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Sustainable Management of Surface & Subsurface Water of HashyimiaRegionby a Hydrogeologic Solution

UnderSocial Contradictions and Terroristic Extremism in Iraq

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Abstract: Corresponding to many social problems arisen in Iraq such as population growth, political problems of controlling terroristic croups the water dams of Tigris and Euphrates Rivers and even collapsing of Al Mosul Dam the biggest in Iraq (happening now in 2016), construction of Aliso Dam in Turkish to prevent surface water (SW) allocations entering Tigris causing a declining of water heads which leaded to stop electrical hydropower stations leaving Iraq with a sharp leakage of electricity , people migration, in addition to worse administration politics, calls for new and effective water resources management were promoted.

A hydrogeologic solution was issued by using 2D groundwater (GW) and conjunctive use models to optimize a conjunctive study for Hashyimia Region of 110km2. Saving the SW is a main objective among other available water resources like rainfall and GW exploitation provided that water requirements are completely satisfied.

Unsteady groundwater modeling process based upon the solution of finite difference approach of Laplace`s Equation required mesh design of a model domain, aquifer properties determination by pumping test analysis, model calibration to modify aquifer properties whereas the conjunctive use model required an assessment of meteorological elements, local plant diversity and water demand estimation, population counting and urban water needs to adapt an integrated water resources management.

The hydrogeologic management study based firstly upon consuming a rainfall and GW resources to satisfy the total water requirements and secondly is integrated by SW wherever and whenever is needed.

The current hydrogeologic study paved the solution to many social and ecosystem problems through encourage an opposite people immigration by satisfying their water needs and overcoming the local environmental problems such drying of swamped lands, and saving of 41mcm/ year of SW. The study revealed that previously a 3.76 cumces of SW is specified to cultivate 48% of the total area whereas the current study showed that2.45 cumces enough to cultivate the total area.

Keywords: SWR: surface water resources, confining layer,conjunctive use, SY: safe yield, WD: water demand, WL: withdrawal, WU: urban water.

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Introduction

The integrated water managements (IWRM) is defined as a promoting processof land and water resources related coordinates management.in order to maximize the economic and social welfare without compromising the sustainability of the environment,WSSD (2005).Merry et al (2005) studied the weakness in the (IWRM) from the perspective of livelihood and reducing of human poverty and economic promoting.They paper concludes an alternate definition for IWRM as involving a promotion of human welfare, especially a poverty reduction levels, better livelihoods encouragementand balanced economic growth with a democratic development and water management.

Najah (2006) Developed and optimum water resources management study in the basin of Al Adhiam Region located north of Iraq, the area of 10 thousands km^2 was divided into four administration divisions. A general soci-ecosystem and water management study was achieved to rearrange a surface and subsurface water.

Silva et al (2008) identified the characteristic to originate a conjunctive use model to achieve an IWRM.The study indicated that IWRM depends basically on the participation of both the stockholders and decision makers. Their analytical results were presented to be accessible by non-expert as presented in the current study.

Evan et al (2011) employed ANEMI mathematical model to overcome a water scarcity by developing the infrastructures and a good management policies. They outlined that water scarcity originated implicitly by internal water resources system and explicitly by soci-economic problems ana environmental changes ecosystem.

In the current study, an optimum and integrated management of surface and subsurface water resources are adapted by using a conjunctive use modeling technique which had been undertaken hydrogeological, meteorologicalelements, soci-economic priorities, political circumstances and terroristic consequences.

Significance of Study

Iraq country endures in recent decades the problem of surface water scarcity issuing of populationgrowth, political problems like acontrolling of terroristic croupson dams inside and outside Iraq, construction of Aliso Dam in south Turkey to prevent the usualSW allocations entering Tigris River, ...etc. Correspondingly in addition to worse political administration managements, social problems arised in Hashymia such population migration leaving own landsdue an impact of local stream drought due to a construction of Tyass Dam, soil water logging of Tyass sector and soil salinity resulted from groundwater salinization. Accordingly, calls have been arisen tosearch for an alternative and necessarily water resources to satisfy a waterdiscrepancy for critical social needs.

Geography and Topography

Hashyimia area of 110km^{2}is a southern-east part of Babylon and is located between longitudes of 44º 36' - 44º 47' and latitudes of 32º 15′- 32º 25'. Nine streams are founded namely; Tebra, Niwedra, Hashimiya…etc to

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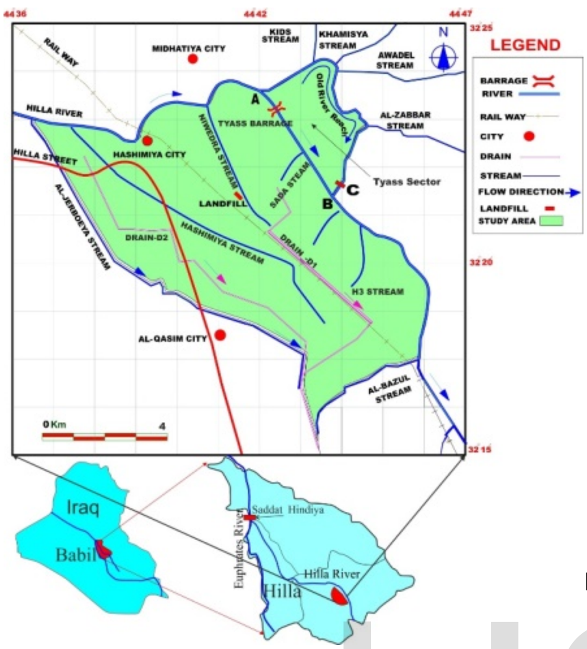
satisfy WD. Whereas D_1 and $D_2$are drains passing the area from the north toward the southas indicated in the location map of Fig.(1).

In general, the area appears to be flat and reduces gradually in elevation from northern east to southern west. In general the highest elevation is 25.5 m a. s. l whereas the lowest is 22.5 m a. s. l as shown in Fig.(2).



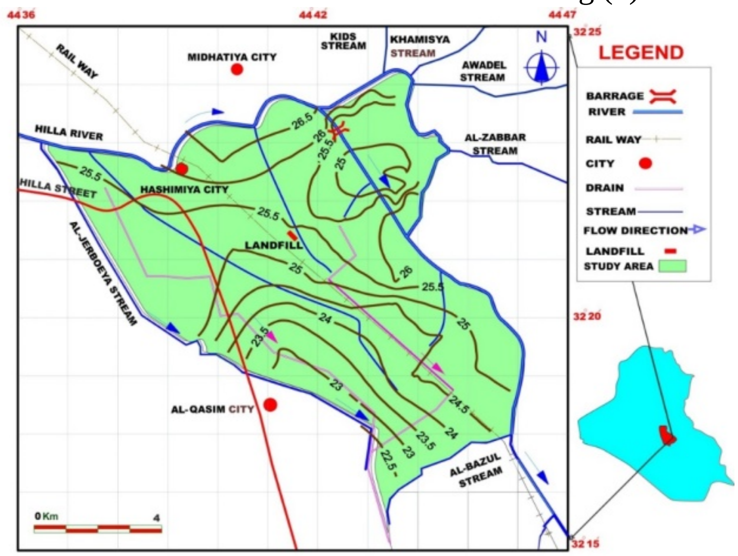


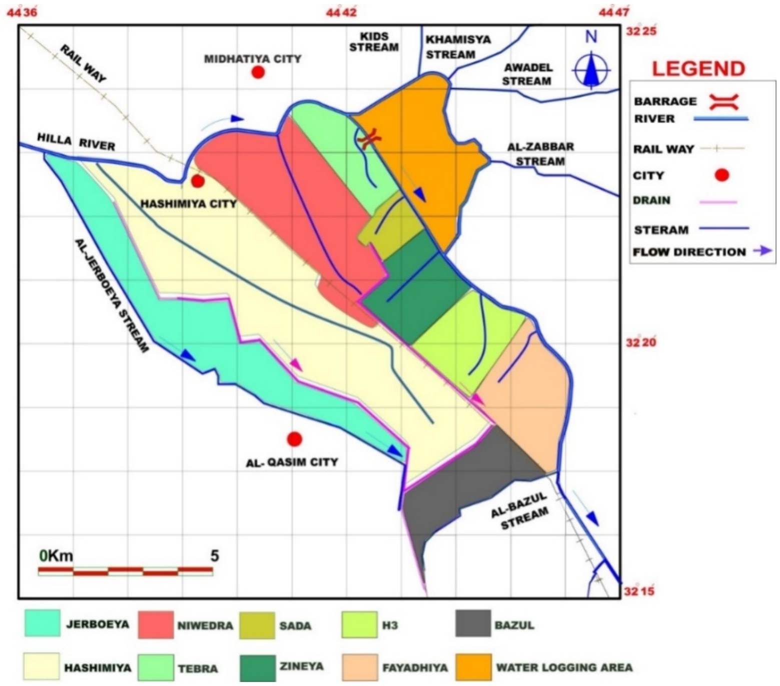
Fig.(2) Topographic Map

Fig.(1) Location Map of HashimiyaRegion

Preparation of Hashyimia Area to Conjunctive Use Modeling

Conjunctive use modeling requires to dividing theareainto a number of most major factors suchSW,geography, topography, demography, available streams, and administration divisions…etc.

Correspondingly, it is preferred to develop the conjunctive use management on the bases of dividing the area into ten sectors referring to local streams and field tributaries namely as, JerboeyiaHashyimia, Niwedra, Tebra, Sada,Zineyia, H3, Fayadhiya, Bazul andTyass sectors. This is shown in the agricultural divisions of Fig.(3) and Table (1).



Fig(3) Agricultural Sectors of Hashyimia Region

Agricultural Sectors Layout& Modeling Consideration

Since the area characterizes with a wide extents of about 110km^2 and plant diversity,the area entirely should be discretized into a number of squaremeshes(357.142m $*$357.142m). (765 meshes) is the totalnumber of meshes within a mathematical model domain of dimensions (NC = 43 $*$ NR = 41). Where NC and NR are a number of columns and rows respectively. Fig.(4) shows the discretization of the model domain.

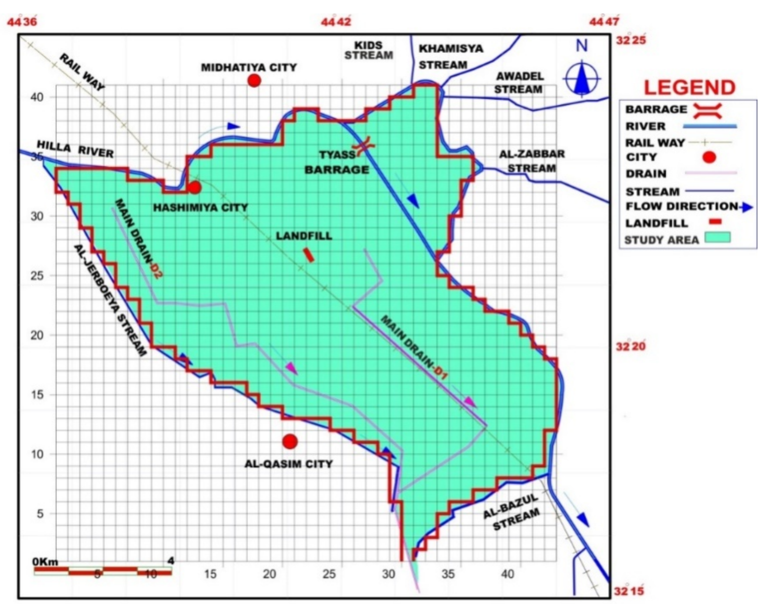


FIG.(4) Discretization of Conjunctive Use Model Domain & Mesh Design

Table (1) presents the agricultural sectors areas in donams.

Table(1) Agricultural Sectors &SWReleases

Sector	Area (Donum)	No. of Total meshes	SW Releases		No. of Actual Cultivated Meshes	Current Surface Water Allocation (m^3/day) /mesh
			m^3/s	m^3/day		
Jerboeya	5456.71	106.95	0.8	69120	49.31	1402
Hashimiya	12801.29	250.9	0.97	83808	46.66	1796
Niwedra	5462.42	107.06	0.47	40608	58.89	689
Tebra	1641.31	32.17	0.102	8812.8	31.79	277
Sada	789.1	15.46	0.108	9331.2	14.25	655
Zineyia	1918.94	37.6	0.25	21600	35.38	610
H3	2312.8	45.3	0.091	7862.4	41.92	187
Fayadhia	2675.71	52.44	0.21	18144	52.01	349
Al-Bazul	2591.88	50.8	0.2	17280	34.16	506
Tyass	3358.85	65.83	None	None		
Total		765	3.76			

In order to start the conjunctive use modeling in the area it is necessarily to assess the hydro-geologic components since it represents the basics to groundwater modeling in addition tosoci-economic priorities and unfortunatelythe political circumstances. Anyhow an optimum management needs the following basic components:-

I) Diversity of Natural Seasonal Planting

In spite of agriculture inHashyimia area comprises different plant crops in spite ofsuffering the problems of unstable SW allocations due to terroristic war and political circumstances, people used to planting summer and winter plants.

A visit to the sectors, one observes that farmers cultivate a permanent plants such as orchards of date palms, fruits such as pomegranate, apricot, apples, orange, quince, pear, grapes, figs…etc. and seasonal planting which comprises summer and winter cropssuch asCotton, Barley, corn, and cotton.

II) Annual RainfallEstimation

Table (2) includes the average monthly rainfall of 35 years historical data.

Table (2) Average Monthly Rainfall in Hashyimia Area

Month	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	Total
Rainfall, mm	4.4	20.4	27	22	14	13.3	12.3	3	0.00	0.00	0.00	0.2	116.6mm

III) Available Surface Water Releases

The water authority specified a certain releases for the nine agricultural sectors as shown in Table (1) with a total quantity of 3.76m^3/sec whereas Tyass sector is left without water allocation and uncultivated.

IV) Groundwater Model Conceptualization &Safe Yield Estimation

The optimum management requires a good figure of the safe yield (SY) of the unconfined aquifer within the model domain. Correspondingly, a groundwater model has been:-

1- Written in Fortran Language which represents a developed copy to the program of Prickett and Lonngquist(1971) to be used for SY evaluation of an existing bearing layer.
2- Fitted to the domain of Hashyimiaboundary and the necessarily aquifer properties. The properties are entered into the model in separate files such as transmissivity, specific yield, aquifer bed levels, initial water levels, constant head boundaries (river, streams, drains)…etc
3- Calibrated and verified by using a WTL comparative between the numerical and theoretical solution of Theis as shown in Figs. (5 &6).

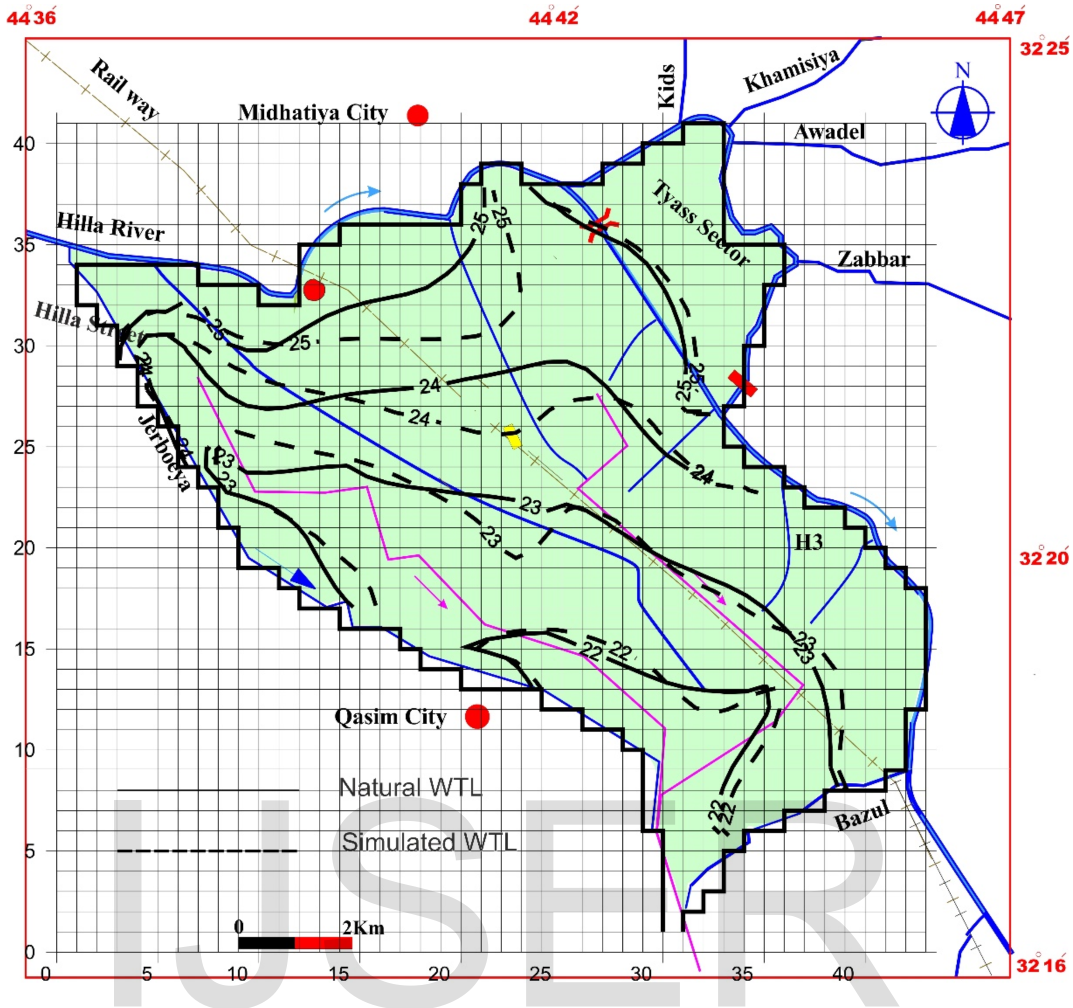


Fig.(5) Comparison Between Measured& Simulated WTL.

The Fig.(5) shows an acceptable matching between the modeled and the natural WTL with a difference ≤ 10% overall domain of the considered area as outlined by Al Assaf (1976) and Najah (2006) among others.

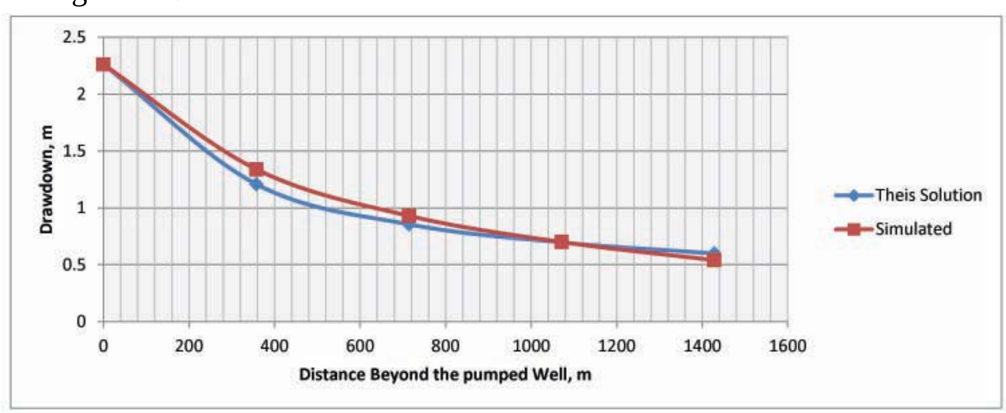


Fig.(6) Distance-Drawdown Comparison due to the Pumped Well at Node (22,33) of 500m^3/day, (5.78L/s) productivity

Fig.(6) shows an acceptable coincidence of distance-drawdown comparison between the numerical and Theis solutions of the pumping well at nodal point (22,33).

Safe Yield (SY) Evaluation

The process of the ground exploitation is carried out for all agricultural sectors to evaluate the safe yields.

Exploitation process may be developed in the model domain by assuming a certain small extraction discharge and then is increased considerably according to a following constraint:-

(Max Drawdown ≤ 30% of Min bearing layer thickness in all meshes within the domain) as outline by many worker in the aspect such as Al Assaf (1976) and Najah (2006).

Significantly the model has been run for a (9000days) to reach a steady state condition hoping to obtain the perennial SY.The technical methodology for obtaining SY is begun by setting an initial discharge and instantaneously observing the corresponding drawdown. The process is proceeded by increasing withdrawal rate until the maximum allowable drawdown has been obtained (30% total bearing layer thickness). A time-drawdown curves for all sectors are obtained and included in Fig.(7).

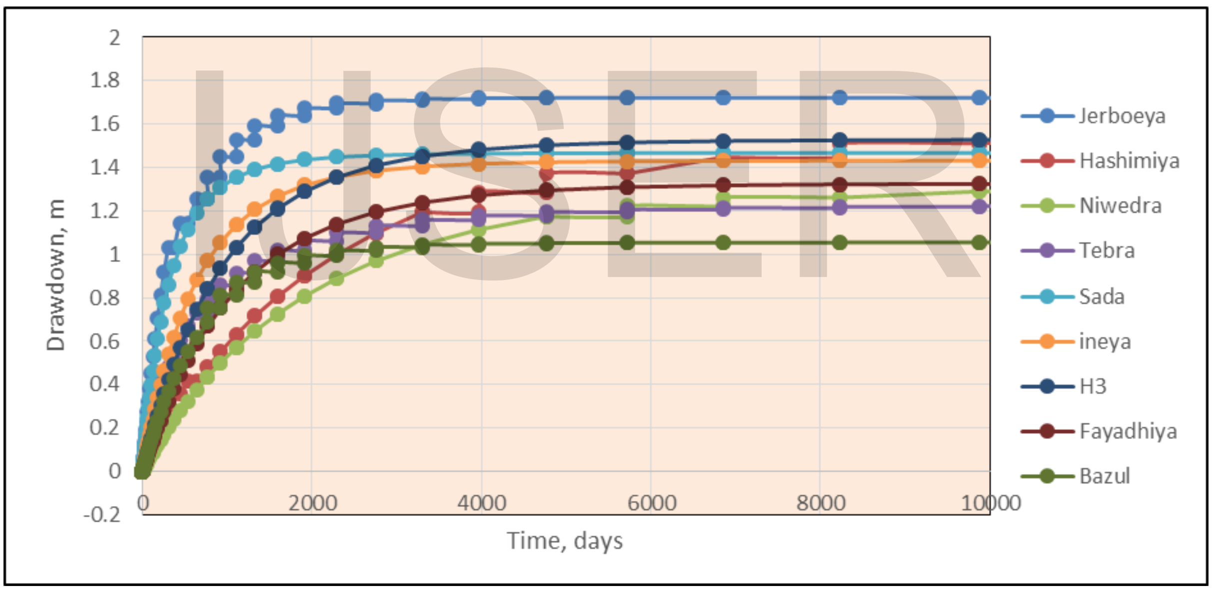


Fig. (7) Safe yield Exploitation

Whereas the final output safe yield values and the corresponding drawdowns forall sectors are listed in Table (3) and shown by contoursin Figs.(8&9).

Table (3) Maximum Safe Yield Values

No.	Agricultural Sectors	Safe Yield (m^3/day/mesh)	Safe Yield liters/Sec	Drawdown, (m)
1	Jerboeya	120.00	1.39	1.721
2	Hashimiya	28.40	0.33	1.668
3	Niwedra	17.90	0.21	1.332

4	Tebra	75.20	0.87	1.225
5	Sada	112.00	1.30	1.47
6	Zineyia	52.00	0.60	1.431
7	H3	37.90	0.44	1.528
8	Fayadhia	29.00	0.34	1.326
9	Bazul	36.30	0.42	1.054
10	Tyass	-	-	-

Comment: Tyass sector is excluded from Table (3) since the unconfined bearing layer was previously depleted by 118.65 m^3/day with a maximum drawdown of 4.25m

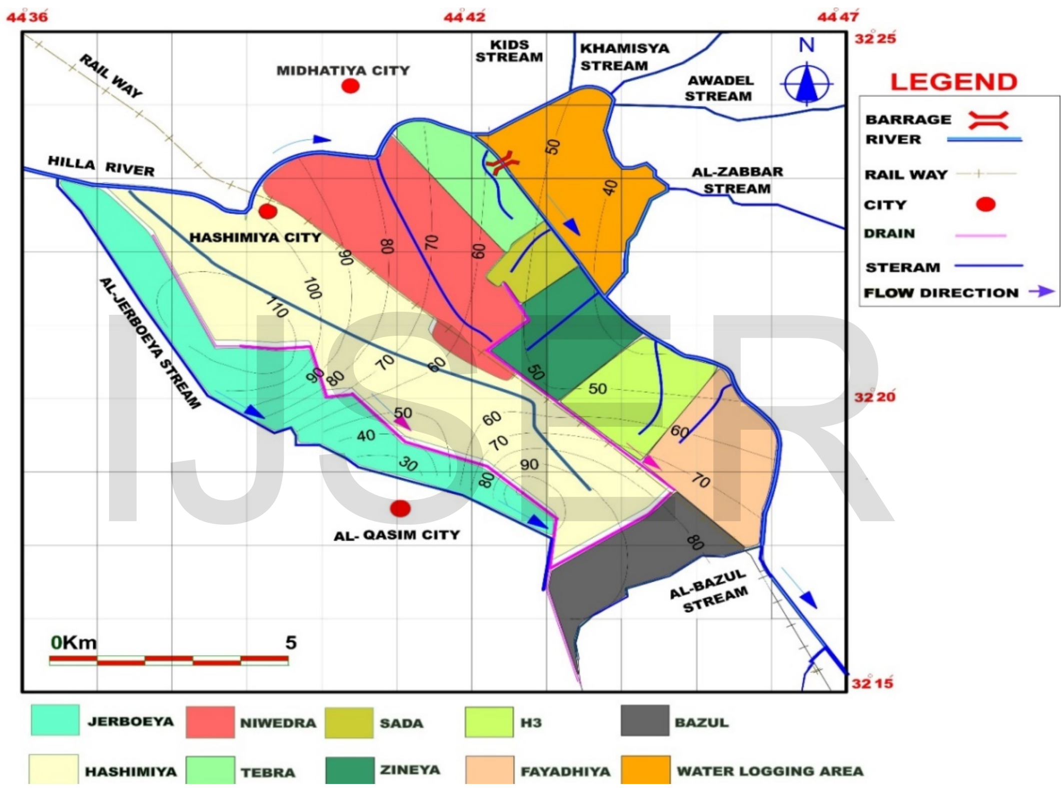


Fig.(8) Safe yield Contour Map, m^3/day/mesh

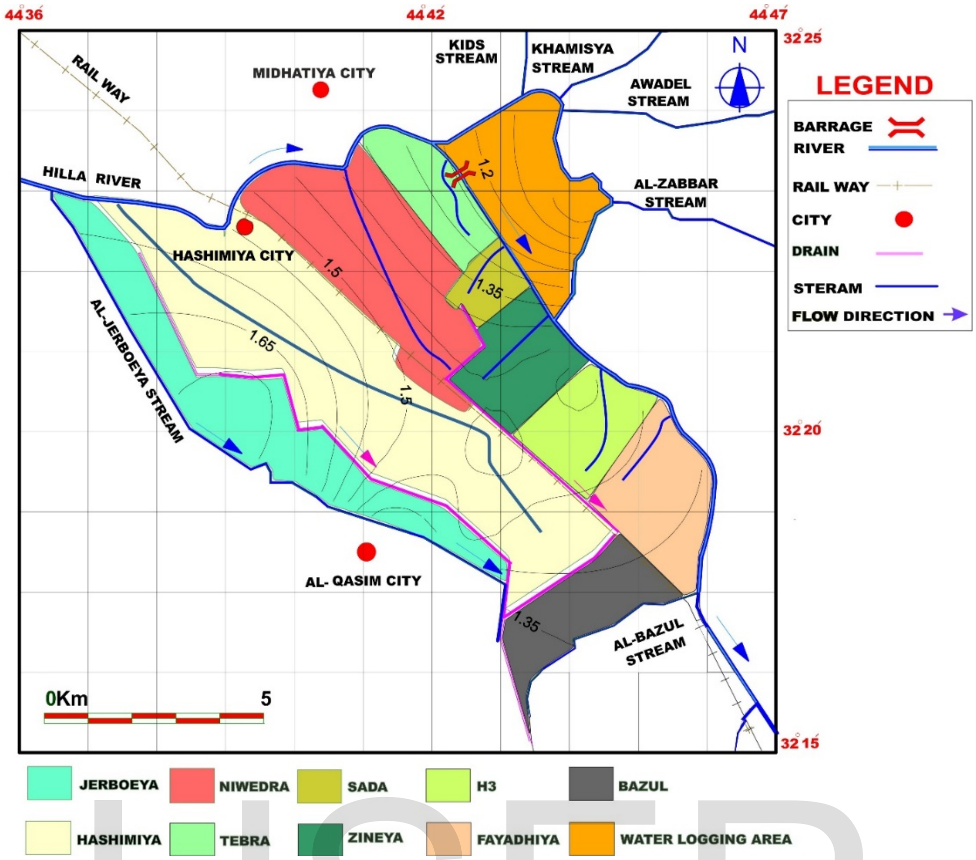


Fig.(9) Maximum Allowable Drawdown Contour Map

V) Water Demand Estimation

a- Evapotranspiration Estimation

Blaney- Criddle method, Israelsen and Hansen (1962) presented the basic rule for estimating the amount of Evapo-transpiration. The method easily takes into account the effects of meteorological components namely as: number of hourly sunshine, temperature, elevation above sea level, speed of wind, humidity, longitudes and latitudes.

The method is mathematically abbreviated in the following empirical forms:-

$U = k_c ET_o$..(1)

$ET_o = p\,(0.46T + 8.14)$..(2)

Whereas:-

ET_o: is a potentialevapotranspiration, in (mm/day)

P: is an average monthly day light percentage per year

T: is an average monthly temperature in (°c)

K_c: crop coefficient

U: monthly consumptive use, mm/day of each crop.

The monthly evapotranspiration values are estimated and listed in Table (3).

b- Crop Coefficients

Crop coefficient is severely affected by many factors such as crop type, stage of growth, soil moisture, health of plants, and cultural practices. Anyhow Table (4) contain the estimated evapotranspiration and crop coefficients (quoted from strategic study of water resources in Iraq, Italian Comp (2015) of local plants in the region.

Table (3) Crop Coefficients and Evapotranspiration

month	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
ET., mm	162	87	59	53	64	101	160	227	283	311	293	227
Barley	0.00	0.30	0.49	1.02	1.18	1.18	0.70	0.30	0.00	0.00	0.00	0.00
Berseem	0.40	0.47	0.79	1.11	1.18	1.19	1.17	1.15	0.00	0.00	0.00	0.00
Broad bean	0.00	0.50	0.50	0.51	0.92	1.19	1.15	0.00	0.00	0.00	0.00	0.00
Onion/Garlic	0.77	1.01	1.06	1.06	1.07	1.06	0.91	0.77	0.00	0.00	0.00	0.70
Wheat	0.00	0.71	0.89	1.11	1.18	1.20	0.84	0.32	0.00	0.00	0.00	0.00
Cotton	0.00	0.00	0.00	0.00	0.00	0.00	0.40	1.01	1.29	1.13	0.78	0.00
Cucumber	0.00	0.00	0.00	0.00	0.00	0.63	0.94	1.04	0.94	0.00	0.00	0.00
Eggplants	0.00	0.00	0.00	0.00	0.60	0.87	1.10	1.04	0.00	0.00	0.00	0.00
Maize (autumn)	0.95	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.73	1.11	1.27
Okra	0.00	0.00	0.00	0.00	0.00	0.40	0.44	0.74	1.07	1.11	1.06	0.98
Sunflower	0.00	0.00	0.00	0.00	0.00	0.37	0.87	1.21	1.04	0.45	0.00	0.00
Tomato	0.00	0.00	0.00	0.00	0.00	0.61	0.96	1.20	1.02	0.00	0.00	0.00
Watermelon	0.00	0.00	0.00	0.00	0.00	0.41	0.83	1.03	0.90	0.00	0.00	0.00
Alfalfa	0.77	1.02	0.83	0.51	0.53	0.80	0.99	1.05	0.94	0.99	0.97	1.06
Date palm	0.90	0.90	0.90	0.91	1.00	1.04	1.04	1.05	1.10	1.11	1.09	0.90
Grape	0.52	0.44	0.42	0.32	0.34	0.34	0.71	0.91	0.95	0.96	0.94	0.80

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The estimation of WD is achieved separately for each sector. The results in m^3/day/meshare listed in Table (4).

Table (4) Estimated WD of Hashyimia, m^3/day/mesh

Months	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.

WD	184	124	92	92	136	303	554	773	695	535	463	344

Water Requirements Estimation

Water requirement (WR) comprises two constituents namely as; water demand (WD) and the urban water, industrial and domestic purposes (WU). Accordingly:-

$$WR = WD + WU \qquad \text{..................................(3)}$$

It is worth to mention thatHashyimia Region is characterized by high population intensity. The final statistical counting of Al Hashyimia population in (2015) is about 80 000 persons. The current andmanaged urban water needs of all sectors are included in Table (5). The values represents the actual drinking water production of the existing pumping treatment plants. Whereas column No. 4 shows the estimated drinking water production basing upon the limitations (daily human needs of 150 Liters/day) of World Health Organization (2016).

Table (5) Urban Water Needs (m^3/day)

sector	Population No.	Design Drinking Water Production	Suggested Drinking Water Allocation
Jerboeya	5882	2400	882
Hashimiya	35294	14400	5297
Niwedra	8823	3600	1323
Tebra	3442	1200	516
Sada	2440	1200	366
Zineya	5882	2400	882
H3	7823	3600	1173
Fayadhiya	5882	2400	882
Bazul	2941	1200	441
Tyass	1591	240	238
Total	80000	32640	12000

Strategic Aquatic Wealth Management of Hashyimia Region

Since surface and subsurface water management nowadays is extremely affected by political and terroristic circumstances in Iraq, therefore the current study is subjectedto many constraints and assumptions corresponding to administration instructions and limitations, they are;

I) Administration Constraints:-

1- The current SW releases should not be exceeded.

2- The population are obligated to local plant crops diversity relating the environment meteorologyas presented in Table (3).

3- SW releases were not set for Tyass sector in the past.

4- Full investment of the area including the bore and uncultivated areas

II) Strategic Assumptions

The current integrated water management study depends thoroughly on the following priorities:

1- Full investment of rainfall since it is inventible water source.

2- Full or partial investment of groundwater exploitation provided that the safe yield should not be exceeded.

3- Preferred that agricultural activities in Tyass sectorsto be thoroughly depended upon rainfall and groundwater exploitation only.

4- Minimization of SW releases.

Conjunctive Use Model Structure

The conjunctive use model is applied for sectors by lunching the necessary meteorological and hydrologic components such as rainfall, crop coefficient, no of meshes per each sector, mesh dimensions, and evapotranspiration whereas the safe yield is obtained from the GW model as an output data. The conjunctive use model then estimates the necessary integrated surface water under the light of the previous assumptions and limitations. Briefly, the flowchart of Fig. (10) illustrates the algorithm methodology of the required SW releases.

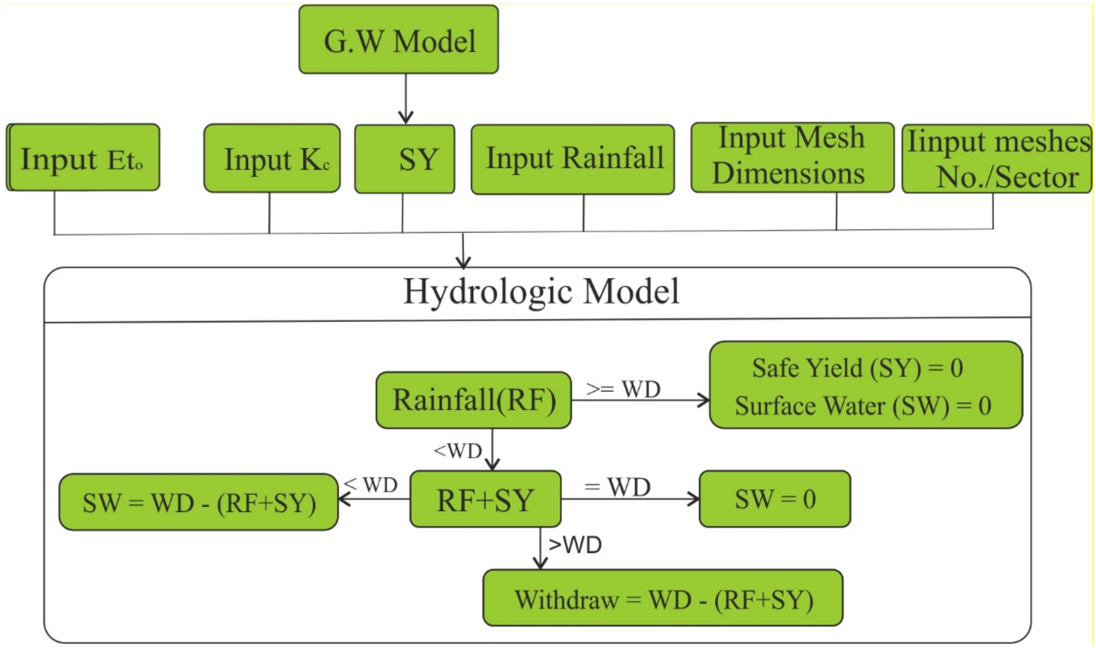

Fig.(10) Conjunctive Use Model

Integratedwater Management

The aquatic management of the region is simply issued to satisfy the WRby critical complementary SW sources and alsocomprising the bore areas within the study domain.

However, the water scarcity in WD of all sectors is satisfied depending upon the available releases of local streams and distributaries as included in Table (6).

Table (6) presents a typical data necessary for an algorithmof a complimentary SW allocations used in the conjunctive use model.

Table (6)WD, RF and SY, m^3/day/mesh

		Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.
WD		184	124	92	92	136	303	554	773	695	535	463	344
RF		18.7	86.6	114.7	93.5	59.5	56.5	52.3	12.7	0	0	0	0.85
Jerboeyia	SY	120											
Hashyimia		28.4											
Niwedra		17.9											
Tebra		75.2											
Sada		112											
Zineyia		52											
H3		37.9											

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Fayadhiya		29
Bazul		36.3
Tyass		118

SY :, SSW: in m^3/day/mesh, RF: Rainfall

Table (7) Complementary SW Releases, m^3/day/mesh

	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.
Jerboeyia	45.3	0	0	0	0	126.5	381.7	640.3	575	415	343	223.15
Hashyimia	136.9	9	0	0	48.1	218.1	473.3	731.9	666.6	506.6	434.6	314.75
Niwedra	147.4	19.5	0	0	58.6	228.6	483.8	742.4	677.1	517.1	445.1	325.25
Tebra	90.1	0	0	0	1.3	171.3	426.5	685.1	619.8	459.8	387.8	267.95
Sada	53.3	0	0	0	0	134.5	389.7	648.3	583	423	351	231.15
Zineyia	113.3	0	0	0	24.5	194.5	449.7	708.3	643	483	411	291.15
H3	127.4	0	0	0	38.6	208.6	463.8	722.4	657.1	497.1	425.1	305.25
Fayadhiya	136.3	8.4	0	0	47.5	217.5	472.7	731.3	666	506	434	314.15
Bazul	129	1.1	0	0	40.2	210.2	465.4	724	658.7	498.7	426.7	306.85
Tyass	47.3	0	0	0	0	128.5	383.7	642.3	577	417	345	225.15

Table (8) Optimum SW Releases, m^3/sec

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Jerboeya	0.05	1.02083E-05	1.02083E-05	1.02083E-05	1.02083E-05	0.156598	0.472496	0.792604	0.711772	0.513717	0.424592	0.276236
Hashimiya	0.397549	0.026196725	6.13079E-05	6.13079E-05	0.13974059	0.63341	1.374494	2.125451	1.935825	1.471195	1.262112	0.914075
Niwedra	0.182646	0.02417816	1.53125E-05	1.53125E-05	0.072627766	0.283278	0.599502	0.919938	0.839024	0.640764	0.551548	0.403039
Tebra	0.033548	5.97222E-06	5.97222E-06	5.97222E-06	0.000490012	0.063787	0.158808	0.255095	0.230781	0.171207	0.144399	0.099774

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Sada	0.009537	4.23611E-06	4.23611E-06	4.23611E-06	4.23611E-06	0.024071	0.069735	0.116008	0.104323	0.075694	0.06281	0.041365
Zineya	0.05	1.02083E-05	1.02083E-05	1.02083E-05	0.010672245	0.084654	0.195713	0.308252	0.279834	0.210205	0.178871	0.126714
H3	0.066797	0.000135	0.000013	0.000013	0.02	0.1	0.24	0.37	0.34	0.26	0.22	0.16
Fayadhiya	0.082727	0.005	0.00001	0.00001	0.03	0.13	0.28	0.44	0.40	0.30	0.26	0.19
Bazul	0.075847	0.000651863	5.10417E-06	5.10417E-06	0.023641215	0.123595	0.273643	0.42569	0.387296	0.293222	0.250889	0.180422
Tyass	0.036039	2.75463E-06	2.75463E-06	2.75463E-06	2.75463E-06	0.09791	0.292352	0.489385	0.439631	0.317724	0.262866	0.171549
Total	0.99	0.056	0.00014	0.00014	0.29	1.7	3.96	6.25	5.68	4.26	3.62	2.564
Total Average	2.45											

Results Discussion

I- In most months, the summation of safe yield and rainfall is no adequate to satisfy the WD therefore it is complemented by surface water releases as shown in Table (7).

II- Consulting Table (6) one observes that sometime a summation of the SY andrainfall exceeds the WD as on November to February.

III- It is encountered in many months that a summation of rainfall and safe yield is exceeded the WD, correspondingly the groundwater extraction (withdrawal rate) is reduced to be less that the safe yield provided that the extracting quantity satisfies the WD.

The optimum SW releases and GW exploitations are indicated inTable (8) and Table (9) respectively. Whereas they are representedgraphically in Figs. (11& 12)respectively.

Table (9) Optimum Withdrawal Rate, L/sec

	OCT	NOV	DEC	JAN	FEB	MAR to SEP
Jerboeya	149	46	0	0	95	149
Hashimiya	82	82			82	82

Niwedra	22	22			22	22
Tebra	28	13			28	28
Sada	20	7			13	20
Zineya	23	16			23	23
H3	20	20			20	20
Fayadhiya	18	18			18	18
Bazul	21	21			15	21
Tyass	90	28			58	90

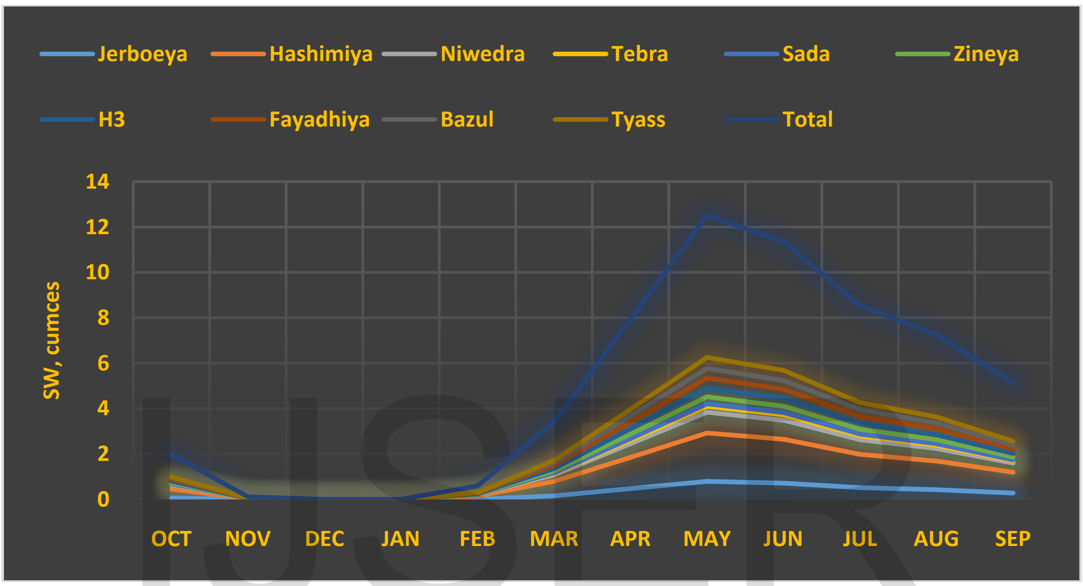

Fig.(11) Optimum Monthly SW Releases

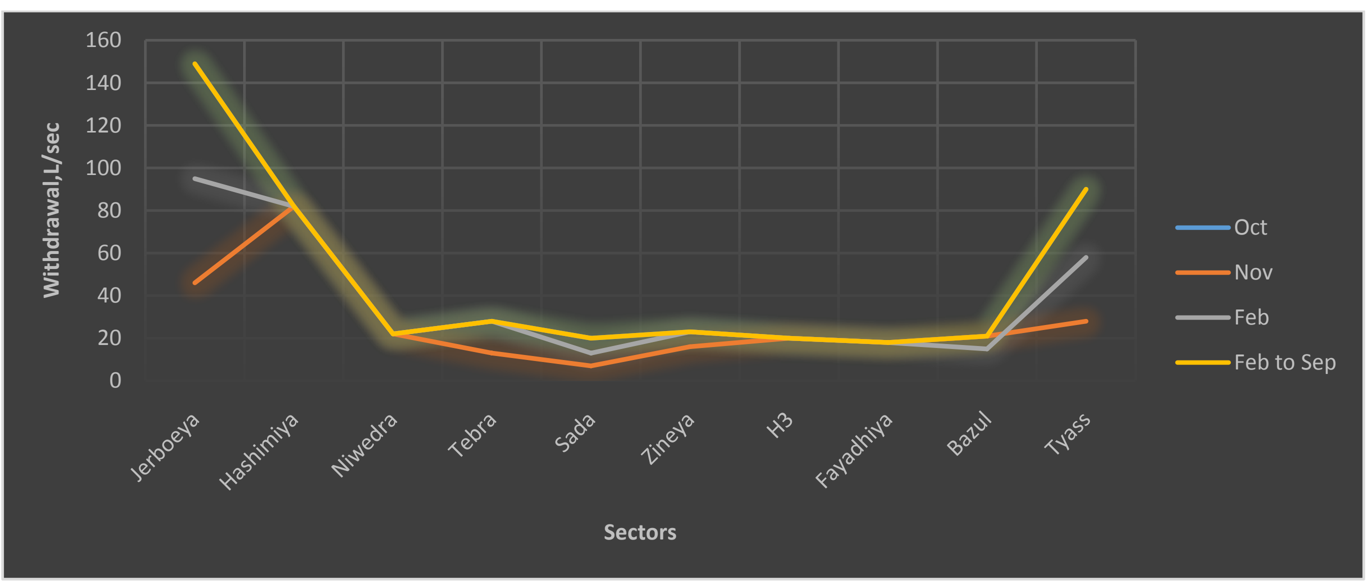

Fig.(12) Optimum withdrawal Rates

Discussion of Strategic Management

Operating scheduling of Table (8) reveals the followings:

1- The WD for agricultural purposes and the urban water requirements UWR are satisfied by a rainfall, Withdrawal rates and even occasionally by the complementary SW releases.

2- Although the total average SW releases of 2.45Table (8) cumces are less than the actual releases of 3.76 cumcesshown in Table (1), all bore lands are cultivated which constitutes52% of the whole area. Table (9) shows the cultivated bore lands of the true optimum operating policy. For instance; the bore lands percentage 54%, 81% and 45% forJerboeyia, Hashyimia and Niwedra sectors respectively whereas the total bore area percentage is 52%. Fig. (12) shows the average total SW releases

Table (9) Bore Area Percentage

Sector	No. of Total meshes	No. of Actual Current Cultivated Meshes	Bore Land Percentage
Jerboeyia	106.95	49.31	54
Hashyimia	250.9	46.66	81
Niwedra	107.06	58.89	45
Tebra	32.17	31.79	1.2
Sada	15.46	14.25	8
Zineyia	37.6	35.38	6
H3	45.3	41.92	7.5
Fayadhiya	52.44	52.01	1
Bazul	50.8	34.16	33
Tyass	65.83	0	90
Total	764.51	364.37	52

Based on Table (1)`

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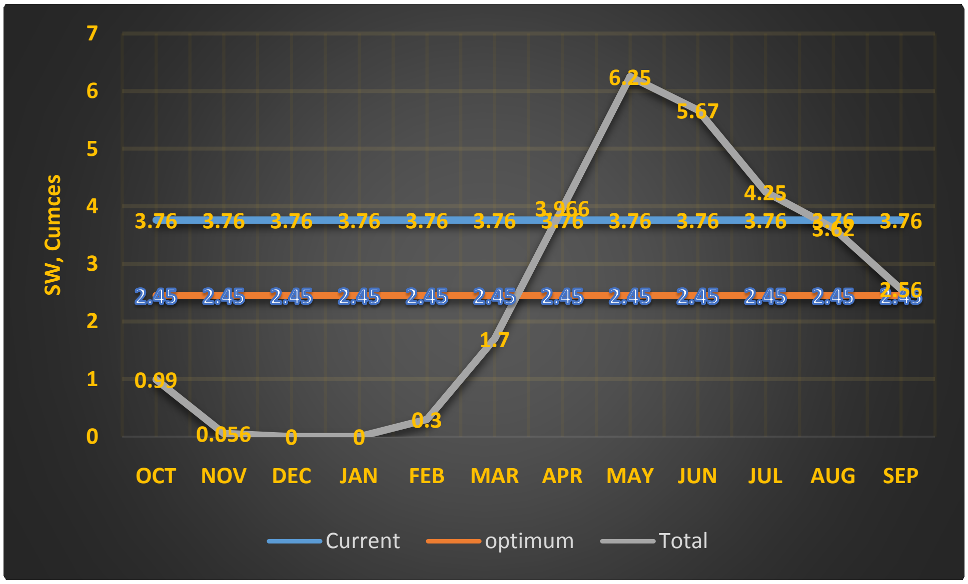

Fig.(12) Current,Optimumand Total Releases

3- The referenced withdrawal rates of Table (8) are evitable quantities and frequently equal or less than the safe yields of the bearing layer. This is occasionally occurred since the rainfall amount in addition to thesafe yield extraction exceeds the total WR in many sectors; for instance the safe yield which is obtained from the mathematical model is 120m^3/day in Jerboeyia sector is reduced to 149, 46, 0, 0, 95 L/sec on Oct, Nov, Dec, Jan and Feb respectively.

4- The current GW exploitationof Hashyimia Region is an active refreshment process for existing old saline unconfined bearing layer. This permanent renewing process of groundwater storage may no longer reduce both groundwater and soil salinity in near future.

5- The withdrawal rates listed in Table (9) in liter/sec are a maximum rates of GW exploitation and should not be exceeded to avoid an aquifer depletion and environmental harmful consequences.

6- Theintegral surface and subsurface management should be constrained to a systematic operating scheduling, pumping well productivities and even the wells number in a specified sector. In addition specifying an agented forces and administration control for protective purposes.

A Feasible Study

The feasibility of the current management pours in several coordinates among them are:-

I- **Total SW Losses:** Table(8) presents that the current average total SW releases of2.45 cumces are needed to cultivate 100%% of Hashyimia Region *including Tyass sector*whereas the actualSW releases decided by the *directorate of water resources* are 3.76 cumces without Tyass sector to cultivate 48% of Hashyimia region. That means under the light of the current management the real releases needed to vegetate 48% of Hashyimia Region = 0.48 ∗ 2.45cumces = 1.176cumces, therefore:-

Total SW Losses = 3.76 – 1.176 = 2.584cumces = 81.5mcm/ year.

These amounts of surface water are truly going continuously to fill drains and penetrating to the unconfinedlayer causing a groundwater rise*(although Tyass sector allocation was ignored)* which accompanied with an extreme bad effects on the environments and on the hydrology of the region, among these effects; are the soil water logging, soil salinity corresponding to evaporation process, discrepancy in a seasonal plant crop productivity which reflecting on the continuous loses in the agricultural economy, full capacity operation of irrigation and drainage networks, and the contaminant transport from the landfill area (at a time the Iraq country suffer a sharp scarcity in different water resources).

II- Total SW Saving:

Briefly, the current management study reveals that the total saved SW is:-

3.76 cumces- 2.45 cumces = 1.31cumces = 41.31216mcm/year, if the scenario of general directorate of water resources is depended with full use of both the rainfall and GW exploitation.

III- Increasing of Agricultural Areas:

Although the optimum average total releases of 2.45 cumces shown in Table (8) is less than the real releases of *water resources directorate* by 1.31 cumces, it allows the populations increase the vegetated areas up to100%.

Conclusions:

The following points are concluded:

1- Corresponding to the current optimum and integrated water requirements management encourages the opposite population migration from Tyass sectors and other lands.

2- Although the total average SW releases of the Directorate of water resources is 3.76 cumces a 52% of the total area is left uncultivated.

3- Although the current total average SWR2.45 cumces < than the true releases by 35%, all the areas of the region are cultivated.

4- The total SW losses are 81.5mcm/ year due to the directorate of water resources releases.

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