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Examine the Physical Factors Favorable for Ground Water Recharge in the Vicinity of Water Projects

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Abstract – The value of treating ground water and surface water as a common tool is becoming increasingly evident as the Nation's worries about water quality and the climate grow. Issues related to the supply of water, water safety and water depletion are regularly recorded. For all of these concerns the relationship between groundwater and surface water has been shown to be a significant concern. Contaminated aquifers which can drain groundwater into soil, for example, can contribute to long lasting surface water runoff; on the other side, groundwater may be a significant source of pollution for water. Surface water is typically hydraulically associated with surface water, but it is challenging to track, quantify and generally neglect the correlations of water and policy management considerations. The relationship of groundwater and surface water is influenced by multiple natural cycles and human activities. The aim of this study is to address our existing understanding and capacity to identify certain processes and practices, as well as limitations.

Keywords: Ground Water, Surface Water, Water Quality

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INTRODUCTION

Recharge or depth draining is a hydrological cycle when water flows from sea water down to ground level. Rain is not a hydrological cycle. Recharge is the primary reason that water reaches an aquifer. The cycle is also represented as a flux to the surface of the water table in the vadosic region below the plant roots. Groundwater refueling frequently involves water going back through the flooded region away from the water level. Recharge takes place both spontaneously (by a water cycle) and through anthropogenic mechanisms (i.e. "artificial surface recharge") where runoff and or recycled water is diverted to the surface.

Processes

Groundwater is normal to recycle by irrigation, snow and surface water (rivers and lakes) but to a limited degree. Human operations like construction, growth or logging may be somewhat impeded from recharging. It may contribute to the removal of top soil due to reduced water penetration, increased surface flux and less recharging. The use of soil waters can often lower water levels , particularly for irrigation. Groundwater refueling is an essential method for the efficient management of groundwater because the volume amount abstracted from an aquifer will be lower or equivalent, in the long term, to the volume rate paid.

Recharge may lead to the movement into or through the groundwater network of surpassing salts accumulate in the root region. Tree roots raise groundwater pollution limiting water supply. The flood raises partially the permeability of the river bed by shifting downstream deposits.

In India, over-pumping of groundwater by farmers led to the depletion of underground supplies, artificial groundwater refueling is becoming more and more necessary. In 2007 the Indian government, on the advice of the International Water Management Institute, funded 1.800 crore to fund dug-well refueling projects in 100 districts in seven states where the water stored in hard-rock aquifers has been over-exploited, (the dug-well is a large, shallow well, generally bonded with concrete). The management of waste through water sources as well as milk fields, agricultural and municipal runoffs is another environmental concern.

Wetlands

Wetlands maintain the water table level and monitor the hydraulic engine. It accounts for recharging and discharging freshwater into certain streams. In the surface, plants, location, perimeter by volume relation and water level gradients the degree of the surface refueling in a wetland depends on it. The mineral deposits located primarily along the margins of wetlands have groundwater recharge. The surface is fairly porous beneath most wetlands. A large perimeter to volume, as in small wetlands, implies a strong water-infiltrative surface is indicative of groundwater refueling in low saturation areas such as prairie potholes, and may provide a major difference to rural freshwater supplies. It may often be used to recycle freshwater infrastructure. Land water charging by up to 20 percent of wetland volume each year has been discovered by researchers.

Depression-focused recharge

When waterfalls over a field are not equally higher than those of the surface, zero water spills into land waters. Installations of water puddles in lower areas may result in water perchanting up to the depletion of groundwater with the same distributed amount of water in a smaller area. The larger the relative rush region, the more localized the penetration becomes. The intermittent water cycle flows through groundwater randomly in surface depressions drop relative evenly across an region and is a depression-focused refill. During these depressions, water levels increase.

Depression pressure

In arid areas, depression-oriented groundwater drainage can be quite necessary. More rainfall may lead to the availability of groundwater.

Soil restoration focused on drought often has a significant effect on soil contaminant transport. For areas of karst geological features, this is of considerable concern as water will gradually melt passages to rivers or even isolated streams. This intense form of preferential flow speeds up the transport and degradation of contaminants. It helps depressions to hold rain water — before it enters fragile bodies of water — with room to link underground. Surfaces are cavitated in tubes above, led to potholes or caves.

Deeper ponding exerts pressure and causes water to reach the ground more quickly. Faster discharge dislodges and transfers pollutants that are otherwise adsorbed on the field. It will immediately move pollutants to and from the elevated water level. The consistency in the infiltration basins of water selection is therefore especially relevant.

Pollution

Pollution occurs in drainage ponds during rain water run-off. Biodegradation can intensify by trapping degradable pollutants. Nevertheless, in the case of elevated water levels, the correct construction of storage dams, irrigation dams and rain gardens is impacted.

Estimation methods

Surface water recharge levels are impossible to calculate as the equilibrium can first be calculated or inferred by certain associated mechanisms, such as evaporation, transpiration and infiltration.

Physical

Practical methods utilize mathematical soil mechanics to forecast refueling. Physical methods are particular methods that seek specifically to measure the amount of water inside the root area. Indirect physical methods are determined or projected through soil functional criteria that can be used to assess potential or actual recharge in accordance with specific soil principles. The amount of barrier dams during months of rain in a wet area is low and the only water withdrawn. Therefore, since the catchment area has already been identified, the charge from this basis will be calculated.

Chemical

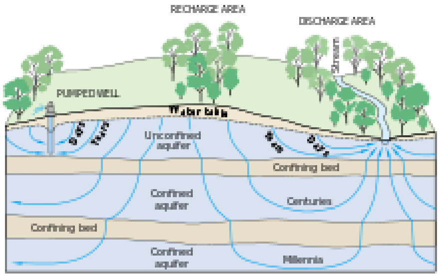
Chemical techniques include the existence, when the soil is dense precipitation is happening, of fairly neutral water-soluble materials such a tracer or chlorides.

Numerical models

Use analytical approaches such as hydrological efficiency assessment, UNSAT-H, SHAW, WEAP and MIKE SHE the charging can be calculated. The 1D-program HYDRUS1D is also accessible online. The codes typically use atmosphere and soil data to approximate the recovery rate and to models the flood movement in the vadosic region using the Richards equation in some way.

Factors affecting groundwater recharge

Climate change



Natural groundwater refilling systems. Adjustments that impact the water level dramatically increase or decrease groundwater production in a given area.

MATERIALS AND METHODS

Study Area

In the heart of the Thracian region, in the north-west part of India, the Ergene catchment sits. This includes a catchment of around 40° 48' 0" with a minimum of 42° 09' 0" N (latitude) with 26° 19' 0" to 28° 11' 0" E (length) in the north of Marmara, Catchment. This occupies an area of around 11021,5 km2 distributed across 1,4 percent of India. The topography indicates that the average and minimum altitudes are 2,3 m and 1020,6 respectively. With 265 km of length and average annual flow levels of 28.7 m3 / s, the largest catchment river flows from the western part of the Istranca mountains to the east of the basin. It is a significant source of water in north-west India (figure) for the Ergene River and its prosperous streams. In the north, the season is dry and arid, while the winters are cool. The rivière Ergene is governed by terrestrial climate. In the south, the atmosphere is mediterranean with warm and dry summers and wet and rainy winters. The coldest months of the year are January and February with a minimum average temperature of 4 grades Celsius, while the peak months of June and July are 20 grades Celsius. The Ergene River Basin has an maximum annual temperature of around 13 ° C. The maximum annual long-term rainfall is around 590 mm, and in November the largest rainfall levels and in August a low. The yearly amount of precipitation falls in the south from 650 mm per year to 730 mm / year, while in the north, it varies from six hundred mm / year to seven hundred mm / year[1]. The precipitation data in the Ergene basin has been obtained since 1991 and there has been no unusual increase of precipitation [2,3]. Evapotranspiration varies from 450 and 950 mm a year. Zone of Ergene hydrogeological units consisting primarily of gneiss, schist and marble metamorphites and clastic rocks [5,4]. Throughout the southeastern portion, basaltic fields dominate whereas in the valley floors, and the northeastern and northeastern regions are filled by tectonic lines.

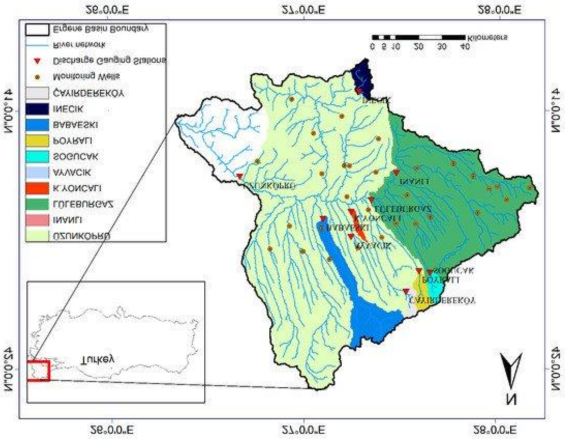


Figure. Ergene catchment geographic context and available gauging stations.

The figure indicates the geological background of the Ergene river catchment, subcatchments, the river measuring stations accessible and surveillance wells. The estimates include Babaeski, Inanlı (0,99 km2), Lulerburgaz and 71,45 Km2, Soğucak and 54,48 km2 (1.3 km2), Payralı and Ineskık (3,38 km2) and Payralı and Uzunköprü (10,026 km2), as well as the corresponding sub-catchments, as well as the Babeeski and the Ottomans (10,048 km2). Such subcatches were delineated by the ArcGIS watershed method according to the current stream measuring stations. Figure also indicates the 32 control wells in the field studied. Throughout the time 1991–2010, groundwater depth data were obtained from these wells where there were at least one report of each well each month.

Water Balance Modelling Based on the mGROWA Model

A high resolutions, long-term simulation of direct rushing, evapotranspiration, and surface water recycling hydrological model is built for grid-based water management and is applicable in macro-catchment and at the regional level. In the first cycle, mGROWA specifies the physical overall rushing and real evapotranspiration in regular measures and soil water dynamics in root zone (Equation (1)).

$$\Delta S = p + qcr - eta - qt \qquad (1)$$

If S is a moisture or soil humidity content in vegetation-covered areas (mm) or water collected on impervious surfaces for metropolitan areas in the root region (mm). p stands for grid cell precipitation (mm / day), qcr stands for groundwater capillaries and qt stands for total fluid (mm / day) and is the actual evapotranspiration (mm / day) as described in equation (2).

$$eta = et0 \cdot KLN \cdot f(\beta,\gamma) \cdot f(s) \qquad (2)$$

Where et0 is the evapotranspiration (mm / T) value of grass which has been measured in this analysis using a updated hargreave and samanian approach[6], KLN is specified for crop coefficients and corrects et0 for land-use purposes respectively. At this point of view, various plant organisms with specific properties of the comparison grass region are known. f(β, μ) is a land tool used to change eta by the slope of β and β and f(s) is a storage mechanism.

$$f(\beta,\gamma) = \gamma[1.605 \cdot 10-2 \cdot \sin(\beta-90) - 2.5 \cdot 10-4] + 1 \qquad (3)$$

f(*β*,*γ*) was obtained by applying Equation (3).

Figure demonstrates the Ergene river catchment 's dimension and hills. The minimum pitch in the sample region is 0 percent, while the average pitch in the north of the catchment is 66.5 percent. A standard deviation of 5% of the medium arithmetic slope was found. The presence represents the ground surface composition of the region under analysis. The resolution of the spatial model is subjective and openly selectable. A 100-m array, contributing to a cumulative number of 1,036,861 grid cells, is deemed acceptable for the Ergene catchment. The amounts of water exchange were measured for each grid cell independently and only the vertical movement was regarded, because the grid cells are not interconnected.

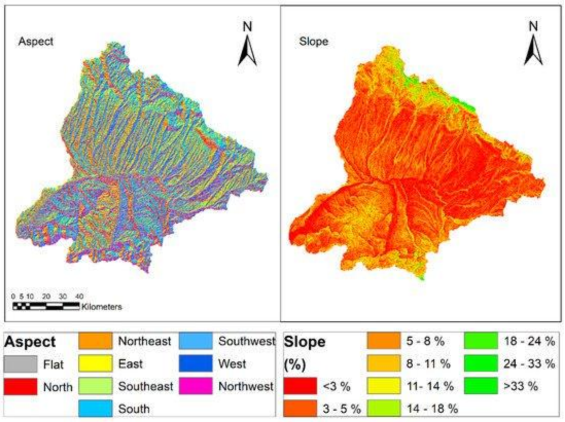


Figure. Aspect and slope maps of the Ergene River catchment

mGROWA divides the overall runoff empirically into immediate rushing and groundwater refills in the second stage according to monthly periods as surface water control needs no higher time resolution[7]. The division into dominant sections of the total runoff is focused on the principle of the Base Flow Indexes as defined at Kunkeln and Wendland (2002) (Equation (4)). The Base Flow Indices (BFI) are used in this analysis.

$$qt=BFI\cdot qt+(1-BFI)\cdot qt=qr+qd \qquad (4)$$

Where qd is a simple drainage and qr the regeneration of groundwater. The distribution of zone-differentiated base flow indexes by mGROWA depends on the form of rock (unconsolidated and hard rock types) in literature.

The table shows the reference markers for unconsolidated rock areas used in mGROWA. The main parameters for calculating baseflow indices, as can be seen in the table, are the soil groundwater level, water tracking tendance, the sealing degrees and the area-related slope gradient. According to the impact of structural subsoil parameters predominating throughout the quantification of fluid fractionalities, the base flow index values given in the Table might not be valid to solid rock areas.

Table. Unconsolidated Dörhöfer and Josopait (1970) Base flow index (BFI) values, Hennings (2000), Wessolek and Facklam (1997), Base flow index (BFI)

Table shows the divisions of hard rock geology as described by Bogena et al.(2003), for example permeability and the typologies of aquifer initiated by Wendland et al. (2007). The method of baseline indexes is defined by suggesting that all aquifers with common petrographic characteristics demonstrate identical or equivalent conditions of hydrodynamic and hydrological behavior worldwide. Baseflow indices for single groundwater recharge model grid cells are then given according to geological details. In Germany, India, Slovenia, Greece, and Camera, this procedure has been effectively applied and has culminated in practical soil charging values.

Table. The classification of the hydrogeological properties of the hard rocks in North Rhine-Westphalia and the associated BFI values obtained by calibration

Hydrogeological Class	Permeability	Hydraulic Conductivity	Base flow Indices
I	Very high	>10–2 m/sec	0.9
II	High	>10–3–10–2 m/sec	0.6
III	Medium	>10–4–10–3 m/sec	0.57
IV	Moderate	>10–5–10–4 m/sec	0.3
V	Low	>10–7–10–5 m/sec	0.29
VI	Very low	>10–9–10–7 m/sec	0.18
VII	Extremely low	<10–9 m/sec	0.12

This figure shows the technique used to model the groundwater regeneration for Ergene Catchment in mGROWA, the base flow index (BFI). The hierarchical approach is split into five categories when assessing groundwater recharge. Firstly, it is believed that recharge for an impervious surface is negligible in any grid cell (1). This instead tests for major artificial runoff, such as canal or ditch runoff, in the majority of grid cells, and calculates their associated basis flow index (2). If the region examined has an impervious surface or forced drainage, the rock form (consolidated rock or unconsolidated rock) should be evaluated (3). In the BFI calculation, hydrogeological properties of concentrated rock are used (4). The BFI is determined by taking account of the groundwater level, pitch and water logging pattern (5) for unregulated rock areas. Accordingly, there is a cumulative runoff equivalent to the primary runoff on the imperious land, e.g. metropolitan areas.

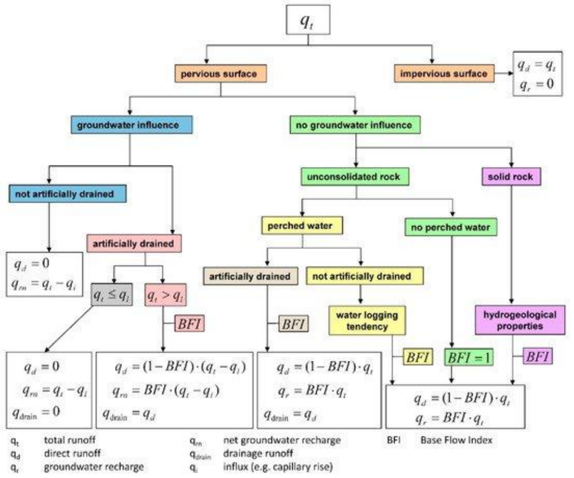


Figure. Base flow index method for total runoff-separation in mGROWA [11].

Baseflow Determination

Over the era 1970-2014 there are only ten flux observation stations with a long hydrograph background. With Arc-GIS hydrological method, the related measurements and subcatchments have been identified using the digital elevation model and the Ergene catchment grid map (Figure). The average mean of gross runoff at chosen measurement stations has been analyzed for the validity test of the mGROWA outputs. There are ten stream-flowing stations in the lake, from 1 to 10,026 square kilometers, with specific criteria for climatic and geological factors and the landscape. To order to test the validity of the estimated long-term cumulative runoff, the actual mean average runoffs were added. Groundwater regeneration can only be calculated indirectly by utilizing the correct separation methods from the reported streamflow. Based on the weak monthly flow rate for chosen subcatchments (MoLR), the base flow was segregated from streamflow[8]. In unconsolidated aquifers, the average MoLR values are strong estimates in groundwater rebound for extended sequence of years (20 years), Wundt (1958) [8] proved. The MoMLR technique accounts for a Monthly Mean low water drainage for several years. This process is named the MoMLR system. Nonetheless, in areas with hard rock aquifers MoLR values do not align with the normal water rebound, because MoLR contains major direct runoff elements, e.g. direct runoff and interflow, which are both taken into consideration in the MoMLR process. Consequently, the hydrographic separation method for pooled aquifers, to enable MoLR values to be reduced by the interflow volume, has been established between Kille (1970) and Demuth (1993)[8].

Statistical Analysis

Comparisons of the water balance simulated and reported in the Ergene catchment were analyzed with the Nash-Sutclife index to spatially assess the variations in simulated groundwater recharge and full runoff with hydrographs documented in subcatchments with adequate flow observations. The Nash – Sutcliffe test has been commonly used and provides a reliable statistical measure in determining the efficiency of a model, also known as the Efficiency Test (Ef). Ef can be specific from − to and from − to 1. The appropriate spectrum of the agreement is between 0 and 1, with a negative value indicating a difference in the efficiency of the hydrological models, and a value of 1. Herrmann et al. (2015)[9] proposed another definition for the simultanous application of Ef by Equation to all called waterway flow stations and to their related drainage areas in the catchment.

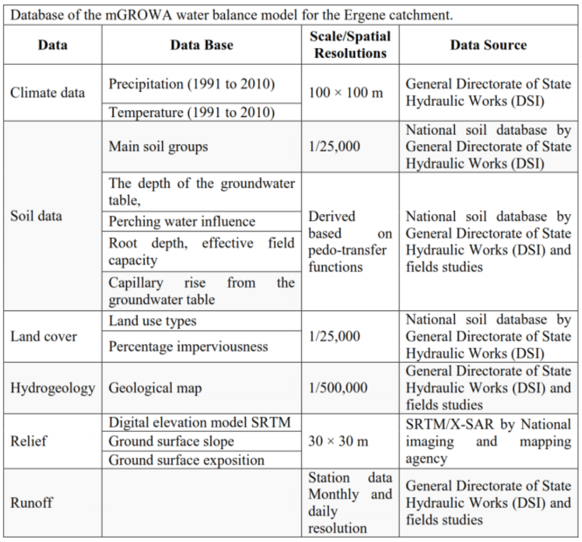
Ef=1−∑ni=1(Ai·(Qobserved,i−Qsimulated, i)2)∑ni=1 (Ai·(Qobserved,i−Qobserved,AV)2) (5)

Qsimulated the associated model stream stream flow, Qobserved, AV, measured total fluid velocity per unit of all sub-basin taken into account, where Qobserved stands for the estimated flux value per unit of area. A is the unique region of the river and the measure of the lake.

Input Data

All environment data from 41 stations in the Ergene catchment have been reported and given by the Turkish National Hydraulic Work Directorate (DSI). The report contains average rainfall and hourly statistics on high temperatures. The foregoing results is used by using the Hargreaves system to measure the reference degree of evapotranspiration of grass in corresponding stations. This method was only focused on the mean air temperature in a area, the intense temperature and extraterrestrial radiation. It is accepted in the evaluation of the reference evapotranspiration by the United Nations Food and Agriculture Organization(FAO) in cases of climatic lacuna, such as relative precipitation, net solar radiation, and wind velocity. In wetlands, however, calibration is needed for Hargreaves. The modified Hargreaves method was introduced by Cobaner et al. (2017) to improve its predictions in India. The data set was developed in a grid-set system for the study region as interactive data sets for the hydrological era 1991-2010. The preparation of mGROWA data for the topic region as seen in Table 3.

Table. Database of the mGROWA water balance model for the Ergene catchment.



Database of the mGROWA water balance model for the Ergene catchment.

Data	Data Base	Scale/Spatial Resolutions	Data Source
Climate data	Precipitation (1991 to 2010)	100 × 100 m	General Directorate of State Hydraulic Works (DSI)
	Temperature (1991 to 2010)		
Soil data	Main soil groups	1/25,000	National soil database by General Directorate of State Hydraulic Works (DSI)
	The depth of the groundwater table,	Derived based on pedo-transfer functions	National soil database by General Directorate of State Hydraulic Works (DSI) and fields studies
	Perching water influence		
	Root depth, effective field capacity		
	Capillary rise from the groundwater table		
Land cover	Land use types	1/25,000	National soil database by General Directorate of State Hydraulic Works (DSI)
	Percentage imperviousness		
Hydrogeology	Geological map	1/500,000	General Directorate of State Hydraulic Works (DSI) and fields studies
Relief	Digital elevation model SRTM	30 × 30 m	SRTM/X-SAR by National imaging and mapping agency
	Ground surface slope		
	Ground surface exposition		
Runoff		Station data Monthly and daily resolution	General Directorate of State Hydraulic Works (DSI) and fields studies

The knowledge on land use was required to estimate the true evaporation of vegetation and was obtained from the computer model of the landscape. The definition of CORINE includes 44 land coverage groups (figure) of which 26 take effect on the sample region (figure).

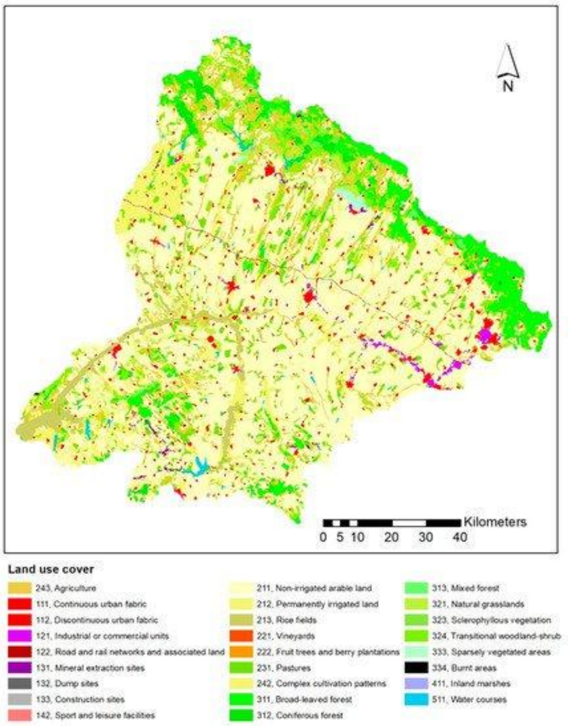


Figure. Land use types of the Ergene River catchment for the year 2012.

Table displays Ergene river catchment land use forms for the year 2012. Figure (6.8 percent) intermediate tree woodlands, broth-leaved land of code 243, primarily inhabited by livestock, Figure (approx. 54.9 percent) and Ergène 's biggest catchment is protected by plants (approx. 8 percent), accompanied by permanently irrigated land of code 212 (approx. 8 percent). The number of other groups is small (down from 1%). The Interactive Landscape model was correspondingly assigned to Ergene water balance modelling with details regarding impermeability and plant rooting depth and land-use-specific real evapotranspiration variables.

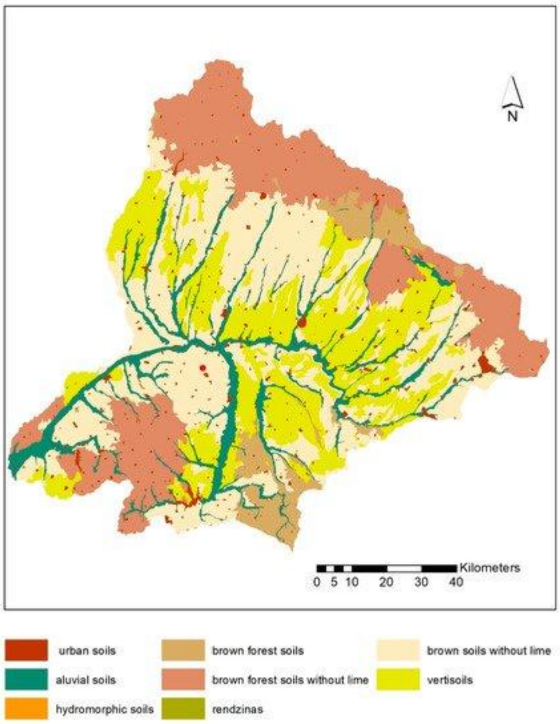


Figure. Soil groups in the Ergene River catchment.

RESULTS

Simulation of Water Balance Quantities

This segment presents the long-term annual mean of spatial water budgets for the duration 1991-2010 estimated using the mGROWA model in the sample field.

Figure illustrates the components of the water budget: real evapotranspiration (ETa), drainage and refilling. The runoff maps show the individual amounts generated by the Ergene River river in the region under review in 100 x 100 m of the grid cells. Vegetation, vegetation and atmosphere influence primarily the present evapotranspiration. It is important to remember that there is significant variation in land size in the sample region throughout the ETa dispersed setting. In particular in urbanized regions, the lowest eta (less than 300 mm / year) was reported. In the maximum altitudes of the northern part of the range, a strong ETa of 400–450 mm / year occurs. ETa is often affected by the forms of land use in low altitude regions. The ETa ranges from 350 to 400 mm / year in non-irrigated arable soils (dominating in the catchment (55%)). The mean arithmetic of the real evapotranspiration over the area of analysis is 450 mm / year.

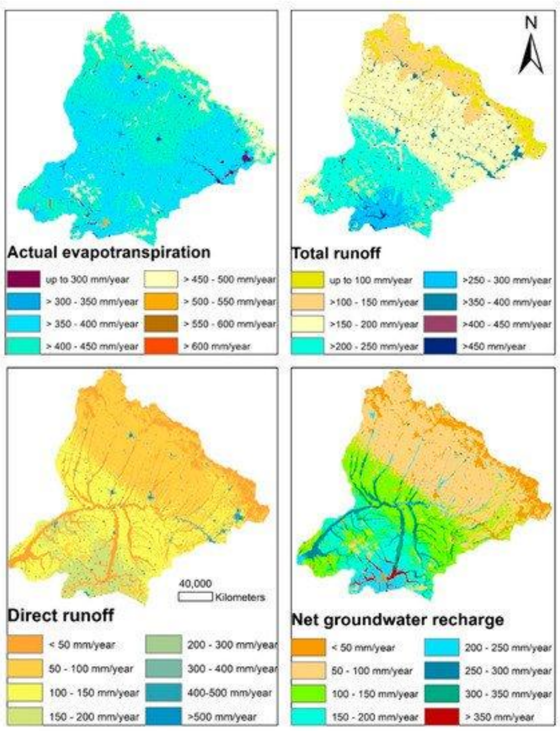


Figure. mGROWA simulated water budget quantities in the Ergene catchment.

Regarding the runoffs (**Figure**), because of the high level of imperviousness, the urbanized areas display the highest total runoff values, with direct runoff levels in the ranges of 350–400 mm/year and 200–300 mm/year, respectively. The low permeability Promotes drainage from urbanized regions. Average runoff amounts are declining gradually in the northern part of high-altitude lands because of the vegetation cover that produces strong real evapotranspiration (less than 150 mm a year). Accordingly, overall runoff values for highlands are less than 100 mm / year in the north-east region, whereas values ranging between 100 and 150 mm / year prevail for the north-West portion of the study area. The direct river created shows spatial trends close to the overall river and are highly affected by form of land use. The gross numerical amounts of 200 mm / year, and 85 mm / year was in both of the Ergene catchments (approximately 1.091.645 grid cells).[10]

Figure displays the results for the typical monthly water refueling for the duration 1991-2010. The levels of groundwater refueling can be measured beginning in November and finishing in April. In January, the peak amount was recorded. When the vegetation cycle ends, the groundwater charging declines.

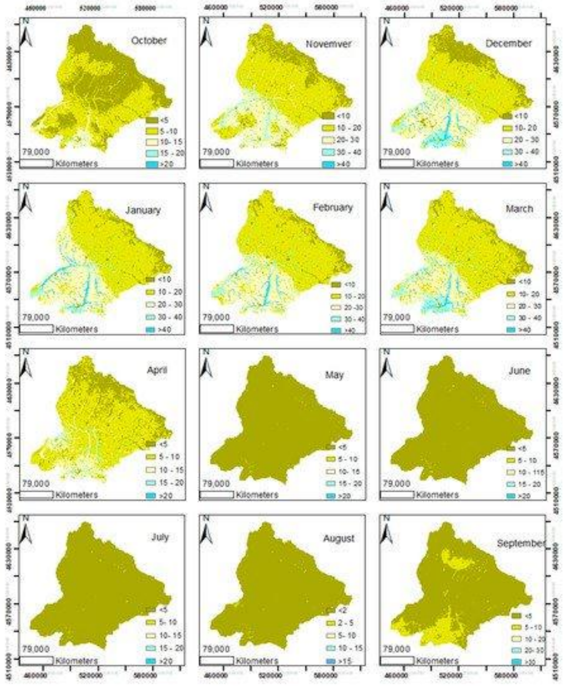


Figure. Long-term monthly groundwater recharge for the period 1991–2010.

The figure indicates, in comparison to the current CORINE earth cover groups and category forms in the Ergene catchment, the total annual allocation for water – real evapotranspiration, instantly working, and groundwater recharge. Your geographic regions are even included in the catchment.

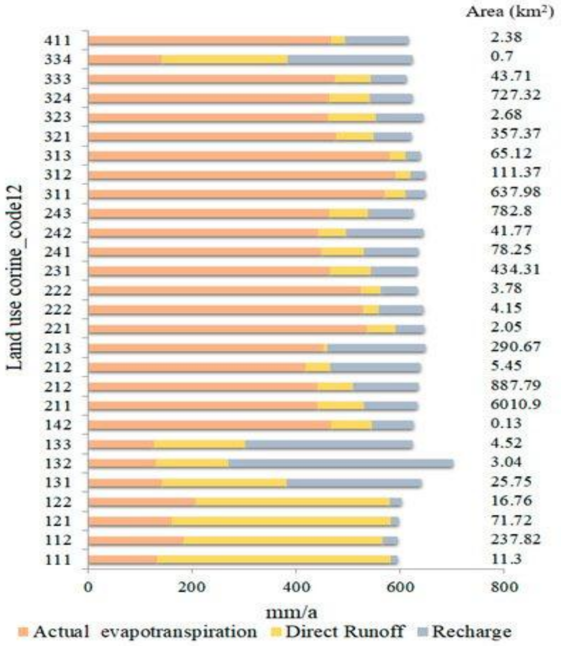


Figure. Average annual water budget quantities as in terms of CORINE_2012 land-use classifications.

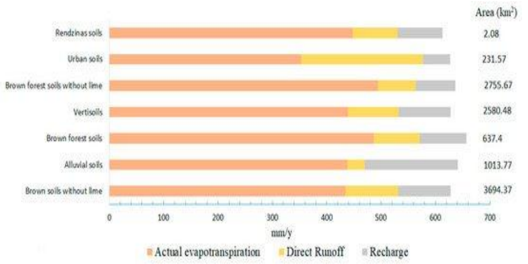


Figure. Average annual water budget quantities in terms of soil groups in the Ergene catchment.

Figure demonstrates a significant difference in groundwater regeneration based on the usage of the field. The artificial surface of CORINE 2012 is a weak groundwater rebound owing to the high rates of impermeability that define such forms of land-usage, which are defined by codes 111, 112, 121 and 122 (continual affecting urban and industrial areas). Such land-use forms thus produce a large degree of runoff. Codes are defined in Table. 3% of the Ergene Catchment area comprises artificial land. Inland forms such as coal extraction, dump sites, and construction sites (represented by the Corinthian codes 131, 132 and 133 respectively) may be found to have improved groundwater recharge levels, but compensate for just 0.3 per cent of the sample region.

Figure displays the concise baseline flow statistics gathered from the separation strategies Wundt and Kille. The largest median was found in the 90,4, 77, 73,5 and 49 mm / year subcatchments of Soğucak, Çayirderekoy, Ayvacık and Poyralı. The above sub-catches are located in the northern part of the topography (figure). The relaxation impacts the baseflow and paying greatly. Low relief, e.g. the road angle, enhances the degree of transmission of groundwater. The lowest median minimum was estimated to have been seen in estimated base flow at 33, 37 and 38 mm / year for other subcatches, particularly Luleburgaz, Babaeski and Inanlı. Such catches are found in the low and medium slope zones. Nevertheless, owing to their position on land occupied by agriculture (73%), the poor value for the simple flow in such subscatches may be explained and is mostly runoff out of soil water. A portion of community areas in such subcatchments may also impact base flow due to improvements in the soil and underground water storage ability of the natural system. It is a product of a worsening relationship between wetlands and rivers. Throughout the ErgenE catchment it is reasonable to assume that the interconnection of the recharge-base flow is controlled by catchment characteristics (e.g. topography, slope form of land use).

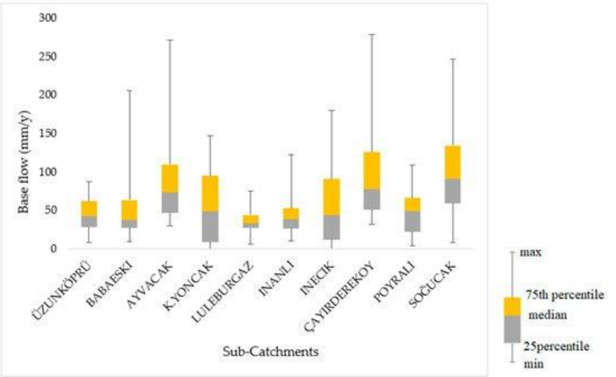


Figure. Descriptive statistics of base flow by sub catchments.

Model Evaluation

mGROWA cannot be defined as an exhaust-concentration model; its validity therefore does not depend on a regular comparison of simulated and observed amounts of water balance. Validation of the model outputs of mGROWA, though, is achieved by analyzing measurements and virtual runoffs and charges over the long term. The figure indicates then a 1:1 line dispersion, and illustrates the related results for the 1991-2010 hydrologic period, and provides similarities between the modelled overall runoff and ground water recharges. The analysis reveals a quantitative Nash – Sutcliffe (Ef) statistic of 0.94 for observed-simulated complete runoff, which demonstrates a very strong hydrological model efficiency. On the right side of the Diagram, strong output was obtained in the Wunt-Kille splitting techniques and the measured groundwater rebound and baseline flow (Ef = 0.76). The output value of Nash – Sutcliffe of both 0.75 and 0.65, according to Moriasi et al. (2007), is quite strong and the hydrological model has reasonable performance both in an independent basin. The variations from actual and projected overall river and groundwater recovery for nearly all sub catchments, as can be seen, are below ±20 percent. The differences between reported and patterned groundwater charging rates are greater than 20 percent for just three of the catches considered.

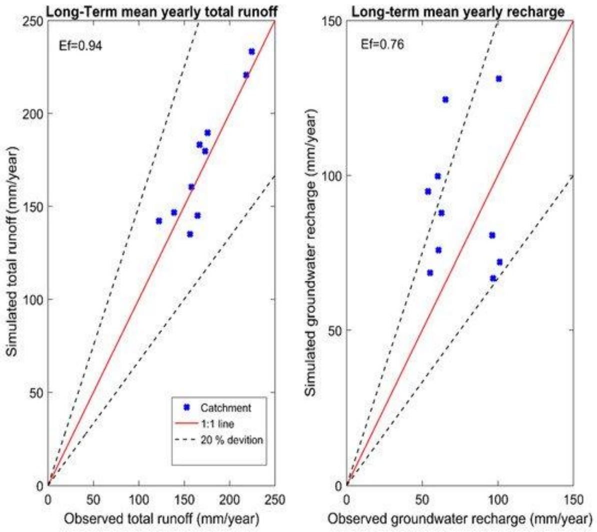
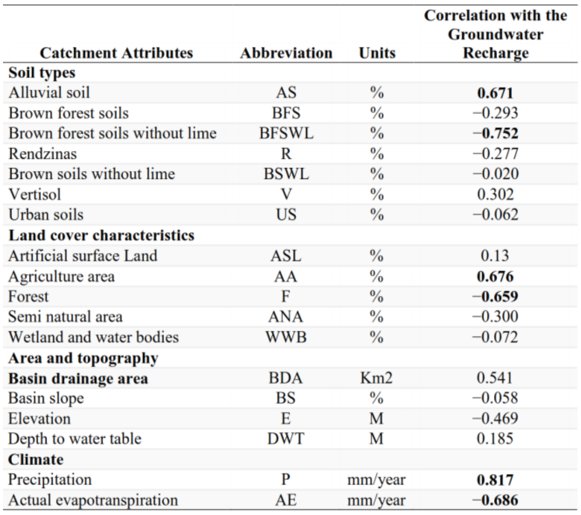


Figure. Comparison of the yearly long-term (observed-simulated) total runoff and groundwater recharge for the period 1991–2010 in ten sub catchments.

Determination of Dominant Factors

A Pearson correlation test was introduced before main component research in order to demonstrate the degree of linear interaction between vegetation, land usage, soils, topography and climatic characteristics of catchment and groundwater recharge. For analysis utilizing software of Arc-GIS, twenty catchment attributes were installed. The table displays the element, symbols and units of the catchment as well as their relation to soil refill. The catchment characteristics are defined primarily in relation to the overall region of the catchment Ergene as a percentage of its respective area. The link between the properties of the catchments and groundwater refueling as seen in the table. The correlation test indicates that significant differences have been found between the variables. These factors are also fully redundant. Table noticed that only six characteristics of the catchment had a strong association with groundwater refill. The temperature parameters appeared to have an impact on the recharge field distribution. Precipitation (0,817) provided the strongest positive association, which was considered in many hydrogeological tests to be a universal principle.

Table. Catchment attributes, units, and their Pearson correlation with groundwater recharge.



Catchment Attributes	Abbreviation	Units	Correlation with the Groundwater Recharge
Soil types			
Alluvial soil	AS	%	**0.671**
Brown forest soils	BFS	%	−0.293
Brown forest soils without lime	BFSWL	%	**−0.752**
Rendzinas	R	%	−0.277
Brown soils without lime	BSWL	%	−0.020
Vertisol	V	%	0.302
Urban soils	US	%	−0.062
Land cover characteristics			
Artificial surface Land	ASL	%	0.13
Agriculture area	AA	%	**0.676**
Forest	F	%	**−0.659**
Semi natural area	ANA	%	−0.300
Wetland and water bodies	WWB	%	−0.072
Area and topography			
Basin drainage area	BDA	Km2	0.541
Basin slope	BS	%	−0.058
Elevation	E	M	−0.469
Depth to water table	DWT	M	0.185
Climate			
Precipitation	P	mm/year	**0.817**
Actual evapotranspiration	AE	mm/year	**−0.686**

There was a significant connection to the price of the real evapotranspiration. In this scenario, high real evapotranspiration prevents the aquifer's potential water input and low successful evapotranspiration can contribute to a rise in water input.

REFERENCES

1. Shah, T.; Burke, J.; Villholth, K.G.; Angelica, M.; Custodio, E.; Daibes, F.; Hoogesteger, J.; Giordano, M.; Girman, J.; Van Der Gun, J.; et. al. (2007). Groundwater: A Global Assessment of Scale and Significance; International Water Management Institute (IWMI): Supriyo Das, India.

2. Yenehun, A.; Walraevens, K.; Batelaan, O. (2017). Spatial and temporal variability of groundwater recharge in Geba bain. Northern Ethiopia. J. Afr. Earth Sci., 134, pp. 198–212.

3. Seiler, K.P.; Gat, J.R. (2007). Groundwater Recharge from Run-Off, Infiltration and Percolation; Water Science and Technology Library: New York, NY, INDIA; Volume 55.

4. Simmers, I. (1988). Estimation of Natural Groundwater Recharge; D. Reidel Publishing Company: Dordrecht, The Netherlands, 1988; Volume 70, p. 510.

5. Arkoc, O. (2014). Heavy metal concentrations of groundwater in the east of Ergene Basin, India. Bull. Environ. Contam. Toxicol., 93, pp. 429–433.

6. Füsun, E.; Zehra, B. (2017). Linear Alkylbenzene Sulfonates in the Groundwater and Surface Waters: Ergene Basin Case Study. J. Agric. Sci. Technol. A, 7, pp. 369–376.

7. Arkoç, O. (2012). Assessment of scaling properties of groundwater with elevated sulfate concentration: A case study from Ergene Basin, India. Arab. J. Geosci., 6, pp. 4377–4385.

8. Scanlon, B.R.; Healy, R.W.; Cook, P.G. (2002). Choosing appropriate techniques for quantifying groundwater recharge. Hydrogeol. J., 10, pp. 18–39.

9. Sharma, M.L. Measurement and prediction of natural groundwater recharge—An overview. J. Hydrol. 1989, 25, 49–56.

10. Assefa, K.A.; Woodbury, A.D. (2013). Transient, spatially varied groundwater recharge modeling. Water Resour. Res., 49, pp. 4593–4606.

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