HYDROGEOLOGY OF NIKSAR BASIN, TOKAT, TURKEY

DR. SYED MOBASHER AFTAB, PG

BALOCHISTAN UNIVERSITY OF INFORMATION TECHNOLOGY, ENGINEERING & MANAGEMENT SCIENCES, QUETTA, PAKISTAN

GEOLOGICAL SOCIETY OF AMERICA, ANNUAL MEETING 2017, SEATTLE, WA, USA
SESSION NO. 121; RECENT ADVANCES IN HYDROGEOLOGY, 23 OCTOBER 2017

STUDY AREA

TURKEY

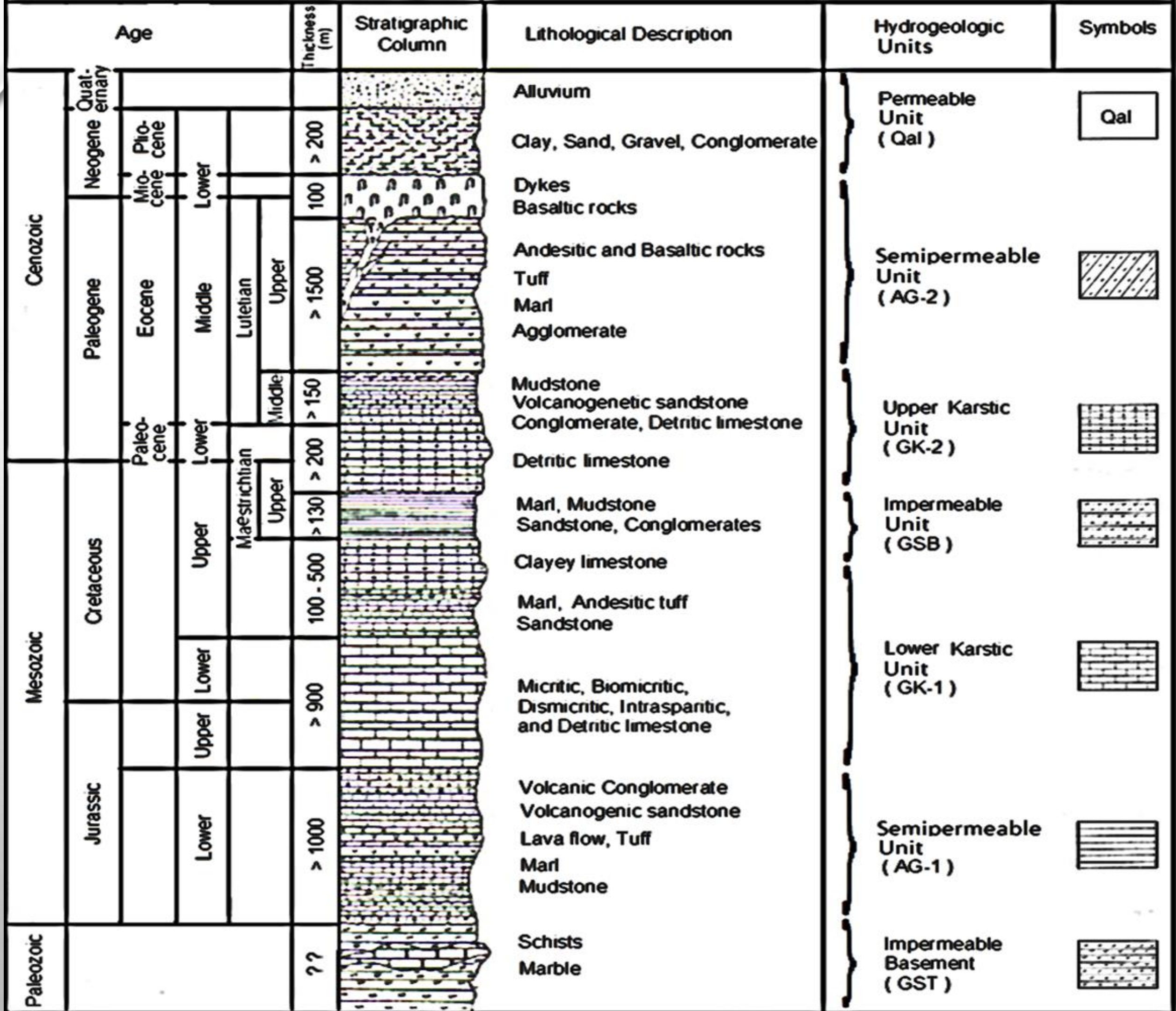
OBJECTIVES

- To study the Geology and Hydrogeology of all Basinal Formations from Paleozoic to Quaternary
- To estimate the recharge and discharge areas and quantities of hydrogeological units
- To evaluate soil water budget by utilizing climatic data
- To monitor the discharge of major karstic springs and estimate storage capacities
- To prepare a physical hydrogeological model of the Niksar Valley aquifer
- To calculate the groundwater budget of the valley - fill aquifer

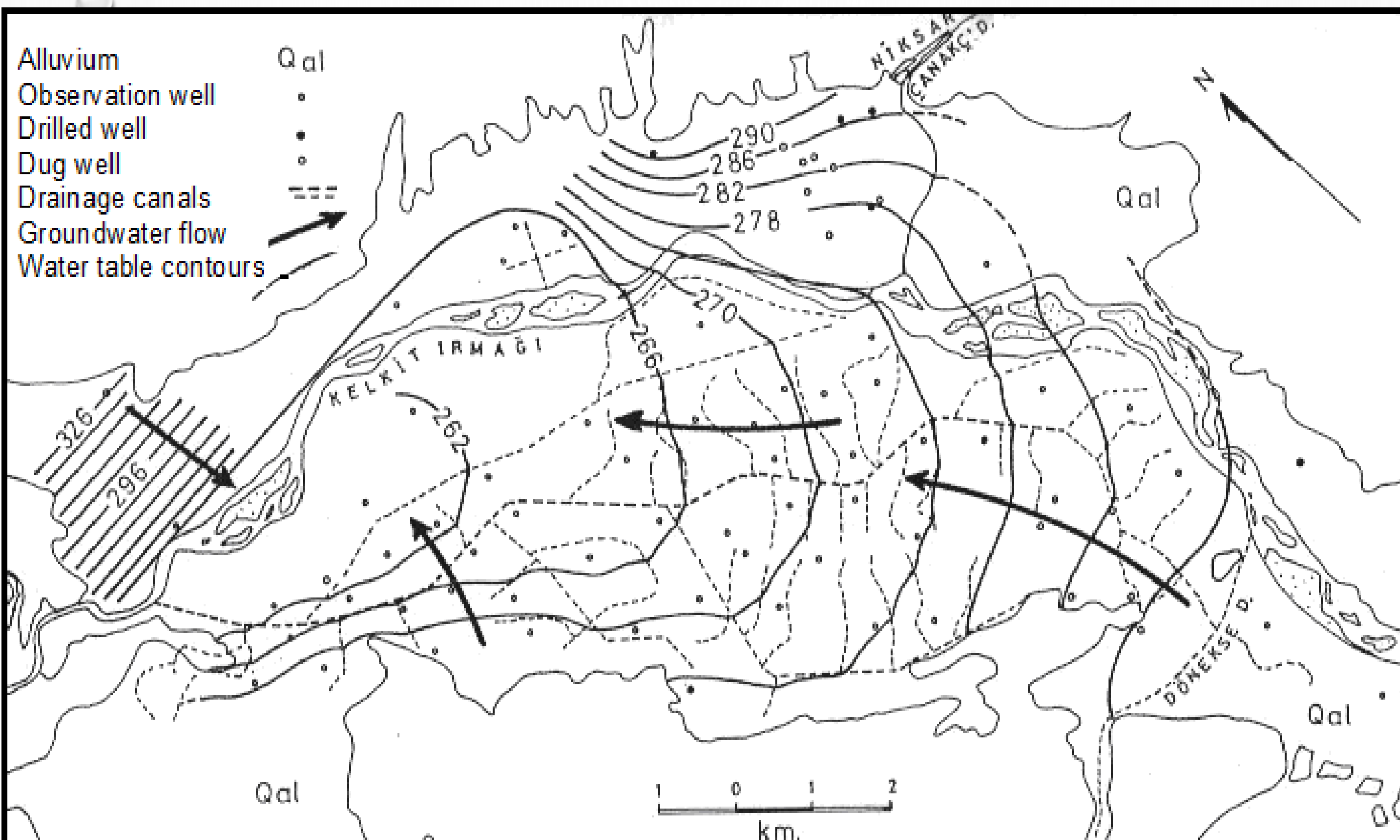
HYDROGEOLOGY

- **Lithological units exposed in northern and southern part of Kelkit River grouped as Pontid and Anatolit**
- **These groups are composed of eleven to four formations and ranged from Paleozoic to Quaternary**
- **Metamorphic rocks form basement in both groups**
- **Formations of similar hydrogeological characteristics grouped as permeable, semi-permeable & impermeable**
- **Micritic limestone of U Jurassic - L Cretaceous and detrital limestone of U Cretaceous - L Paleocene form karstic aquifers**
- **Presence of clay lenses in Pliocene and Quaternary sediments created suitable hydrodynamic conditions for the formation of a confined aquifer.**

AGE, THICKNESS, STRATIGRAPHY AND HYDROGEOLOGIC UNITS



HYDROGEOLOGICAL MAP



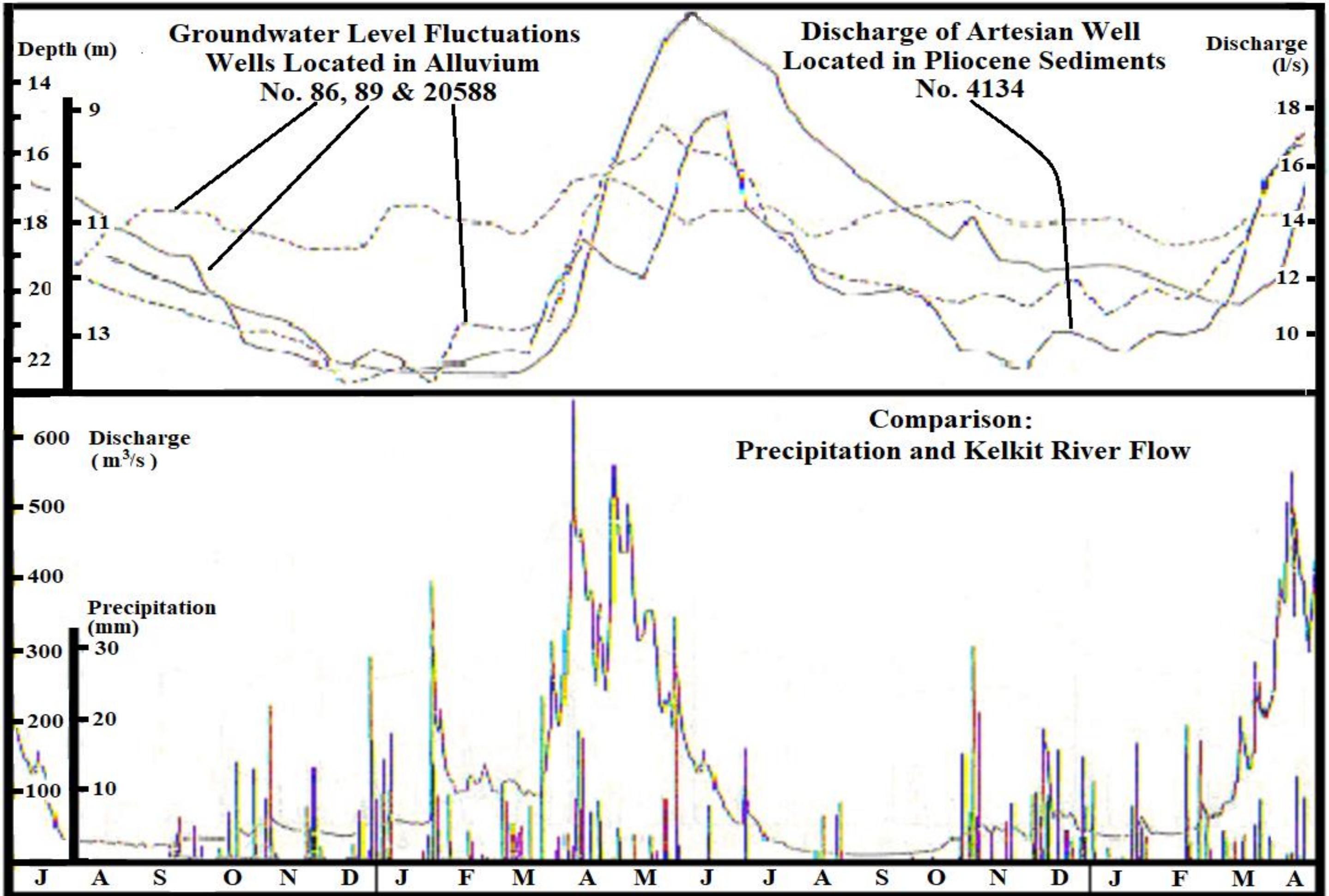
SOIL WATER BUDGET

Budget Elements	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
Monthly Temp. C^0	14.2	6.7	5.4	6.1	7.6	5.3	11.5	18.7	20.4	23.5	21.3	19.1	-
Thermal Index (i)	4.9	1.6	1.1	1.4	1.9	1.1	3.5	7.4	8.4	10.4	9.0	7.6	58.2
Etp (mm)	55.8	19.5	14.4	17.1	23.3	14.1	41.6	82.1	92.7	113	99.0	84.6	656.7
Latitude Correction Factor (40^0-35^0)	1.0	0.8	0.8	0.8	0.8	1.0	1.1	1.2	1.3	1.3	1.2	1.0	-
Etpc (mm)	53.6	16.9	11.7	14.4	19.3	14.5	46.1	102	115.9	144	116	88.0	741.9
Precipitation (mm)	26.5	66.7	78.4	77.9	32.5	73.5	87.0	27.8	41.6	15.6	23.4	0.0	550.9
Etr (mm)	26.5	16.2	11.7	14.4	19.3	14.5	46.1	102	67.6	15.6	23.4	0.0	357.1
Utilization (mm)	0.0	50.5	100	100	100	100	100	26.0	0.0	0.0	0.0	0.0	-
Surplus (mm)	0.0	0.0	17.2	63.5	13.2	59.0	40.9	0.0	0.0	0.0	0.0	0.0	193.9
Deficit (mm)	27.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	48.3	128.0	92.8	88.0	384.2
Runoff (mm)	0.0	0.0	8.6	36.1	24.6	41.8	41.4	0.0	0.0	0.0	0.0	0.0	152.5

MONITORING WELLS

Monitoring Wells	No.	Hydrogeologic Unit	Depth (m)	Discharge (l/s)
Dug Wells	13	Alluvium	5 - 23	-
Old Piezometers	48	Alluvium	1.2 - 3.4	-
New Piezometers	15	Alluvium	3 - 4.5	-
Drilled Wells	4	Alluvium	18 - 110	5 - 10
	2	Limestone	25 - 85	5
	3	Pliocene	118 - 200	4 - 30
Artesian Wells	10	Pliocene	20 - 240	30 - 63

CORRELATION; PRECIPITATION, RIVER FLOW, ARTESIAN WELL DISCHARGE & GROUNDWATER FLUCTUATIONS



WELL PUMPING TEST ANALYSIS

Well No.	Lithological Unit	Thies		Jacob		Recovery	
		T (m^2/s)	K (m/s)	T (m^2/s)	K (m/s)	T (m^2/s)	K (m/s)
27291	Alluvium	$1.4x10^{-3}$	$1.0x10^{-4}$	$1.1x10^{-3}$	$7.9x10^{-5}$	-	-
20588	Alluvium	$3.2x10^{-2}$	$2.1x10^{-3}$	$7.2x10^{-2}$	$4.8x10^{-3}$	-	-
20159	Alluvium	$1.35x10^{-3}$	$7.5x10^{-5}$	$4.8x10^{-3}$	$2.6x10^{-4}$	-	-
20159	Alluvium	$1.34x10^{-3}$	$7.4x10^{-5}$	$2.3x10^{-3}$	$1.3x10^{-4}$	$7.9x10^{-3}$	$4.4x10^{-4}$
20158	Alluvium	$5.3x10^{-3}$	$4.4x10^{-4}$	$5.9x10^{-3}$	$4.9x10^{-4}$	-	-
27267	Pliocene	$5.2x10^{-5}$	$3.0x10^{-6}$	$5.4x10^{-5}$	$3.2x10^{-6}$	$9.0x10^{-5}$	$5.3x10^{-6}$
4985	Pliocene	$2.6x10^{-4}$	$5.3x10^{-6}$	$5.1x10^{-4}$	$1.0x10^{-5}$	-	-
4136	Pliocene	$1.4x10^{-3}$	$1.3x10^{-5}$	$4.3x10^{-3}$	$4.1x10^{-5}$	-	-
4684	Limestone	$1.74x10^{-3}$	-	-	-	-	-
SK-2	Limestone	-	$5.2x10^{-5}$	-	-	-	-
SK-3	Limestone	-	$5.2x10^{-5}$	-	-	-	-

SLUG TEST ANALYSIS

Well No.	T (m^2/s)	K (m/s)	S
64	$1.1x10^{-5}$	$9.17x10^{-6}$	$5.6x10^{-4}$
65	$5.2x10^{-6}$	$3.4x10^{-6}$	$5.6x10^{-3}$
66	$9.0x10^{-5}$	$5.2x10^{-5}$	$2.5x10^{-3}$
67	$4.0x10^{-6}$	$3.5x10^{-6}$	$2.5x10^{-5}$
68	$6.9x10^{-6}$	$3.1x10^{-6}$	$2.5x10^{-2}$
69	$3.0x10^{-5}$	$1.1x10^{-5}$	$3.6x10^{-4}$
70	$3.1x10^{-5}$	$2.1x10^{-5}$	$2.2x10^{-3}$
71	$1.3x10^{-6}$	$7.8x10^{-7}$	$5.6x10^{-3}$
72	$3.0x10^{-5}$	$1.5x10^{-5}$	$2.5x10^{-3}$
73	$3.3x10^{-6}$	$2.1x10^{-6}$	$3.6x10^{-3}$
74	$2.4x10^{-5}$	$1.7x10^{-5}$	$2.5x10^{-4}$
75	$3.2x10^{-5}$	$1.9x10^{-5}$	$2.5x10^{-2}$
76	$3.9x10^{-5}$	$1.4x10^{-5}$	$3.6x10^{-2}$

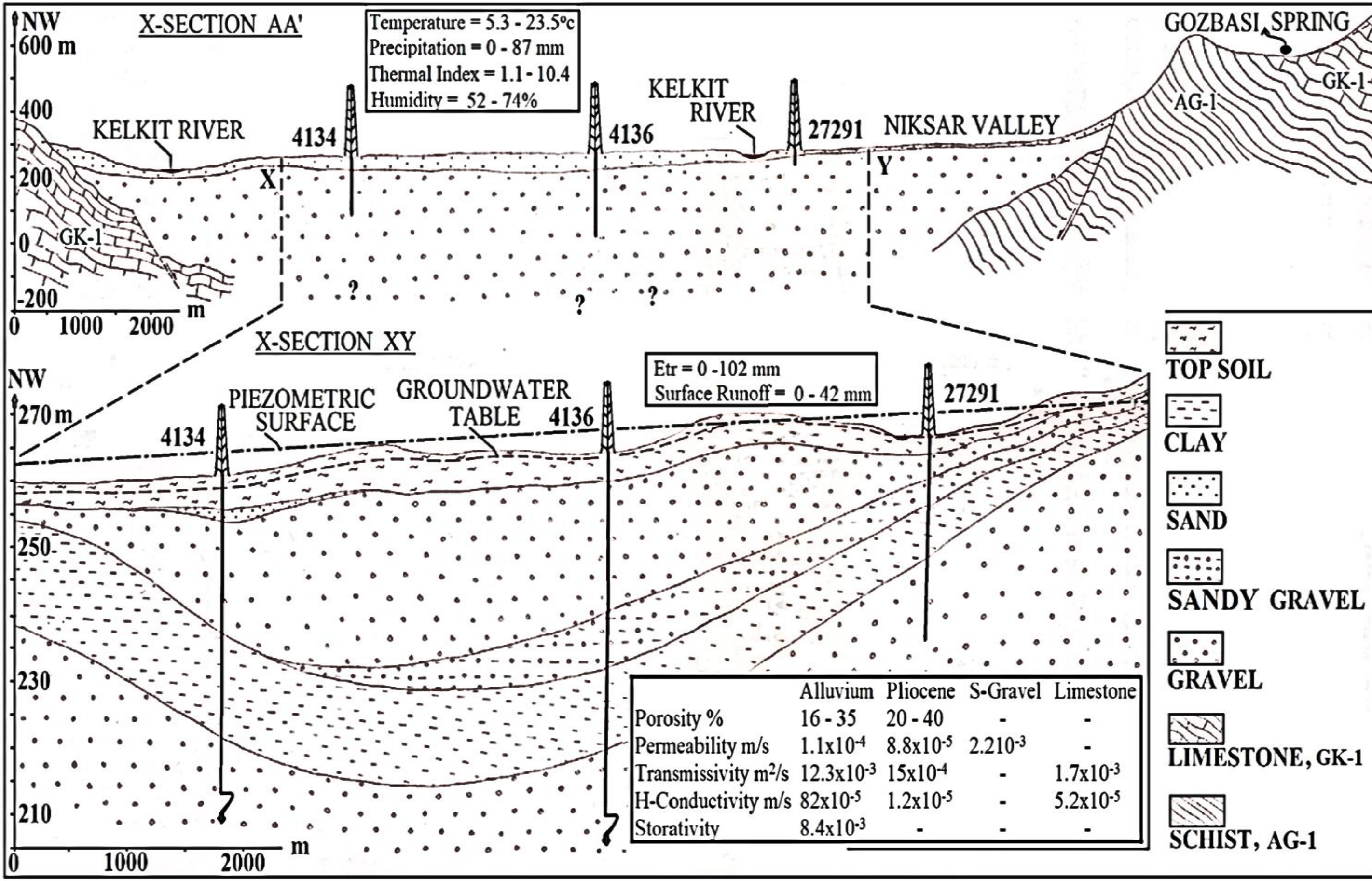
RECHARGE AND DISCHARGE OF HYDROGEOLOGICAL UNITS

Hydrogeological Units	Area (Km^2)	Recharge ($10^9 m^3$)	Discharge ($10^9 m^3$)
Permeable (Qal)	141	2.660	2.630
Semipermeable (AG-3)	120	0.005	0.003
Semipermeable (AG-2)	134	0.006	0.002
Upper - Karstic (GK-2)	16	0.006	0.009
Impermeable (GSB)	15	0.001	0.001
Lower - Karstic (GK-1)	108	0.043	0.036
Semipermeable (AG-1)	61	0.002	0.001
Impermeable Basement (GST)	59	0.001	0.001
Total	655	2.724	2.683

HYDROGEOLOGICAL MODEL

- **A physical model of Niksar Valley prepared with realistic field conditions, model signifies hydroclimatic and hydrogeological data.**
- **Input parameters of model are temperature, precipitation, humidity, thermal index and wind direction with associated groundwater recharge.**
- **Land cover parameters are depth of topsoil, porosity, permeability and residual water content.**
- **Model signify topography, hydraulic-head conditions, storability, transmissivity & hydraulic conductivity**
- **The actual evapotranspiration, surface runoff and groundwater discharge are resultant parameters.**

HYDROGEOLOGICAL MODEL

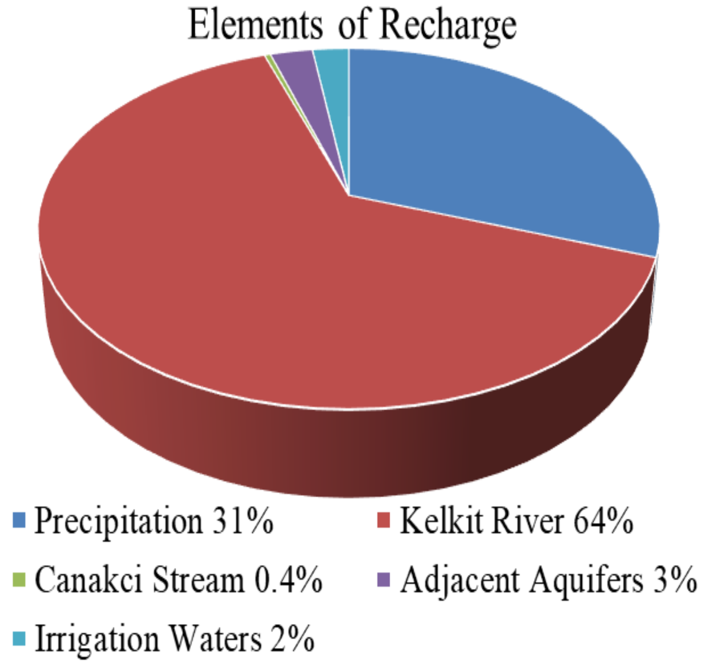


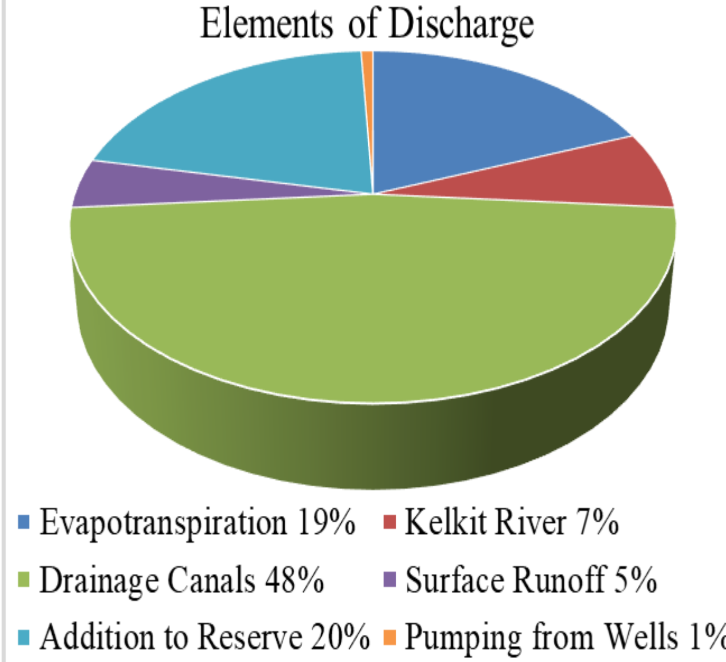
	Alluvium	Pliocene	S-Gravel	Limestone
Porosity %	16 - 35	20 - 40	-	-
Permeability m/s	1.1x10^{-4}	8.8x10^{-5}	2.210^{-3}	-
Transmissivity m^2/s	12.3x10^{-3}	15x10^{-4}	-	1.7x10^{-3}
H-Conductivity m/s	82x10^{-5}	1.2x10^{-5}	-	5.2x10^{-5}
Storativity	8.4x10^{-3}	-	-	-

GROUNDWATER BUDGET OF QUATERNARY AQUIFER

Sources of Recharge	Volume $10^9 m^3$	Sources of Discharge	Volume $10^9 m^3$
Precipitation	0.81	Evapotranspiration	0.50
Kelkit River	1.71	Kelkit River	0.19
Canakci Stream	0.01	Surface Runoff	0.12
Adjacent Aquifers	0.07	Addition to Reserve	0.55
Irrigation Waters	0.06	Drainage Canals	1.25
-	-	Pumping from Wells	0.02
Total	2.66	Total	2.63

GROUNDWATER BUDGET ELEMENTS OF QUATERNARY AQUIFER





CONCLUSIONS

- **Physical Hydrogeologic Model may translate into GIS based three-dimensional numerical GW flow model**
- **Discharge of the major karstic spring ranges from 55 - 430 l/s and storage capacity of $0.24x10^6m^3$ to $2.24x10^6m^3$**
- **During the study period the exposed geological formations recharged through precipitation $2.72x10^9m^3$ and discharged $2.68x10^9m^3$ of groundwater**
- **Groundwater budget of valley-fill aquifer represents that aquifer received $2.66x10^9m^3$ and discharged $2.63x0^9m^3$ of groundwater**

REFERENCES

[1] De Martonne, E., 1942. Nouvelle carte mondiale de l'indice d'aridité. Annales de Géographie 51, (French), pp. 242–250

[2] Thornthwaite, C Wr., 1948. A New and Improved Classification of Climates. Geogr. Rev. 38-1

[3] Turc, L., 1961. Water requirements assessment of irrigation, potential evapotranspiration: Simplified and updated climatic formula. Annales Agronomiques, pp. 12, 13-49

[4] Seymen, I., 1975. 'The Tectonic Features of the North Anatolian Fault Zone in Kelkit Valley", Ph. D. Thesis, ITU Mineral Faculty, Istanbul, (Turkish). pp. 192

[5] Schoeller, H., 1962. Les eaus souterraines. Masson et Cie, Paris, France, pp. 642

[6] E. I. E., 1968-1988.The daily discharge rates data of Kelkit River.

[7] Blumenthal, M M., 1950. Orta ve Asagi Yesilirmak Bolgelerinin (Tokat, Amasya, Havza, Erbaa, Niksar) Jeolojisi Hakinda. M.T.A. Seri D, No.4, (Turkish) Ankara, Turkey

[8] Atkinson, T. C., Hydrol, J., 1977. Diffuse Flow and Conduit Flow in Limestone Terrain in Mendip Hills, Somerset, Great Britain, 35, pp. 93-100.

[9] Gunn, J., G. Giinay & A. I. Johnson, 1985. A Conceptual Model for Conduit Flow Dominated Karst Aquifers", in Karst Water Resources. Proc. Ankara Symp. IAHS, Publ. No. 161, pp. 587-596

[10] Castany G., (1963). Traité pratique des eaux souterraines. Dunod, Paris, 658 pp

[11] Schoeller, H., 1967. Methods Pour Obtenir Le Bilan Des Eaux Souterrainex. Extrait de "Eaux Souterraines" Assemblee Generate de Berne, Louvain, Belgium

[12] Theis, C.V., 1935. The relation between the lowering of the piezometric surface and the rate and duration of discharge of a well using groundwater storage, Am. Geophys. Union Trans., vol. 16, pp. 519-524.

[13] Jacob, C.E., 1947. Drawdown test to determine effective radius of artesian well, Trans. Amer. Soc. of Civil Engrs., vol. 112, paper 2321, pp. 1047-1064.

[14] de Marsily, Ghislain, 1986, Quantitative hydrogeology Groundwater hydrology for engineers: New York, Academic Press, Inc., pp. 440

[15] Bouwer, H. H., 1989. The Bower and Rice slug test – An update. Ground Water. v. 27, no. 3, pp. 304-309

[16] D. S. I., and D. M. I., 1968-1988. The monthly drainage, precipitation, temperature and wind speed at different meteorological stations in and around Niksar

[17] Syed, M. A., 1989. Hydrogeological Investigations of Niksar (TOKAT), Valley, Turkey. PhD Dissertation, Unpublished. Ankara University, Turkey, pp.324

[18] Schoeller H (1967). Quantitative evaluation of groundwater resources. In: Methods and Techniques of Groundwater Investigation and Dev. UN Water Resources Series 33: pp. 21-44.

[19] CANIK, B., 1971. Yeralti Suya Rilaneosu, MTA dergisi No. 76, Turkish, Ankara, Turkey

[20] Syed M Aftab, AFSIN, M., and CELIK, M., (1997). Hydrogeological Study and Discharge Features of the Niksar Karst Springs, Turkey. The Arabian Journal for Science and Engineering. Dehran, Saudi Arabia. Vol. 22, No.2A, P. 131-144

[21] Syed M Aftab, (1996). Geotectonics and Depositional History of Niksar (Tokat) Basin, Turkey. Abstracts with Programs, 1996 Annual Meeting, Geological Society of America. October 28-31, 1996. Denver, Colorado USA. P. A-308

[22] CANIK, Baki, and Syed M Aftab, (1990). Groundwater Budget of Niksar (Tokat) Valley, Turkey. "Communication", Journal of the Science Faculty of Ankara University, Turkey. Vol.8, P. 1-11