal near Ramadi called Sin Al-Dhuban. The canal passes through Al-Saglawiya and the calcareous Al-Guss hills, which separate the canal from Habbaniya. The excess floodwaters drain out on the southern edge of the lake through the narrow Al-Majarah Canal, which drains to Bahar Al-Milih and the northern part of Razzaza Lake in Karbala Governorate**.** The capacity of the lake is 3.3 billion m^3; area of reservoir is 426 km^2 and Storage level 51m, dead storage is 43 billion m^3 and live storage 0.743m^3. The area elevation curve of Habbania Lake is shown in figure (9).

Qurna marsh: The Central or Qurna Marshes were a large complex of wetlands in Iraq.Formerly covering an area of around 3000 square kilometers, they were almost completely drained following the 1991 uprisings in Iraq . The area elevation curve of Qurna Lake is shown in figure (10).

Hawizah marsh: Situated to the east of the River Tigris, Haur Al Hawizah (Hawaizah) and its associated marshes cover an area of approximately 2,200 km^2 between Amara and Basrah. Al Hawizah provides wintering habitat for some of the largest concentrations of wildfowl in the world. The area-elevation curve of AL Huwizah marsh is shown in figure (11).

Table (1) shows data available which have been taken from **(Ministry of Transportation, 2013)** to the evaporation for each month for Reservoirs and lakes.

Estimate the losses of the evaporation:

The area of Reservoir changing with the different elevation of level then the area-elevation curves were used to find the area for different elevation and multiply this area by the evaporation for the same month the volume of evaporation in m^3 was found.The Rule curve for evaporation - storage was drawn as shown in (from Fig.12-21).

Calculated water quality:

Increase of evaporation affects water quality then it increases the water salinity. Salt mass balance equation was used for calculating the increase in salt mass due to water evaporation from reservoirs,Table (2) show the mean monthly Total Dissolved Salts (T.D.S) for each location. The storage (max.,avg and min.)is shown in Table (3).

The Total Dissolved salts (T.D.S) calculated from the Equation:

$T.D.S = (S * T.D.S)/(S – Eva.)$

When:

S: Volume of Storage (Km^3);

Eva. : Volume of Evaporation (Km^3).

Table (4) shows the T.D.S for each of the Reservoir and Lakes for (Smax. , Savg. and Smin).

Conclusions and Discussion:

Building of dams and water storage has a lot of benefits when the process of water storage has negative effects, most important factor is evaporation losses which lead to lose large of amount of water every year, evaporation also leads to increase the salinity of water.

The paper studies the effect of evaporation from reservoirs, lakes and marshes in Iraq on salts with increasing or decreasing with different conditions of storage (Min., Avg., Max.). The results show that the volume of losses because of evaporation is reaches about (22%) from storage volume at average condition, also the results show that the process of water storage affects water quality of reservoirs, lakes and marshes through increasing the T.D.S to about (17) % from the average.

Recommendation:

1. Studying variation of evaporation loss according to the reservoirs and lakes rules curve.
2. Collect more data about reservoirs in Iraq and study the effect of evaporation on the reservoirs.
3. Studying the effect of water loss from reservoirs on the ecological of rivers.

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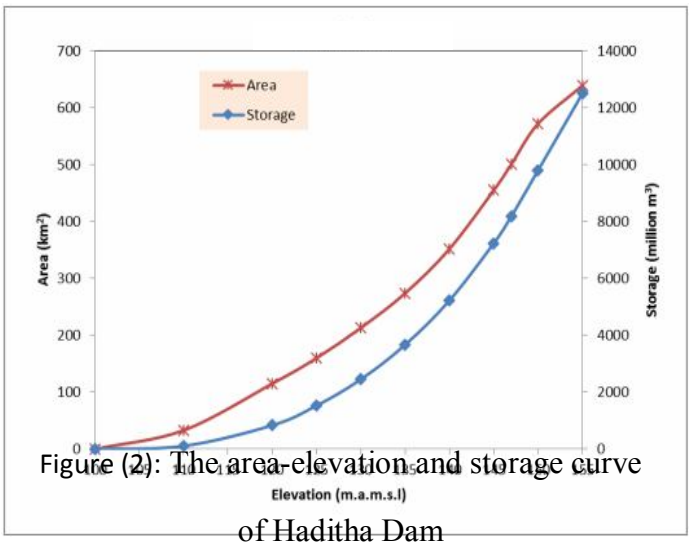


Figure (2): The area-elevation and storage curve of Haditha Dam

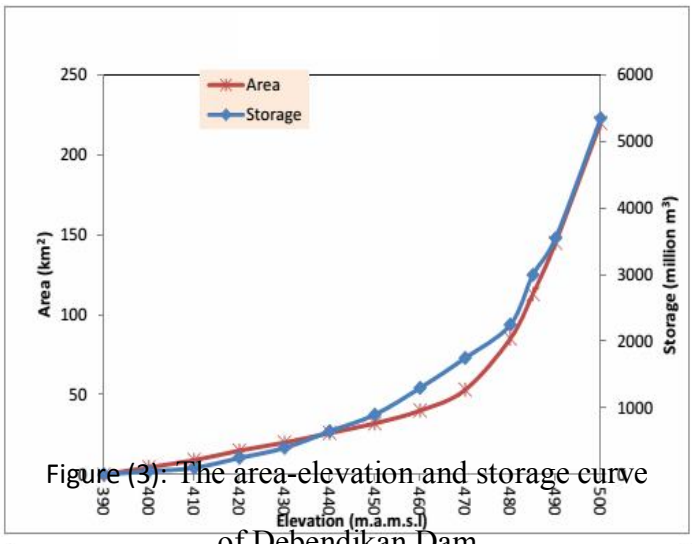


Figure (3): The area-elevation and storage curve of Debendikan Dam

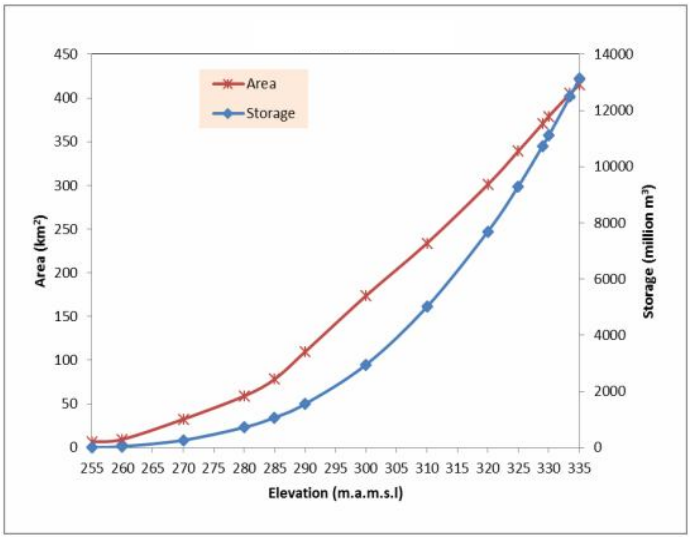


Figure (4): The area-elevation and storage curve

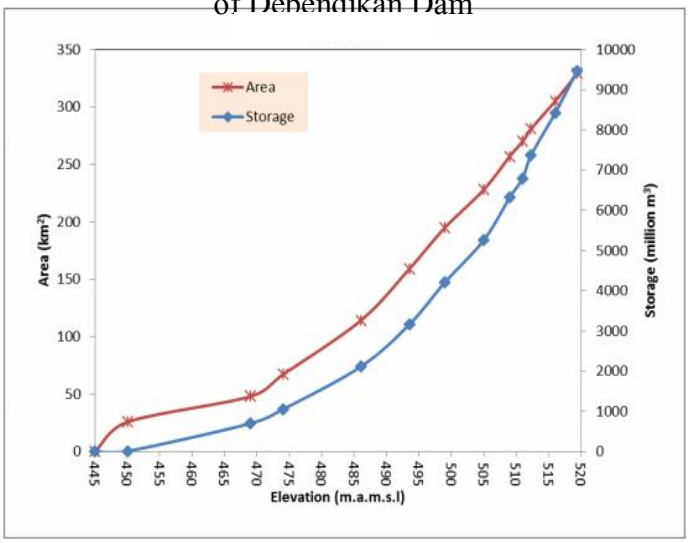
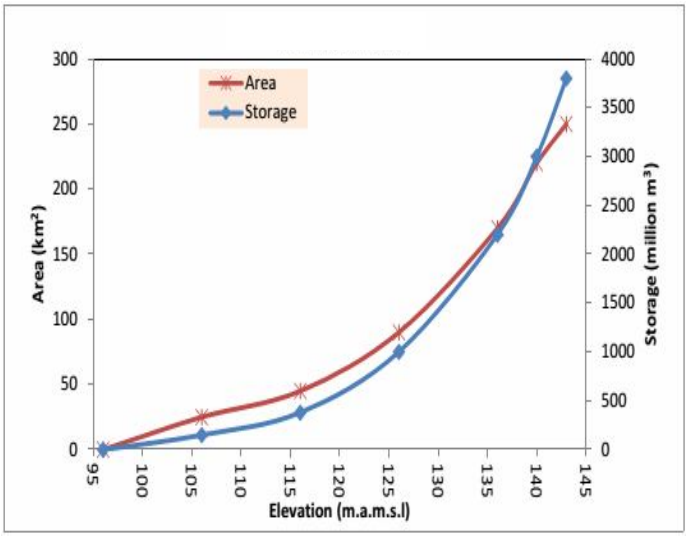
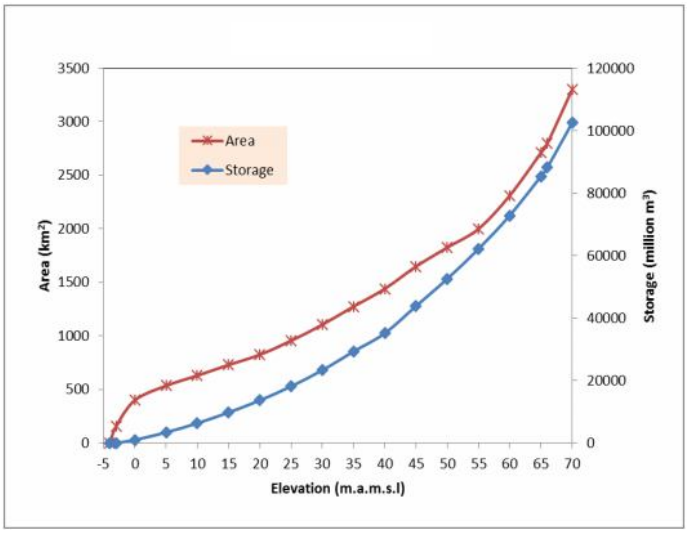


Figure (5): The area-elevation and storage curve of Dokan Dam





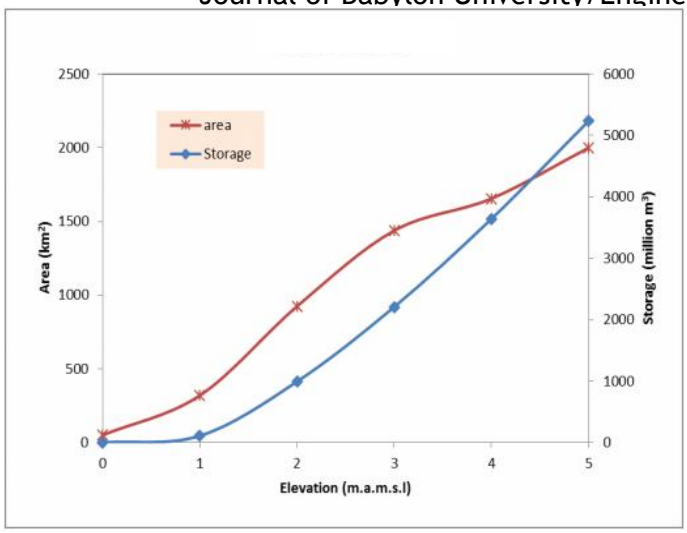


Figure (8): The area-elevation and storage curve of Al_Hammar lake

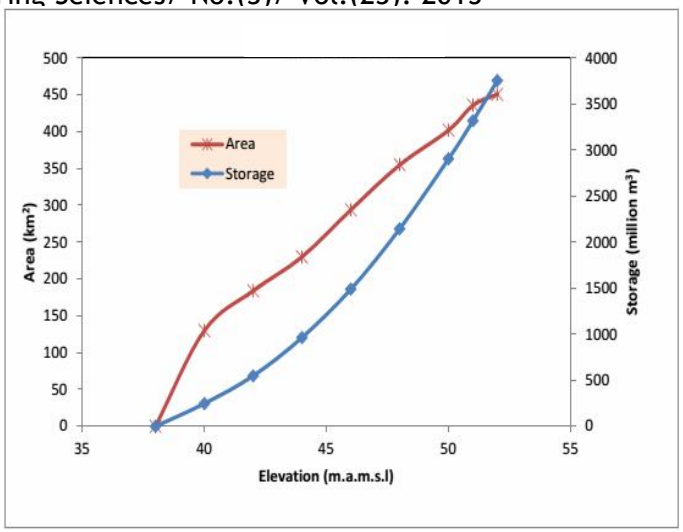


Figure (9): The area-elevation and storage curve of Habbania lake

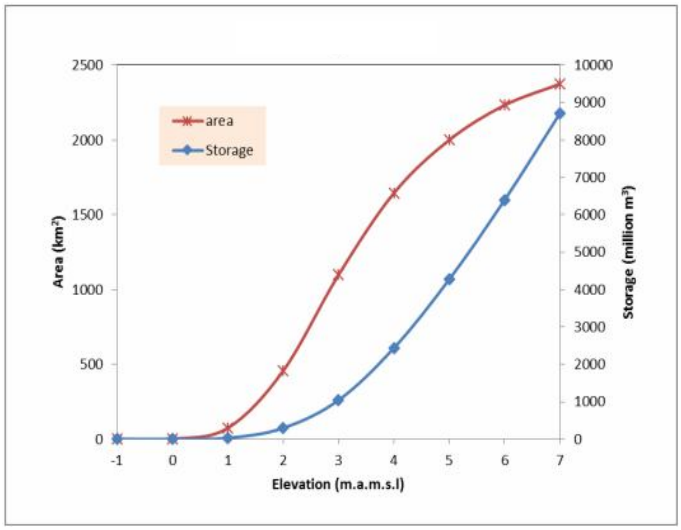


Figure (10): The area-elevation and storage curve of Al_Qurna Marsh

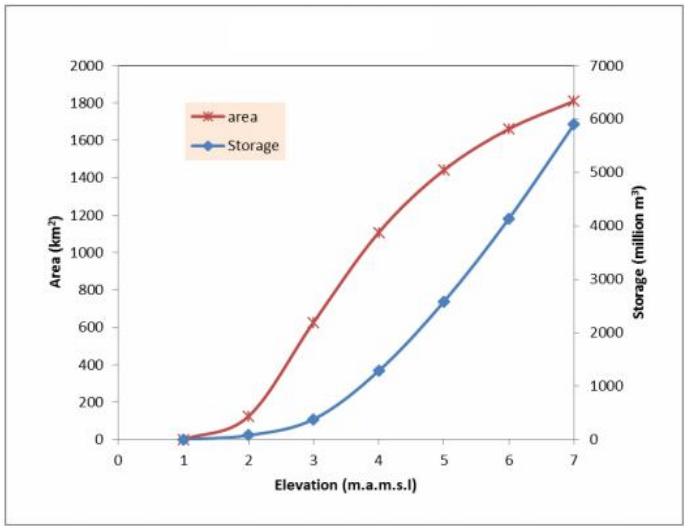


Figure (11): The area-elevation and storage curve of Al_Huwizah Marsh

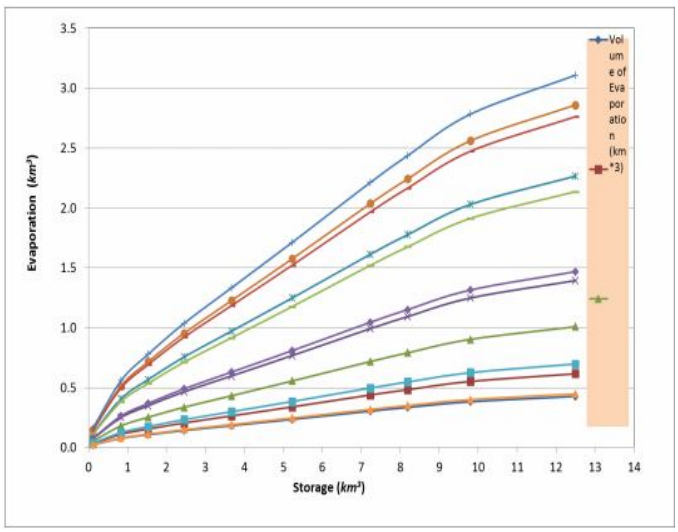


Figure (12): The Rule curve for evaporation _ storage for Haditha Dam

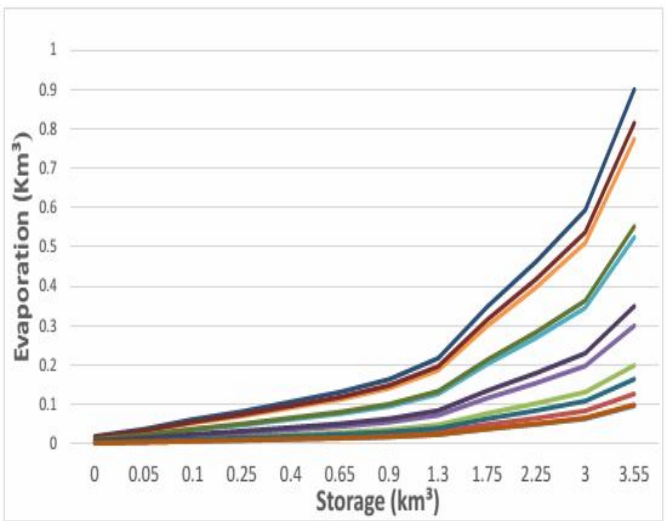


Figure (13): The Rule curve for evaporation _ storage for Derbendikan Dam

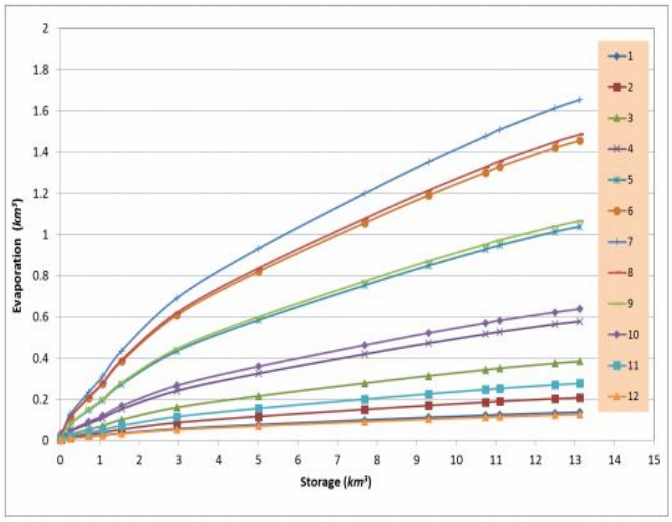


Figure (14): The Rule curve for evaporation _ storage for Musel Dam

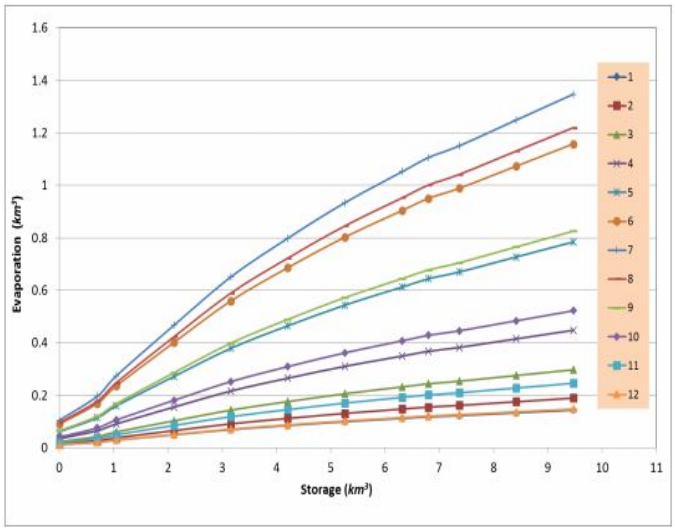


Figure (15): The Rule curve for evaporation _ storage for Dokan Dam

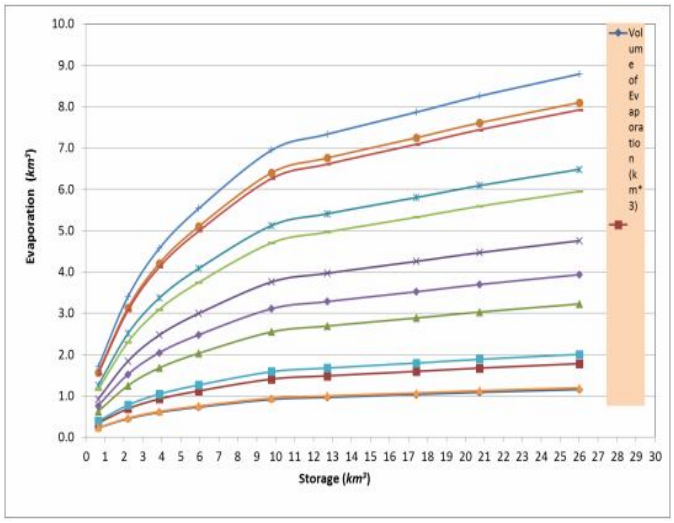


Figure (16): The Rule curve for evaporation _ storage for Al_Adhaim Dam

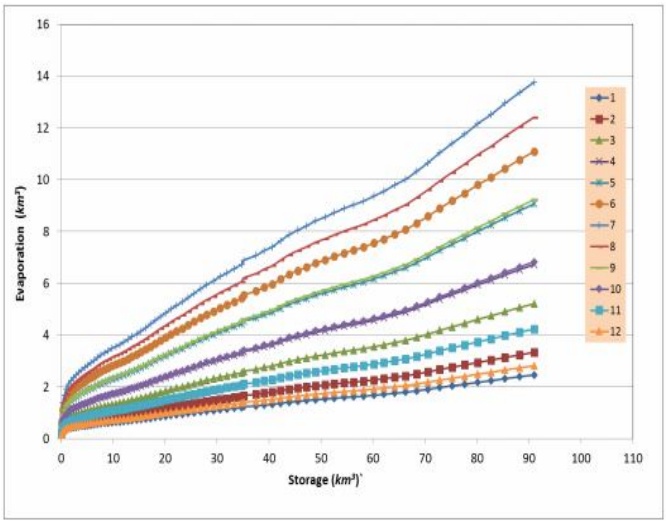


Figure (17): The Rule curve for evaporation _ storage for Tharthar lake

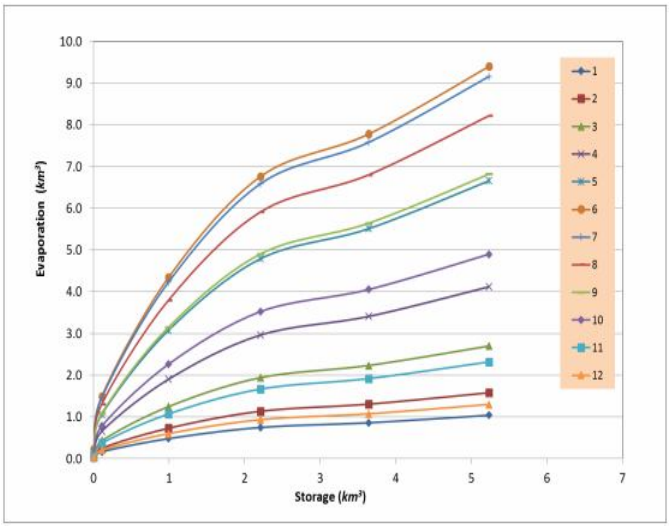


Figure (18): The Rule curve for evaporation _ storage for Al_Hammar Lake

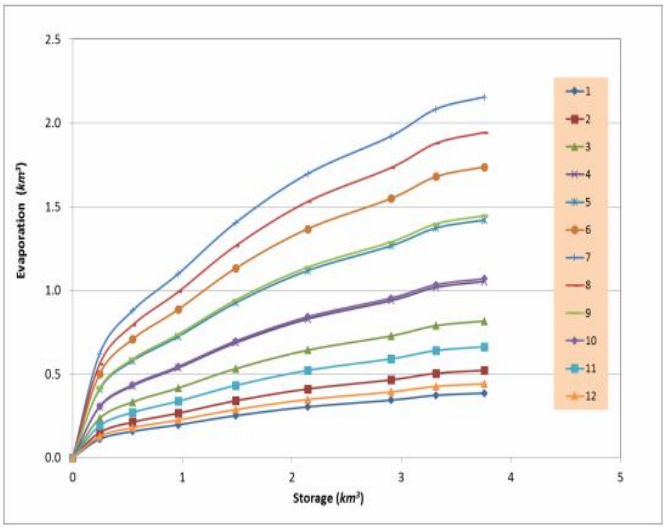


Figure (19): The Rule curve for evaporation _ storage for Habbania Lake

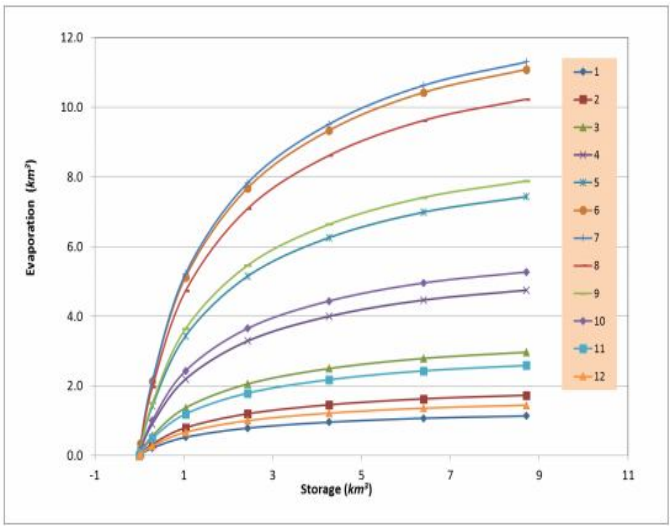


Figure (20): The Rule curve for evaporation _ storage for Qurna Marsh

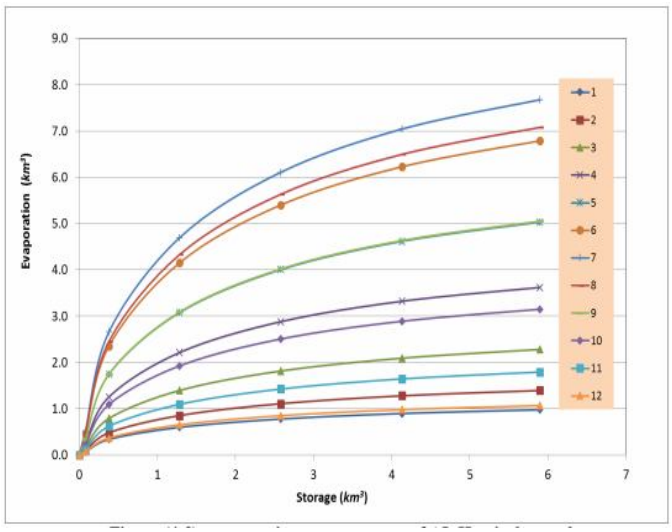


Figure (21): The Rule curve for evaporation _ storage for Huwizah Marsh

Figure(1): Iraq Map shows the location of Dams

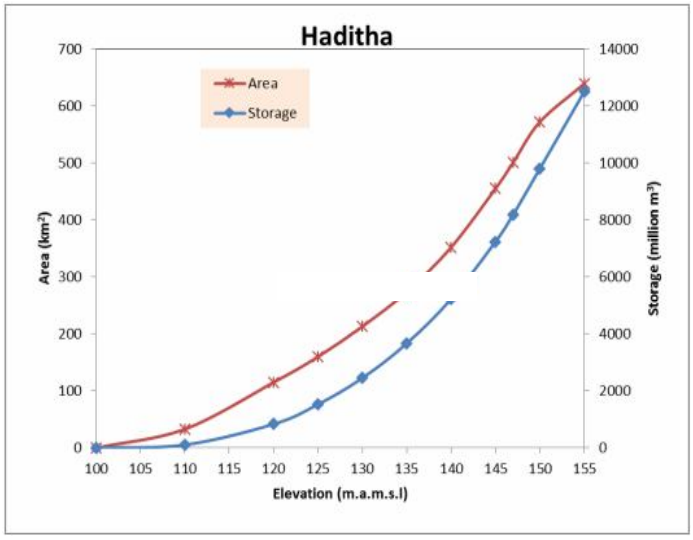


Figure (2): The area-elevation and storage curve of Haditha Dam

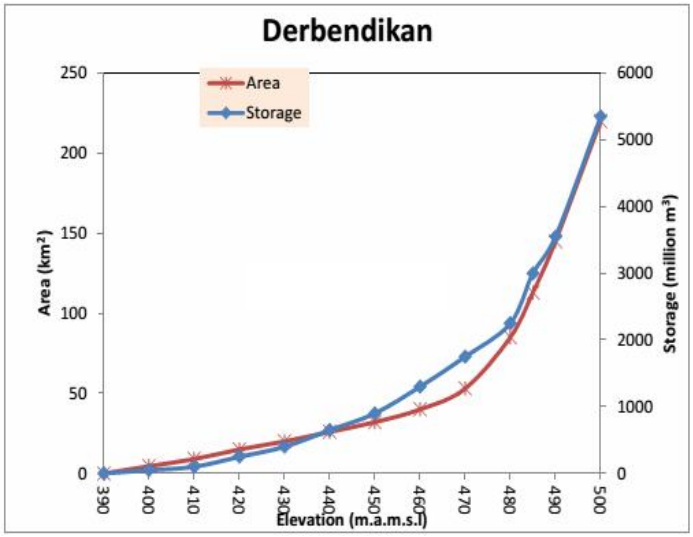


Figure (3): The area-elevation and storage curve of Debendikan Dam

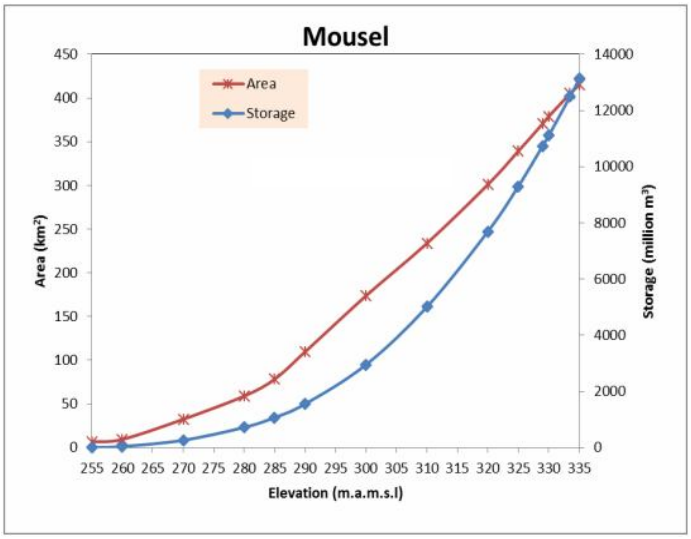


Figure (4): The area-elevation and storage curve of Musel Dam

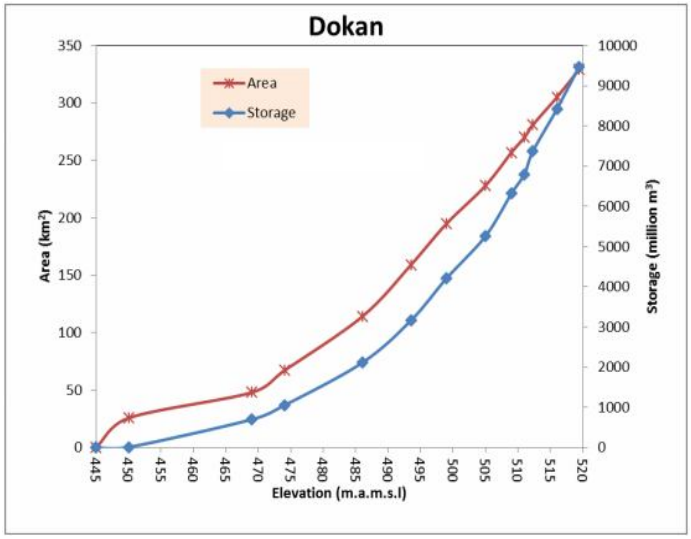


Figure (5): The area-elevation and storage curve of Dokan Dam

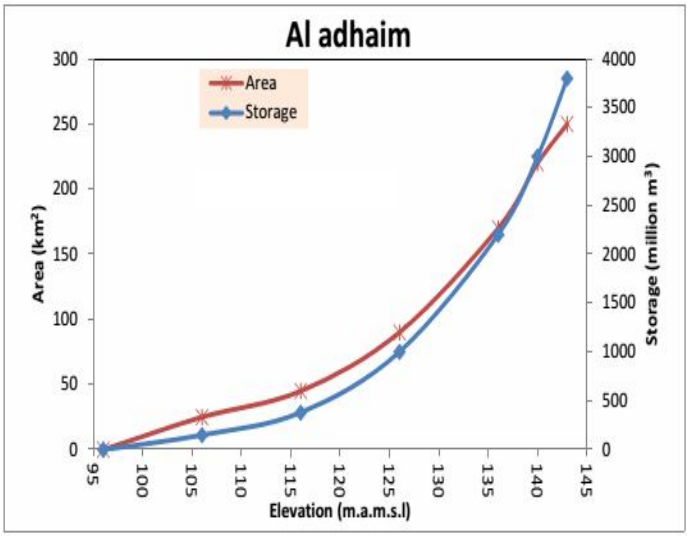


Figure (6): The area-elevation and storage curve of Al_Adhaim Dam

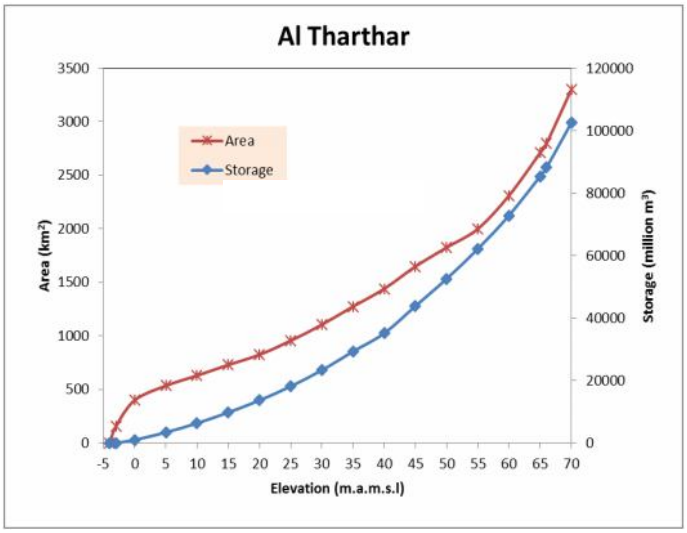


Figure (7): The area-elevation and storage curve of Tharthar lake

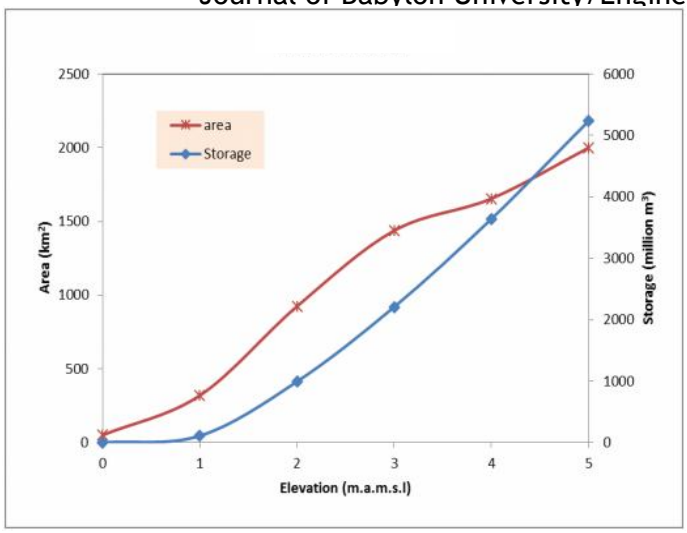


Figure (8): The area-elevation and storage curve of Al_Hammar lake

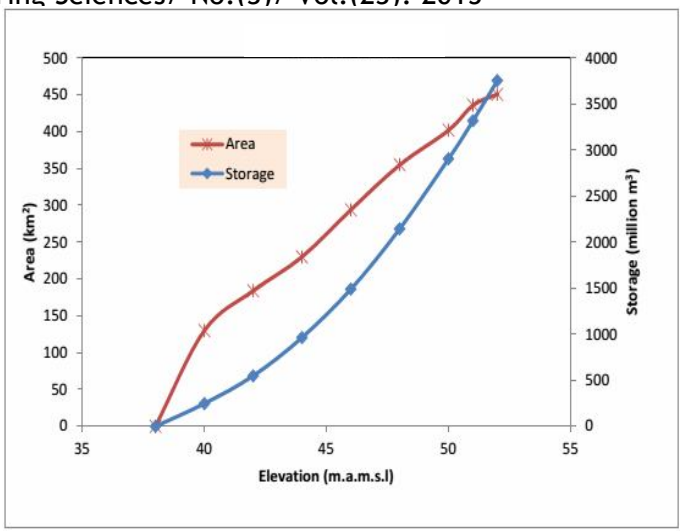


Figure (9): The area-elevation and storage curve of Habbania lake

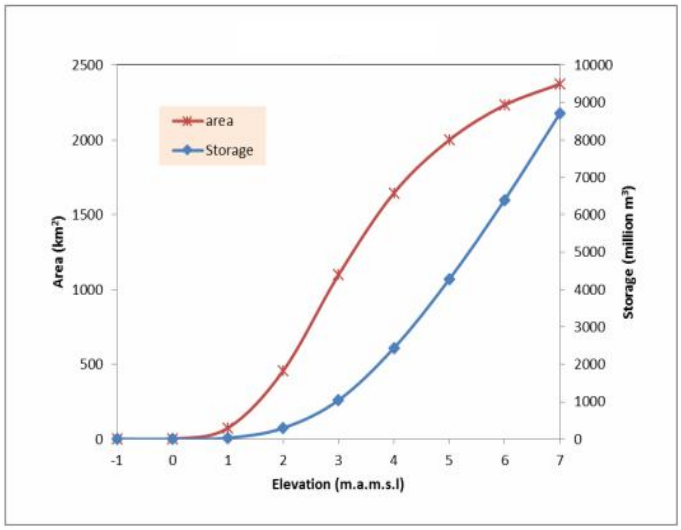


Figure (10): The area-elevation and storage curve of Al_Qurna Marsh

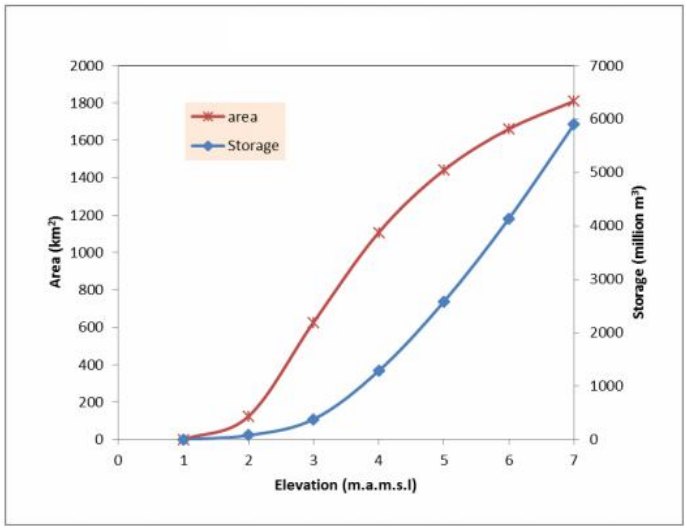


Figure (11): The area-elevation and storage curve of Al_Huwizah Marsh

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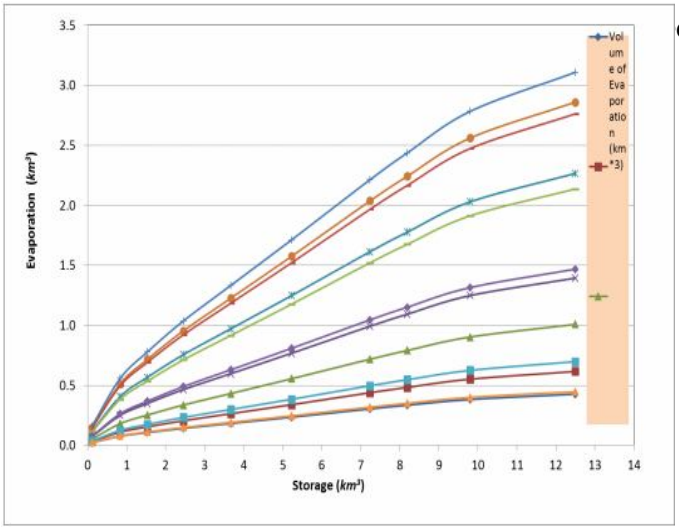

Figure (12): The Rule curve for evaporation _ storage for Haditha Dam

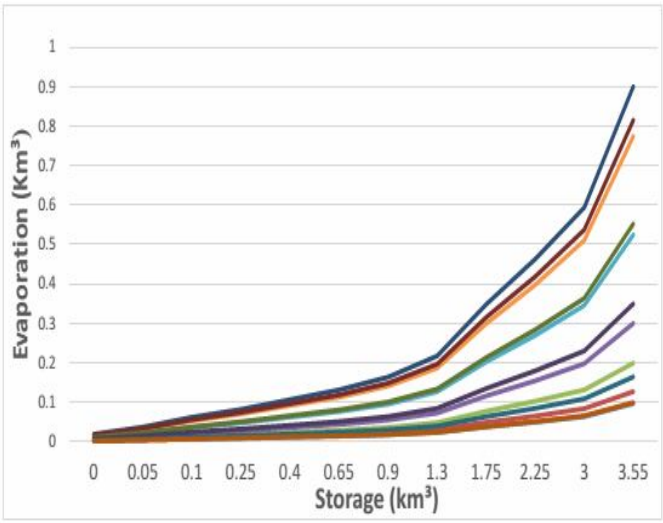

Figure (13): The Rule curve for evaporation _ storage for Derbendikan Dam

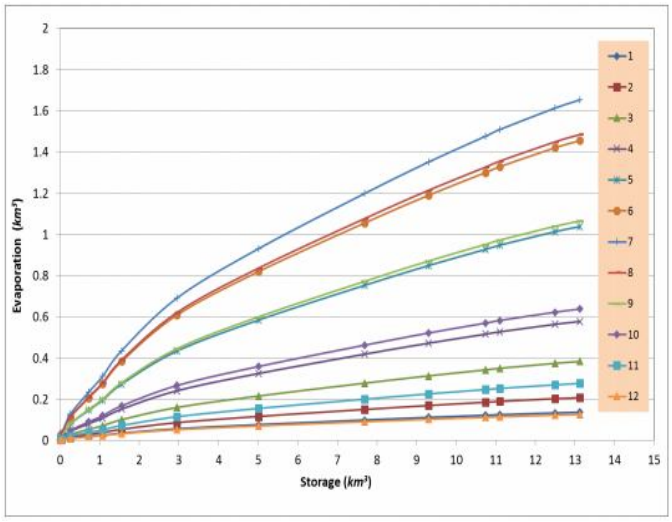

Figure (14): The Rule curve for evaporation _ storage for Musel Dam

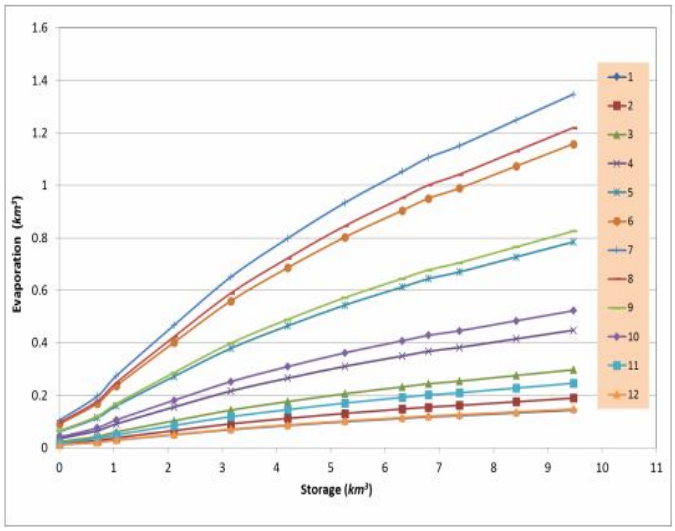

Figure (15): The Rule curve for evaporation _ storage for Dokan Dam

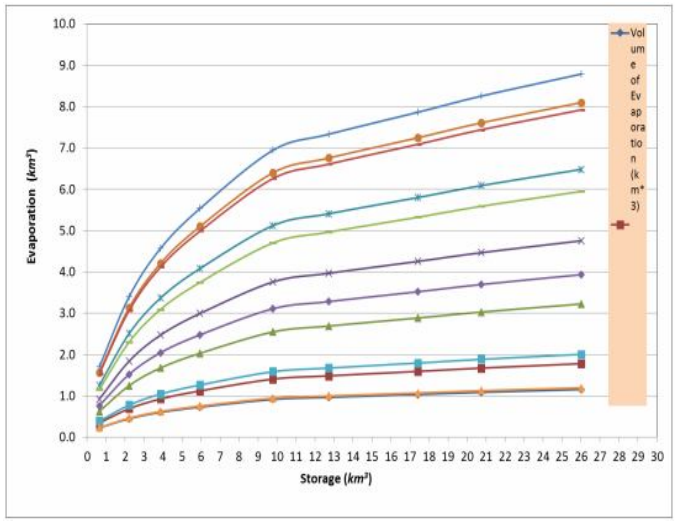

Figure (16): The Rule curve for evaporation _ storage for Al-Adhaim Dam

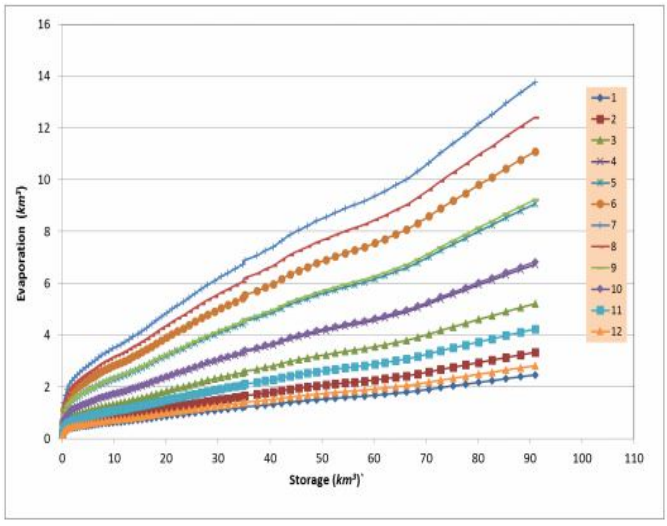

Figure (17): The Rule curve for evaporation _ storage for Tharthar lake

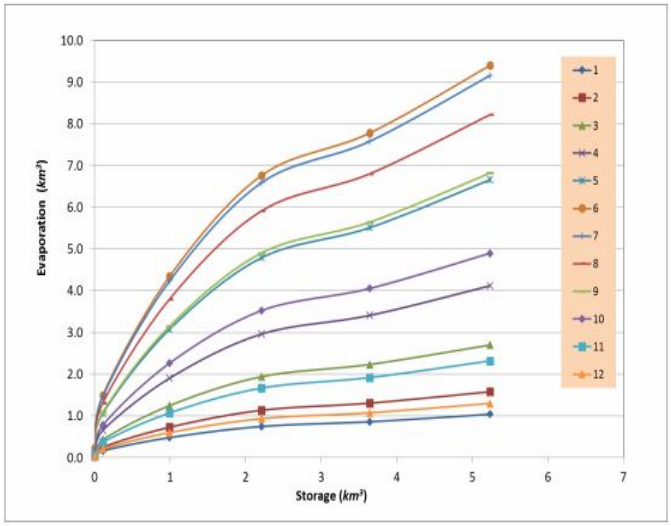

Figure (18): The Rule curve for evaporation _ storage for Al_Hammar Lake

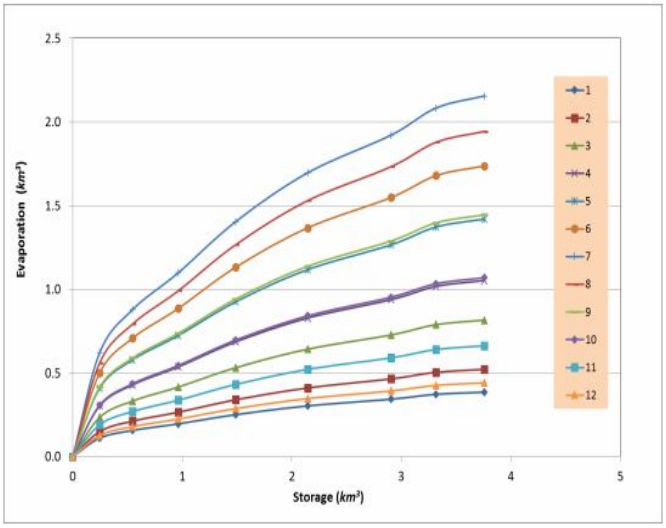

Figure (19): The Rule curve for evaporation _ storage for Habbania Lake

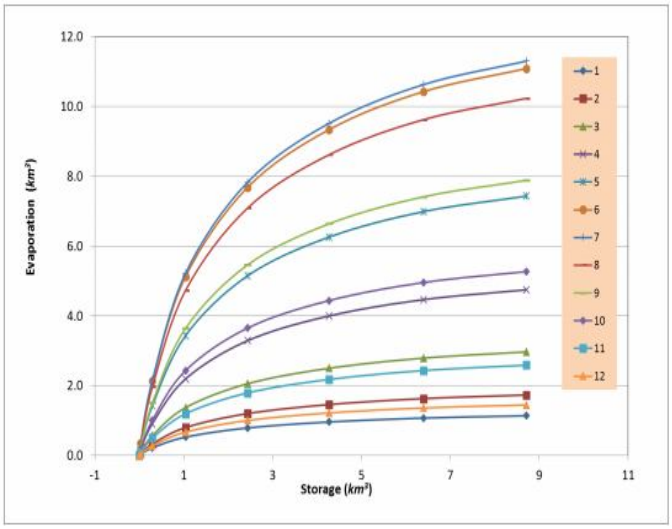

Figure (20): The Rule curve for evaporation _ storage for Qurna Marsh

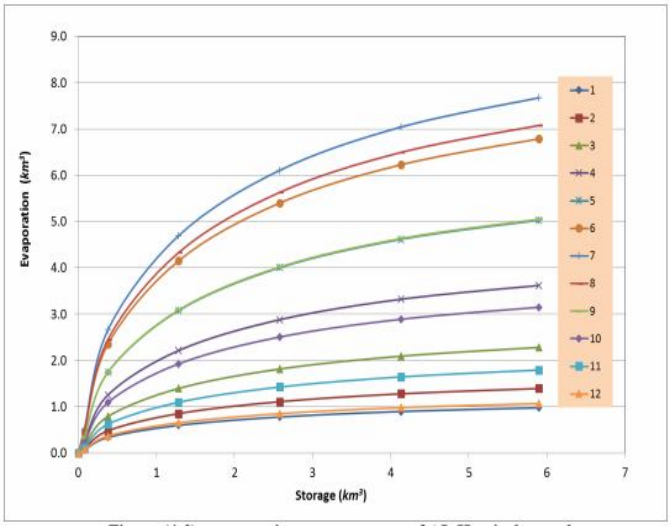

Figure (21): The Rule curve for evaporation _ storage for Huwizah Marsh

Table (1): The evaporation for each month for Reservoirs and lakes taken from **(Ministry of Transportation,Iraq, 2013)**.

Location	Evaporation(Km)											
	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
Haditha Dam	0.00066	0.00095	0.0015	0.00219	0.00355	0.00438	0.00477	0.00444	0.00443	0.0032	0.0019	0.001
Derbendikhan	0.0005	0.0005	0.001	0.0018	0.0035	0.0037	0.0047	0.0036	0.0021	0.002	0.001	0.0004
Mousel Dam	0.0003	0.0006	0.0009	0.0015	0.003	0.0037	0.0041	0.0031	0.0021	0.001	0.0007	0.0003
Dokan Dam	0.0004	0.0006	0.0009	0.0014	0.0024	0.0035	0.0041	0.0037	0.0025	0.0016	0.0007	0.0004
AlAdhaim Dam	0.0003	0.0006	0.001	0.0014	0.0025	0.0038	0.004	0.0036	0.0025	0.001	0.0007	0.0003
Tharthar Lake	0.001	0.0014	0.0017	0.0023	0.003	0.004	0.0048	0.0041	0.0031	0.0026	0.0014	0.001
Hammar Lake	0.0005	0.0009	0.0016	0.002	0.0032	0.0048	0.0046	0.0041	0.0035	0.0026	0.0013	0.0007
Habbania Lake	0.00085	0.00115	0.00182	0.00235	0.00319	0.00382	0.00479	0.00432	0.00326	0.00231	0.00147	0.00098
Qurna marsh	0.00049	0.0007	0.0013	0.0023	0.0031	0.0047	0.0049	0.0043	0.0033	0.0025	0.0015	0.0006
Hawizah marsh	0.0005	0.0008	0.0015	0.002	0.0029	0.0038	0.0044	0.0039	0.0028	0.0017	0.001	0.0006

Table (2) : Mean monthly totaldissolved salts (T.D.S) for each location

Reservoir Name	Mean monthly(p.p.m)	Mean monthly(p.p.m)	Mean monthly(p.p.m)	Mean monthly(p.p.m)	Mean monthly(p.p.m)	Mean monthly(p.p.m)	Mean monthly(p.p.m)	Mean monthly(p.p.m)	Mean monthly(p.p.m)	Mean monthly(p.p.m)	Mean monthly(p.p.m)	Mean monthly(p.p.m)
HadithaDam	625	570	598	573	575	547	615	638	637	643	638	635
Derbendikhan Dam	264	264	255	235	200	179	202	222	224	259	230	236
MouselDam	247	249	247	247	226	210	212	201	204	220	232	240
DokanDam	197	188	233	199	180	179	157	141	153	149	203	201
AL-Adhaim dam	399	413	425	385	380	370	370	363	364	334	369	384
Thartharlake	1440	1490	1504	1457	1378	1212	1259	1341	1255	1454	1422	1326
Hammarmarsh	1871	1348	1890	1356	1310	1288	1216	1264	1327	1320	1330	1480
Habbanialake	958	928	865	929	904	921	918	1115	976	1144	1112	1245
Qurnamarsh	1568	1048	1651	1106	1048	863	746	827	886	830	893	1015
Huwizahmarsh	625	601	437	508	535	850	1111	875	852	1234	885	750

Table (3): Max., Avg. and Min. storage for the Dams and Marshes

Reservoir	Smax	Savg	Smin
Haditha Dam	12.5	5.2	0.85
Derbendikhan Dam	5.4	1.65	0.1
Mousel dam	13	5.9	0.3
Dokan dam	9.5	5.0	0.8
AL_ Adhaim dam	3.8	1.8	0.4
Tharthar lake	91	32.3	1.4
Hammar marsh	4.6	5.2	0.2
Habbania lake	3.75	2.1	1
Qurna marsh	8.3	5.3	0.41
Huwizah marsh	5.9	3.3	0.1
Haditha Dam	5.15	12.5	0.9

Table (4): Total Dissolved Solids (T.D.S) (continue)

location	Storage Km^3	Total Dissolved Salts (T.D.S)											
		Jan.	**Feb.**	**Mar.**	**Apr.**	**May**	**Jun.**	**Jul.**	**Aug.**	**Sep.**	**Oct.**	**Nov.**	**Dec.**
Tharthar lake	Smax.	1480	1540	1598	1579	1533	1367	1496	1553	1504	1574	1482	1368
	Savg.	1490	1563	1622	1610	1577	1425	1570	1621	1554	1607	1501	1381
	Smin.	1460	1525	1556	1520	1455	1270	1361	1425	1434	1530	1436	1345
Hammar marsh	Smax.	1322	1212	1301	1302	1233	1212	1223	1301	1332	1861	1334	1845
	Savg.	1485	1341	1322	1325	1275	1236	1298	1322	1366	1886	1350	1871
	Smin.	1501	1388	1398	1367	1298	1342	1356	1354	1398	1910	1456	1916
Habbania lake	Smax.	1078	1059	1100	1254	1442	1700	1085	2105	1585	1610	1350	1400
	Savg.	1117	1118	1221	1444	1676	2263	3543	3061	1940	1820	1440	1451
	Smin.	1245	1333	1298	1455	1730	2050	2952	2685	1790	1731	1411	1425
Qurna marsh	Smax.	987	850	811	820	799	732	786	988	1012	1632	1013	1523
	Savg.	1015	893	830	886	827	746	863	1048	1106	1651	1048	1568
	Smin.	1087	1001	889	911	887	881	913	1148	1167	1711	1148	1612
Huwizah marsh	Smax.	713	834	1211	832	856	1111	801	504	512	432	561	621
	Savg.	752	887	1236	862	888	1211	880	545	548	457	621	645
	Smin.	767	910	1298	914	954	1298	953	615	611	512	687	689

Table (4): Total Dissolved Solids (T.D.S) (continue)

		Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
Haditha Dam	Smax.	637	600	650	645	701	712	804	820	756	728	672	668
	Savg.	645	612	668	668	745	770	885	883	799	760	690	678
	Smin.	632	598	636	630	660	658	750	770	720	710	668	665
Derbendikhan Dam	Smax.	269	267	265	260	222	244	255	257	276	238	239	240
	Savg.	268	271	263	258	221	219	241	248	247	273	246	239
	Smin.	284	288	282	272	227	222	253	262	267	290	249	251
Mousel Dam	Smax.	250	253	255	258	247	237	243	227	222	231	237	242
	Savg.	251	253	258	260	253	249	260	240	231	235	236	243
	Smin.	257	264	277	321	361	364	424	360	295	272	252	249
Dokan dam	Smax.	190	182	233	212	215	2!7	179	169	195	162	219	233
	Savg.	190	182	231	210	212	211	177	168	181	161	210	225
	Smin.	188	178	201	199	202	203	161	165	179	158	198	215
AL_adhaim Dam	Smax.	425	450	464	437	480	437	500	460	424	411	401	416
	Savg.	456	501	585	622	1096	2105	3566	1780	895	613	462	455
	Smin.	630	590	632	625	662	659	750	776	724	717	667	663