



Investigation of meteorological variables on runoff archetypal using SWAT: basic concepts and fundamentals

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Abstract

Hydro-climatic excesses, for example humid and overflows, have most probable enlarged owing to climatically alteration and could due to simple effects on socio-financial, organizational and ecological areas. It was premeditated greatest hydraulic plans, for example barricades, it was distinct the excess of the streams. If the stream presences any situation to quantify the profit, the hydraulic mockups can be used to guesstimate it. SWAT is widely-used high-tech mockups. This investigation contemplates the understanding of the excess approximation for streams, by the SWAT prototypical; depend on changes in such meteorological parameters as rainfall, cosmological energy, airstream, moisture and temperature. The gained significances require that by 30.46% decay in the normal scheduled rainfall, brightness, qualified moisture, airstream and temperature, it was usual ermined 64.73% decay, 115.14% rise, 45.99% decrease, 126.58% rise and 40.15% rise in exhibited excess, independently. The wind speed and the solar energy are the most sensitive and temperature is the smallest penetrating parameters in the overflow approximation. These consequences signify “acceptable” and “very good” performances for discharge. While there is still some quantity of ambiguity, the practice of balancing information, for example soil dampness, to adjust and confirm the SWAT model package prototypical is beneficial, particularly when discharge information is infrequent, as for some watersheds in the humid region. Evaluation of the water usage efficacy is the important to efficiently accomplish agronomic water resource.

Keywords Climatological parameters · Rainfall runoff · Sensitivity investigation · SWAT model package · Watershed profit

Introduction

So as to shape a dam, it was essential to detzermine the monthly and annular yields of the river to calculate the volume and the height of the dam. Device positions can quantify the input water of the dam. In the nonappearance of the device place, a computerized model, for instance SWAT prototypical, was being used to evaluate stream and input runoff. The computerized models can perform precise and complicated calculations in a short time. In order to calculate the watershed runoff on the one hand, the model requires such powerful meteorological data as rainfall, temperature, wind speed, solar energy and relative moisture and on the other hand we need the watershed basin information together with the curve number and the coarseness constant. Owing

to the limitation in the quantity of climate positions in watershed basins, the standards registered in a position do not signify the entire watershed. There is a requirement to compute the overflow approximation fault. This research is depending on SWAT model Package, objects to observe the sensitivity of the stream runoff approximation to differences in the most prominent meteorological mechanisms including rainfall, solar energy, wind, moistness and temperature. The improvement of a nation is straight connected to the energy invention. Certainly, water corrosion is a main delinquent in northern Algeria. The foremost reason of corrosion is overflow which is measured by those of rainfall and physical and bio-physiographic features. The corrosion is established mostly on slopy soils deprivation in the rocky zones. Collective water scarcity and the absence of water resources development and organization are main responsibilities for assembly forthcoming water difficulties and dropping civilization defenselessness. Certainly, water corrosion is a main issue in Talar watershed. The foremost source of corrosion is overflow which is measured by those of rainfall and

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environmental and bio-physiographic features (Eslamian et al. 2018b; Derakhshannia et al. 2020, Fatahi Nafchi et al. 2021a, b; 2022a, b; Ostad-Ali-Askari et al. 2017a, 2019). The corrosion is established mostly on sloppy dusts dereliction in the rocky zones. It enhanced afterward the gauge advance on forestry which defended the compound dusts. The aquatic corrosion concentration differs from one region to extra, the Western portion (52% of all the terrestrial), is the greatest corroded area of the republic, then originate the areas of the epicenter (32%) and East (33%). Hydrological mockups afford a global consideration of procedures subtleties that happen in the soil–vegetable atmosphere organization, while presenting a mark of ambiguity in their consequences. Progressively, such apparatuses have been applied for development, organization and water resources strategy. Revisions connected to the investigation of doubts of dispersed mockups have been cumulative carried out. calibration and examination of doubts of semi-dispersed watershed mockups are topic to a quantity of problems, for example their parameterization, the non-individuality of an established of components, the description of what is a ‘‘calibrated prototypical’’, are the proper restrictions of its practice, and the calibration in watersheds somewhere land usages or rivers have been importantly adapted (Apostel et al. 2020). Furthermore, input information and three-dimensional gauge explanations are similarly measured as bases of doubts. In addition, the watershed prototypical shows a critical part in the development and resident possessions progress (Javadinejad et al. 2019b; Amoakowaah et al. 2019). To forecast dependable measurement and sediment conveyance proportion from terrestrial superficial into rivers, rivers and water forms, to classify corrosion issue regions within a watershed and to suggest the finest organization performances to decrease corrosion effect, mockups are applied (Kondo et al. 2021). Inappropriately, Iran is fronting disastrous dynamism catastrophe at current period. The elementary and inexpensive basis of control manufacture is hydropower in Iran owing to the attendance of usual landscape which makes ordinary hydraulic heads lengthwise watercourses particularly in mountainous zones. The water issue in north Iran is severe. Agronomy water feeding is very great that directed to a solemn descent in water table. Consequently, investigation on actual water equivalent in the area is very significant (Shrestha et al. 2020). The revision enhanced SWAT prototypical and used it on the region level actual water equivalent reproduction: Usage the enhanced SWAT prototypical, by climatological information and distant detecting Evapotranspiration (ET), the Talar dispersed model is advanced depend on the soil plan, water Conservancy and terrestrial usage from the distant detecting of Talar county, Mazandaran province (Zhang, et al. 2009). Harvest design alteration, irrigation arrangement alteration and irrigation aquatic basis alteration circumstances is pretend and

actual water equivalent of dissimilar situations is examined (Raeisi Vanani et al. 2017; Shayannejad et al. 2022; Ostad-Ali-Askari et al. 2017b, 2018b; Ostad-Ali-Askari and Shayannejad 2021; Ostad-Ali-Askari and Shayan 2021; Ostad-Ali-Askari 2022a; Ostad-Ali-Askari and Shayannejad 2020c; Sandeep Dash 2020). The consequence of the investigation can suggest situation to the agronomy for actual water equivalent organization. Great agronomic water feeding caused in greatly lower groundwater stage. Consequently, investigation on agronomic physical Water-equivalent has a significant theoretical consequence (Frizzle et al. 2021; Ostad-Ali-Askari et al. 2019). Engineering water-equivalent, mostly accepted in modern agronomic water-equivalent, can decrease the evaporation and improve the draining efficiency (Zhang, et al. 2015). However prolonging irrigation zone and cumulative irrigation occurrence will consume more water possessions owing to the intensification of ET, which will reason severe significances for example deteriorating of water scarcity, severe decline of unnecessary groundwater corruption, devastation of environmental situation, amazing effect on downstream water usage and unmaintainable usage of water possessions in zones deficient of water (Golian et al. 2020; Zettam, et al. 2017; Ostad-Ali-Askari et al. 2020). So, in the Talar basin, a zone missing of water possessions, we must, on the evidence of cumulative harvest and equivalent water, perform a novel agronomic water-equivalent style with the determination of decreasing ET, which comprises regulating agronomic construction, enhancing irrigation technique and accepting agronomic organization events and a dispersed water series prototypical is essential while creating and assessing organization events. SWAT is an extensively applied complete dispersed prototypical of water possessions and situation. SWAT prototypical is mostly applied to pretend and estimate diverse organization procedures and effect on water possessions source produced by weather alteration and assess contamination in the washbasin (Pourabdullah, et al. 2006). But, since sub basin separation is depending on DEM instinctive abstraction, usage of SWAT will encounter prodigious problems in basic zones, particularly zones with severe anthropological disruption. Conferring to the fault of SWAT prototypical presence depend on DEM instinctive partition of sub-basins in natural zones and in view of that Iran’s water possessions existence accomplished on the foundation of managerial separation, depend on SWAT basis program, we has advanced a novel SWAT border, enhanced the technique by which SWAT prototypical shares the sub-basins, allowable the operators to do anthropological-processor interrelated hydrological component illustration conferring to considering superficial evidence in the investigation zone, built SWAT prototypical conferring to the hydraulic association amongst the hydrological components and supported the arithmetical examination purposes of SWAT prototypical,

through which the numerical examination of hydrological aspects can be done depend on together ordinary hydrological components and managerial separation (USDA Soil Conservation Service. 1972). Fundamental superficial evidence in the investigational zone, comprising DEM, terrestrial usage and soil, ought to be lengthily measured while separating sub basins. Anthropological features for example water engineering in the element region ought to be considered since water engineering is greatest possible to alteration the divergence condition in the element region (USDA Soil Conservation Service. 1983). Afterward the separation of sub basins, the water engineering association amongst sub basins ought to be defined, which requisite a complete deliberation of DEM, soil, land usage and water engineering in the point region for the consequence correctness will affect the pretend consequence prepared by SWAT prototypical. Collecting the hydraulic forms is required afterward the purpose of water engineering association. The information ought to be contribution into the prototypical to distribute sub basins and make connected component collections. It was used SWAT in Emameh and claimed that the above model was efficient in the runoff estimation (Eslamian et al. 2018a; Behtari Nejad, et al. 2011; Poorabdollahi et al. 2006). It was applied SWAT to assess the over land current in a 33.4 square kilometers watershed situated in Maryland. The obtained consequences proved that the estimations made by the SWAT model package were not so accurate during very wet years. By omission of the wet year, the monthly estimations of the over land current runoff were more accurate (Pirnazar et al. 2018; Mwendera, et al. 1992). It was decided that the estimations of runoff made by SWAT agree by the amounts quantified in basin (Behtari Nejad et al. 2011; Hatou et al. 2004). Schuol et al. (2008) claimed that SWAT is highly capable in making realistic stimulations of hydrological balance (Behtari Nejad et al. 2011). It was used SWAT to stimulate the discharge of the current in Bask river watershed and the model was proved to be satisfactory in forecasting the current (Salehi-Hafshejani et al. 2019; Talebizadeh et al. 2009; Santhi et al. 2001). Collective water scarcity and the absence of water resources development and organization are main responsibilities for assembly forthcoming water difficulties and dropping civilization defenselessness (Yang et al. 2008). Hydrological mockups afford a global consideration of procedures subtleties that happen in the soil–vegetable atmosphere organization, while presenting a mark of ambiguity in their consequences. Progressively, such apparatuses have been applied for development, organization and water resources strategy (Xue, et al. 2014). Revisions connected to the investigation of doubts of dispersed mockups have been cumulative carried out. calibration and examination of doubts of semi-dispersed watershed mockups are topic to a quantity of problems, for example their parameterization, the non-individuality of an

established of components, the description of what is a “calibrated prototypical”, are the proper restrictions of its practice, and the calibration in watersheds somewhere land usages or rivers have been importantly adapted (Werneck et al. 2011). Furthermore, input information and three-dimensional gauge explanations are similarly measured as bases of doubts. SWAT (Soil & Water Assessment Tool) is a stream washbasin gauge prototypical advanced to measure the effect of land organization performances in great, compound watersheds (Abdollahi et al. 2021; Wanders et al. 2014). It is a hydrology prototypical with the succeeding parameters: climate, superficial runoff, reoccurrence current, filtration, evapotranspiration, broadcast losses, pool and basin loading, crop development and irrigation, groundwater current, spread directing, nutrient and insecticide loading, and water transmission. SWAT can be measured a watershed hydrological conveyance prototypical (Talebmorad et al. 2021; Javadinejad et al. 2018, 2019a, 2021; Ostad-Ali-Askari et al. 2018a, 2020, 2021; Wallace et al. 2018). Water is an essential natural resource in the socio-economic development of human society as well as in the life of the cosmos, which is difficult to treat, expensive to transport and impossible to replace. Due to climate change and socio-economic change, water resources around the world are in a critical phase and the problem of scarcity and pollution has created many problems for the world. Quantitative and qualitative water management often relies on watershed distribution models that can model point and non-point source pollutants as well as the fate of pollutants under current conditions or management scenarios. Soil and Water Assessment Tools model is also applied to guesstimate the supreme daily flow degree. The SWAT model was executed to test its capability in visualizing the impacts of sediment and discharge control structures in the watershed. Hydrological procedures in a varied terrestrial practice watershed are evocatively persuaded by earthly procedure and earthly fortification. So as to measure the consequence of terrestrial usage/terrestrial protection, geography, and geomorphology, runoff and deposit crop of a minor multi-regulated watershed in an area were replicated by the Soil and Water Assessment Tool (SWAT) prototypical and were contrasted with quantified standards. It considers the Soil and Water Assessment Tools model for imitation of runoff and deposit throughout the considered dated of 1996–2012 was examined for two conditions of presence and nonappearance of overflow controller constructions. But another research is considered one condition for their investigation. It examines the new situation of two conditions related to the existence and absence of flood control structures and it control discharge and sediment by flood control structures to manage capacity of sediments and discharge.

Literature

It was measured SWAT to study the deposit and the sewage of nutrients in the east of basin. The same prototypical has been used and established from 1999 to 2006. Information from 2007 to 2010 was used to inspecting the accuracy and in the equally phases of confirmation and justification the consequences were appropriate. The SWAT prototypical retains the capability to make numerous situations to study diverse management problems (Ostad-Ali-Askari 2022b; Chu et al. 2004). It was used SWAT to motivate the average monthly discharge of Emameh watershed. The increased implications quantified an open-minded attention of the classical to the over terrestrial roughness constant (Behtari Nejad et al. 2011; Gholami et al. 2003). Saadati et al. (2003) considered the incentive of the daily discharge, water balance and land application in Talar watershed (Soil Conservation Service. 1964). The consequences prepared by the prototypical were sensitive to the period, that is, the annual and the monthly phases shaped more normal significances in difference with the everyday. It was used the SWAT prototypical to measure the discharge and permitted the effectiveness of the prototypical (Behtari Nejad et al. 2011; Alavinia and Nasiri-Saleh et al. 2010). Omani et al. (2007) used the above prototypical in model Ghareh-sar watershed and definite that the SWAT classical is a skilled tool for stimulating hydrologic instruments (Behtari Nejad et al. 2011; Omani et al. 2007). Rostamian et al. (2006) inspired the runoff in Behestabad watershed and definite that the SWAT prototypical is not accomplished of inspire the supreme flows (Behtari Nejad et al. 2011). The water mark is a novel guide for water usage assessment, and its quantification is a condition for assessment of the agronomic water usage productivity. Owing to the scarcity of water mark scheming approaches and computational component faults, this investigation goals to create a technique for scheming the water mark of discharge depend on hydrological procedures. Water mark plans depend on the SWAT prototypical can reproduce the dimensional variances of water ways throughout the procedure of discharge production. The SWAT-depend water mark offers high spatial determination and is active in discovering the spatial assortment of features. The imitation of overflow and deposit throughout the considered dated. The original purpose of usage the flood control structures are able to manage control sediment and discharge for usage of agriculture and other familiar topics related to the agronomics. The SWAT model is beneficial and useful to manage and control rather than another software because it has best results and precise rather than others software and it can be suitable to manage water resource management for agriculture. The consequences prepare evaluable data for targeted organization so as to instrument the most operative agronomic in the watershed.

Materials and methods

The case to be studied was restricted to Talar watershed together with Sangdeh, Darzikela, and another town. The zone of Talar basin is almost 67.74 km² and the foremost stream gives for 18.9 km. The topographical organizes of the rivers are as follows: Latitude from 36° – 07' to 36° – 15' N and longitude from 53° – 14' to 53° – 29' E. There is a measurement position on Talar River at Valikbon. The position, constructed in 1969, is situated at longitude of 53° – 20' and the latitude 36° – 19' to quantity it's Discharge. Figure 1 displays the position of Talar watershed (Lei, et al. 2015). This model takes the meteorological information available from January 1979 till January 1990 into account to stimulate the runoff. The mentioned numerical components were reprocessed from Pol-e-Sefid Synoptic, Sangdeh and Darzikela climatology, Valikchal rainfall-gauge and Valik hydrometer positions. In this model, information on meteorological information during the statistical period of December 2006 to December 2017 has been used to simulate runoff. The mentioned statistical parameters are the information of Pol-e-Sefid synoptic station, Sangdeh and Darzikla climatology stations, Valikchal rainfall station and Velik-Bon hydrometric station. In New Year, Talar watershed has been designated as a watershed directory in the north of Iran and many investigators and organizations are reviewing in this watershed. The great zones of highlands, forestry's, and agronomic domains have been transformed to inhabited zones in new ages, owing to satisfactory climatically situations. Consequently, the value of agronomic terrestrial has amplified and highlands have been employed illegitimately. In this article, land usage kinds are separated to four stages: agronomy, forestry, agreement, and highland. Application of the investigation was performed in the research of satellite images from three dissimilar periods and carrying out numerous alterations. There is no concurrent study of environment and land use alteration in this zone and its properties on erosion and soil loss. Consequently, the goal of this investigation is to examine the belongings of these theories in the Talar watershed (Leong et al. 2020). Soil corrosion is a simple topic that attitudes a substantial risk to the environmental situation and anthropological lifetime at the Talar watershed in northern Iran. This zone is defined by the Alborz mountain range, in which the ecology is extremely disposed to soil corrosion owing to disforestation, land recovery, and other unsuitable land use performances. In New Year's, a fast development in inhabitants has happened in the higher Talar watershed. Thus, a great zone of grassland and forestry has been domesticated to forage the inhabitants, thus consequential in plain soil corrosion and ecology impairment. A consciousness of forthcoming soil loss situation below the result of environment and terrestrial usage alteration

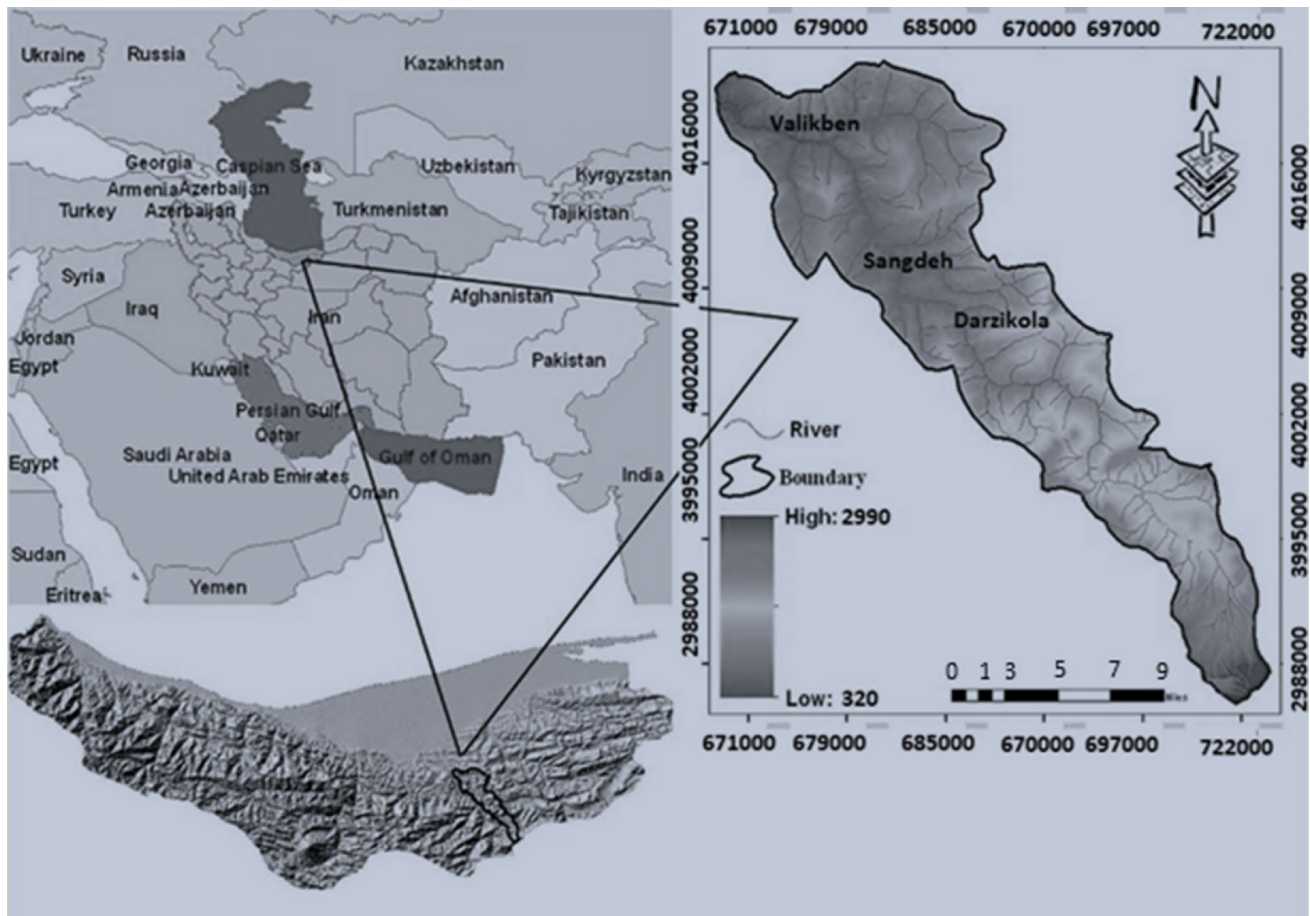


Fig. 1 Show the position of Talar Watershed until Valik hydrometer Position

importantly donates to Talar watershed organization (Phiri et al. 2021; Ostad-Ali-Askar et al. 2018a). I use the information requirements SWAT to estimate runoff and sediment results after and before the usage of the flood control constructions. a everyday, Scheduled reproduction period phase and a continuous-time stage limit the practice of the SWAT design for inclusive, incidence-built flood simulation. The existence of acridities and unforeseen forecasts in numerous areas of IRAN, similarly the density on straightforward expediencies evaluable by frame development, has due to a wider alteration in negotiation to the difficult of water conservative in the association. Structure and adjusting a hydrologic prototypical of Talar Basin. applying SWAT. Subjective Workload Assessment Technique (SWAT) is a multidimensional grading technique intended to measure period load, intellectual exertion load and pressure load. It is applied in two stages, measurement expansion and scale grading. Imposing consequences from the prototypical can be gained if the employer sets up a highly comprehensive prototypical. SWAT is one of the precise models that are widely useful for such purposes. For scheming the basin discharge, the prototypical desires climatological data, for

instance precipitation, temperature, wind speed, solar radiation and relative humidity, as well as physiographic data linked to the basin superficial, for instance curve number and roughness component.

Study area

The Talar watershed includes a zone of about 69 km² and is situated in northern Iran within the restrictions of eastern longitude from 53°15' to 53°33' and northern latitude from 35°55' to 36°12' in the easterly portion of the Mazandaran area. The zone's environment is semi-moist and cold, by an average yearly rainfall of 793.3 mm and medium temperature of 10 °C. The medium, extreme and smallest altitudes of the basin are 3351, 1118 and 1675 m, correspondingly (Abunada et al. 2020). The basin grade of the basin, the medium gradient of the foremost network and the measurement of the foremost network are 15.9%, 15% and 16.7 km, correspondingly. A gravimetric position is situated at the channel of the basin, and a rain plotter location is situated upriver of the position (Khaleghi et al. 2011). The Talar watershed is portion of the Talar

River washbasin, which is situated in the central district of northern Iran south of the Caspian Sea. The smallest and supreme advancements in the washbasin are 290 and 3285 m, correspondingly. The zone's terrestrial category is hilly with average grade of 16.1% and, conferring to the Iranian biological organization, this washbasin depends to the central Alborz with its superficial astounds fitting to the primary, another, and 3rd ages (Yamini et al. 2021). The popular of this washbasin is enclosed to dissimilar forestry types that have terrestrial apply for example rangeland and agronomy, in addition to forestry terrestrial usage. It was planned to forecast the hydrological procedures that could feature environment and anthropized watersheds. The model can be required applying input information of environment forecast prototypical, soil features and land application situations to predict their consequence on hydrological procedures. SWAT was intended to forecast the effect of agronomic organization performances on aquatic discharge, deposit, nutrient and insecticide masses for great ungagged sub-basins. SWAT was advanced by the agriculture ministry of the US and the agriculture research service of Grassland water and soil investigation workshop in Texas. This prototypical stimulates the stream release and to this end such climatically information as meteorological information are needed. This software needs as a minimum the temperature and rainfall data and is able to stimulate the other items. It similarly requires land map and the numerical elevation prototypical. Arc GIS software performs the SWAT prototypical (Akram, et al. 2018). The number of SCS curve is a purpose of soil penetrability, terrestrial application and the humidity already retained in the soil. Different types of curve number were considered for humidity condition II in various kinds of terrestrial from 65 to 79 based on the SWAT methods tables and the best quantity for the district was gained as 69 (SCS Engineering Division, 1972; SWAT Theoretical Documentation Version, 2009). SCS runoff equation is an empirical model developed in 1950 after 20 years of studying the relationship between rain and runoff in the small American villages' watersheds. The model estimates the runoff in various land applications and different types of soil (SWAT Theoretical Documentation Version, 2009).

Equation 1 shows the curve number as follows (SCS, 1972):

$$Q_{\text{surf}} = \frac{(R_{\text{day}} - I_a)^2}{(R_{\text{day}} - I_a + s)} \quad (1)$$

where, Q_{surf} is the collected overflow or the additional of rainfall (mm), R_{day} is the height of water per day (mm), I_a

is the original leakage of the superficial replacement, the dispersal before extra (mm) and S is the water saving (mm). A change in saving parameter ends in changes in the type of the soil, land application, organization, gradient and soil content. Saving parameter is measured in Eq. 2 (SWAT Theoretical Documentation Version, 2009):

$$s = 25.4 \left(\frac{1000}{CN} - 10 \right) \quad (2)$$

I_a is about assessed as 0.25 and fed to Eq. (1). To get Eq. 3:

$$Q_{\text{surf}} = \frac{(R_{\text{day}} - 0.2s)^2}{(R_{\text{day}} + 0.8s)} \quad (3)$$

Runoff occurs only if $R_{\text{day}} > I_a$. The graphic explanations for Eq. 3 with the arithmetical standards of diverse curves are existed. For example, apparent in the developed the quantity of the curve, the supplementary rainfall runoff. The runoff ensuing from rainfall varies in a curve consistent with the Curve Number (Hao, et al. 2004). SCS curve describes three humidity situations: 1-dry 2-Medium humidity 3-wet. The moisture state 1 (dry) keeps the bottommost rate in the regular CN. The CNs for humidity situations 1 and 2 are designed depends on Eqs. 4 and 5:

$$CN_1 = CN_2 - \frac{20 \cdot (100 - CN_2)}{(100 - CN_2 + \exp[2.533 - 0.0636(100 - CN_2)])} \quad (4)$$

$$CN_3 = CN_2 \cdot \exp[0.00673 \cdot (100 - CN_2)] \quad (5)$$

where, CN_1 , CN_2 and CN_3 are the number of curves 1, 2 and of previous humidity, respectively.

William (1995) developed the equation of curve numbers for diverse gradients as Eq. 6:

$$CN_{2s} = \frac{(CN_3 - CN_2)}{3} \cdot [1 - 2 \cdot \exp(-13.86 \cdot slp)] + CN_2 \quad (6)$$

where, CN_{2s} (the number of previous humidity II) is set for the slope, CN_3 (the curve number III) is a 5% gradient, CN_2 (the number of previous humidity II) is for a 5% gradient and SLP is the usual gradient of washbasins. SWAT does not establish the CNs for the gradient. Situation is completed before ingoing the CN and over the input case organization. SWAT input flexible, using the curve number technique, marks the highland overflow design as in Table 1. Manning over land roughness constant value for the planned watershed district and connected SWAT tables are in the assortment of 0.05 to 0.2. The finest rate for this district was designed as 1 (SWAT Theoretical Documentation Version, 2009). The land current concentration time t_{ov} is calculated as Eq. 7 (SWAT, 2009):

Table 1 SWAT input variables that pertain to surface runoff (SWAT, 2009)

Various name	Description	Input file
IEVENT	Rainfall, runoff, routing option.bsn	
ICN	Regular curve number design technique: 0 compute regular CN rate as a purpose of. bsn	
Soil moisture, 1 computer daily CN rate as a purpose of vegetable evapotranspiration		
CNCOEF	CNCOEF: Weighting quantity applied to compute the preservation constant for daily. bsn curve quantity designs reliant on vegetable evapotranspiration	
PERCIPITATION	R _{day} : Daily rainfall (mm H ₂ O).pcp	
CN ₂	CN ₂ : Humidity state II curve number.mgt	
CNOP	CN ₂ : Humidity state II Curve Number.mgt	

$$t_{ov} = \frac{L_{slp}}{3600 \cdot v_{ov}} \tag{7}$$

where, L_{slp} is the distance of washbasin gradient, v_{ov} is the rapidity of land current (m/s) and 3600 is the component alteration component. The speed of the land current was assessed depend on Eq. 8 or Manning calculation:

$$v_{ov} = \frac{q_{ov}^{0.4} \cdot slp^{0.8}}{n^{0.6}} \tag{8}$$

where, q_{ov} is the regular of the terrestrial existing, slp is gradient of washbasin and n is the Manning coarseness quantity for the washbasin. The degree of stream is presumed as 6.49 mm/h and component alteration was completed over Eqs. 9–14:

$$v_{ov} = \frac{0.005 \cdot L_{slp}^{0.4} \cdot slp^{0.8}}{n^{0.6}} \tag{9}$$

$$t_{ov} = \frac{L_{slp}^{0.6} \cdot n^{0.6}}{18 \cdot slp^{0.8}} \tag{10}$$

$$v = D^{2/3} S^{1/2} n^{-1} \tag{11}$$

$$q = Dv \tag{12}$$

$$q = D^{5/3} S^{1/2} n^{-1} \tag{13}$$

$$n = D^{5/3} S^{1/2} q^{-1} \tag{14}$$

Anywhere v = the mean flow rapidity ($m s^{-1}$), n = the Manning resistance coefficient and S = the angle gradient ($m m^{-1}$) (Mwendera et al. 1992). The present dataset (Raba_SYLD) comprises the widespread sediment profit investigations, for the SYLD component, i.e., deposit from the hydrologic response unit that is transformed into the foremost conduit. The cost of the SYLD component was

defined applying the Macro-prototypical DNS/SWAT applying the form as Eq. 15:

$$sed = 11.8 \times (Q_{surf} \times q_{peak} \times area_{HRU})^{0.56} \times K_{USLE} \times C_{USLE} \times P_{USLE} \times LS_{USLE} \times CFRG \tag{15}$$

wherever: sed is the deposit product on an expected day, Q_{surf} is the superficial overflow dimensions (mm H₂O/ha), $q_{highest}$ is the highest overflow grade (m^3/s), district HRU is the portion of the HRU (ha), K_{USLE} is the USLE soil erodibility component ($0.013 t m^2 h / (m^3 - metric ton cm)$), C_{USLE} is the USLE cover and association parameter, P_{USLE} is the USLE establishment preparation parameter, LS_{USLE} is the USLE geographical parameter, $CFRG$ is the rough portion component. SWAT uses Eq. 16 to perform the hydrological series. The hydrological series is environment reliant on and provisions energy and dampness contributions for example everyday rainfall, supreme and smallest air temperatures, wind rapidity, qualified moisture and solar energy. The information can be recited straight from documents by SWAT to yield simulated information at runtime follows as Eq. 16:

$$SW_t = SW_{o+} \Sigma (R_{day}^- Q_{surf}^- Ea^- W_{seep}^- Q_{gw}^-) \tag{16}$$

where t is period (days), SW_o and SW_t are the initial and latter soil water contented, R_{day} , Q_{surf} , Ea , W_{seep} and Q_{gw} are the quantities of rainfall, superficial overflow, whole evapotranspiration, measurement of water entering the vadose area from the soil shape and reoccurrence current correspondingly. All components have units in mm and i denote the component value for a day (Talebmorad et al. 2020; Amoakowaah et al. 2019).

Soil category

In this research, we deal with the optimal CN and highland Coarseness constant of watershed. The rainfall information was selected from the diverse climatological parameters to

Fig. 2 Compare monthly simulated discharge of the SWAT with measured discharge

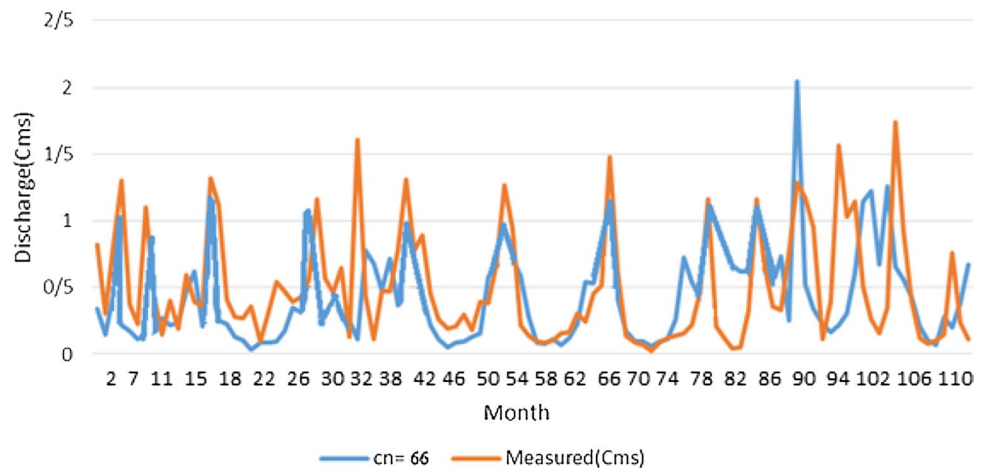


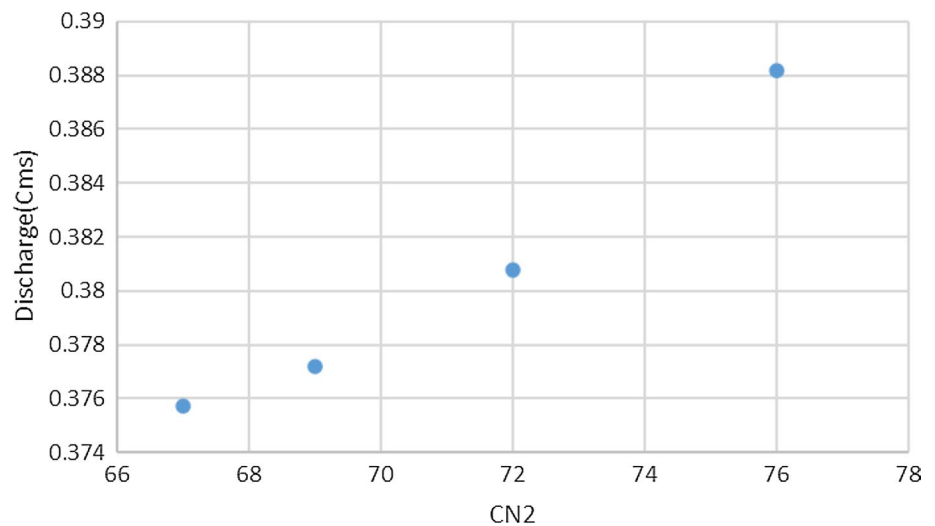
Table 2 Examine effective CN in the average simulated discharge

CN	66	70	73	77
Average simulated discharge	0.376987	0.377344	0.38055	0.388605
Average measured discharge (m ³ /s)	0.498976	0.498976	0.498976	0.498976
Error (m ³ /s)	0.121989	0.121632	0.118426	0.11075
Percent change or variable	0	0.3999%	1.3601%	3.3283%

Table 3 Examine effective over land roughness coefficient

Manning overland roughness coefficient	0.1	0.15	.17	0.23
Average simulated discharge (m ³ /s)	0.375814	0.375814	0.375814	0.375814
Average measured discharge (m ³ /s)	0.498972	0.498972	0.498972	0.498972
Difference average measured discharge And simulated discharge (m ³ /s)	0.123170	0.123170	0.123182	0.123182
Percent change or variable	0	0	-0.0043%	-0.0009%

Fig. 3 Difference CN2 with simulated discharge



gain the optimal Curve Number and the Overland Roughness factor of the watershed. SWAT was originally performed with the curve number $CN_2 = 66$ and the Overland Roughness factor 0.15. The results are presented in Fig. 2.

To improve components diverse standards for the Curve Number and roughness factor were applied and the relationship of the Discharge variations with individually one of parameters presented in Tables 2 and 3 are denoted in

a Figs. 3, 4 and 5. In comparison with runoff quantities recorded in hydrometer position and the planned quantity of current, the finest Curve Number was 67 and the Roughness factor of watershed was 0.1. Next, depend on the obtained values; differences in SWAT input components were applied to simulate the river runoff (Soil Conservation Service, 1972). The effects of difference in individually

of climatological components on runoff was planned and contrasted with the experimental runoff. It would be stated that in this phase of designs individual rainfall information was considered the prototypical (Soil Conservation Service Engineering Division, 1972). Figure 6 Shows Simulated discharge river with variable manning overland roughness factor to compare measured discharge. Table 3 shows Examine

Fig. 4 Variance manning overland roughness factor with simulated discharge

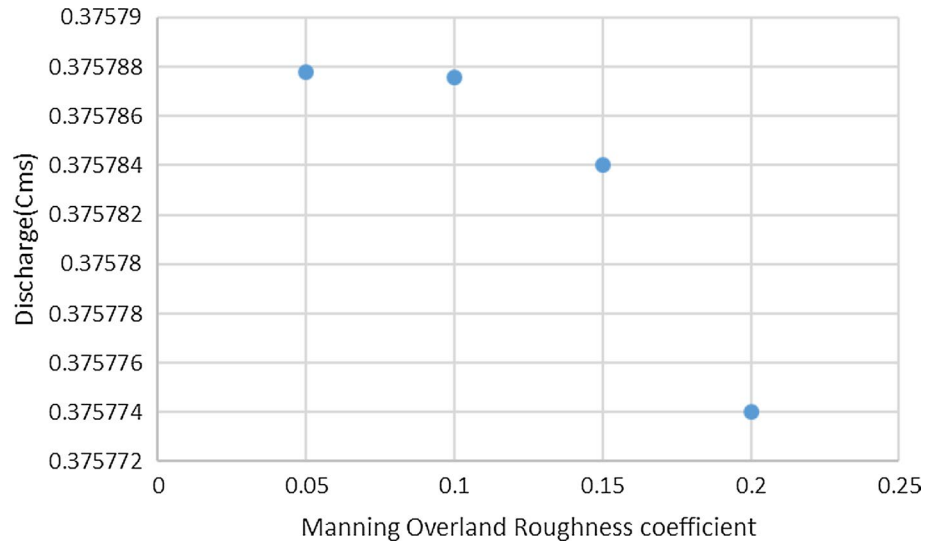


Fig. 5 Simulated discharge stream with variable CN to compare measured discharge

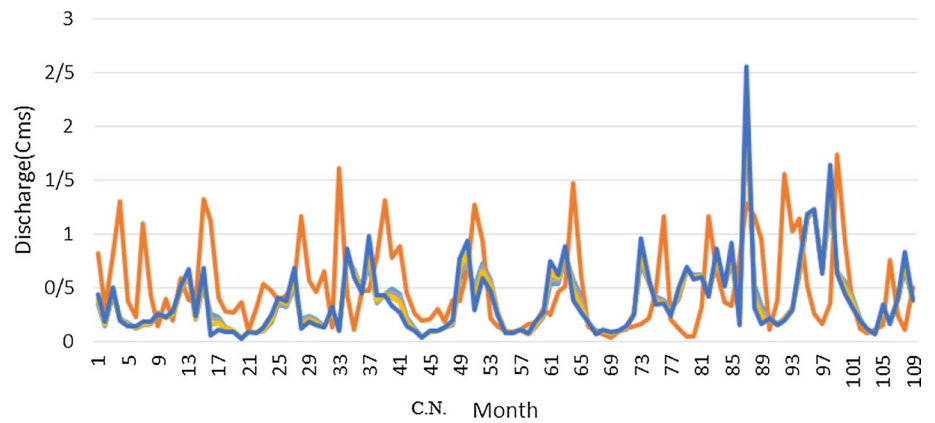
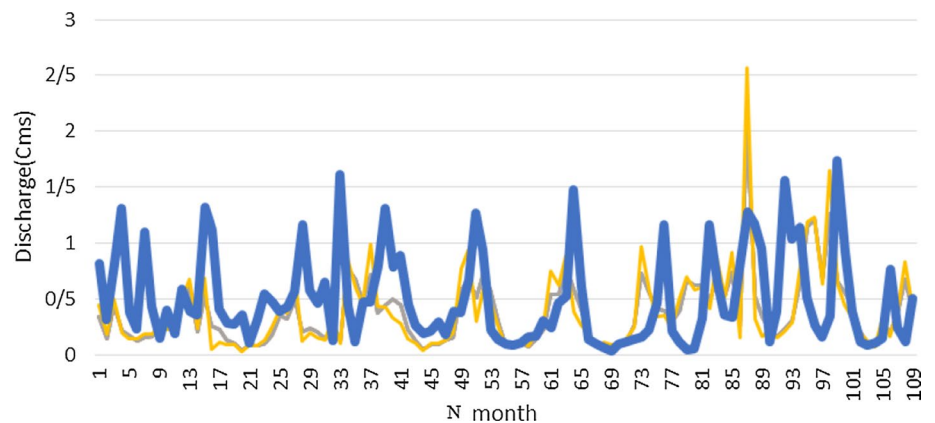


Fig. 6 Simulated Discharge River with variable manning overland roughness factor



effective over land roughness coefficient in the average discharge calculation.

Sensitivity analysis

In this stage of research, other essential climatological components with meteorological information was considered SWAT and the medium overflow, as is exposed in the tertiary row if the Table 4, was designed as 0.5752 cubic meters per second.

Rainfall effect

So as to study the sensitivity of the runoff assessed by the prototypical to rainfall, originally, all rainfall standards were multiplied to 1.6 and the overflow was designed. The factual quantity of rainfall was applied to gain the regular lasting runoff of the river (0.5704233). With a 53% increase in the rainfall, the river runoff was enlarged to 1.285224082 (a 133% increase). With a 33% decline in rainfall, the average runoff reduced for 65.3% (0.203889459 cubic meters per second). Accordingly, we face 0.7153 rises and 0.3676 declines in monthly runoff.

Table 4 Result variable simulated discharge that change rainfall

Difference Average				
Rainfall (mm)	Average simulated Discharge (m ³ /s)	Average Measured Discharge (m ³ /s)	Measured Discharge and Simulated Discharge (m ³ /s)	Percent Variable Simulated Discharge
PCP×1.5=3.11193	1.285224082	0.49895316	0.7866	126.21%
PCP×0.7=1.452184	0.203898444	0.49895316	0.2959	-65.07%
PCP=2.07462	0.5704314	0.49895316	0.0719	0

Fig. 7 Result simulated discharge with change rainfall

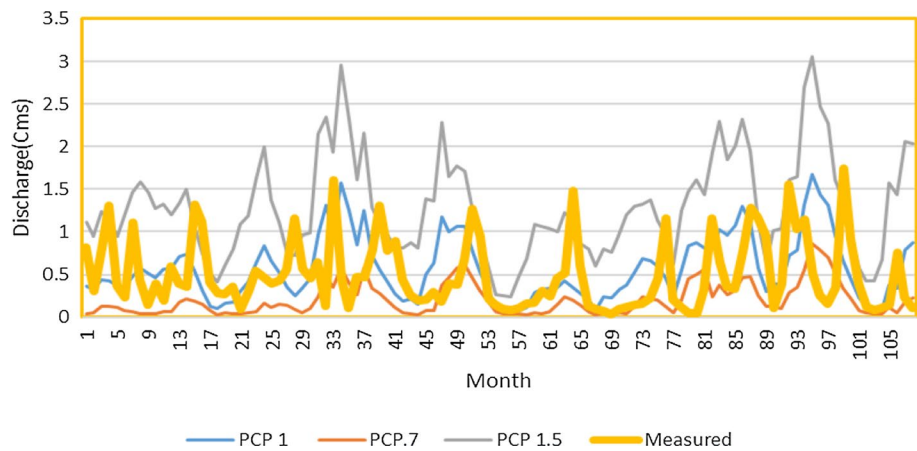
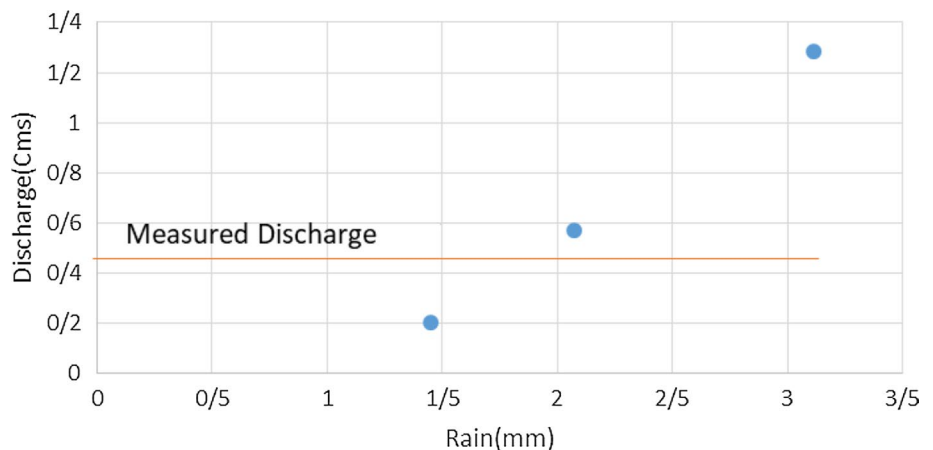


Fig. 8 Difference simulated discharge



As apparent in Fig. 7, the monthly runoff route is rising depend on the rainfall. With a 53% rise and a 32% decline in input rainfall, the inspired runoff will be 0.82 and 0.31 which are higher and lower than the average observed monthly overflow, individually (Fig. 8).

Solar radiation

Effect with a 22% rise and a 33% decline in the input solar energy, the replicated overflow diverse from 0.59 cubic meters per second to 0.60 and 1.24 cubic meters per

second, individually. The monthly differences are considered in Table 5 and Fig. 9 and Fig. 10 with a 22% rise and a 33% decline in the input solar energy, the replicated overflow would increase 0.12 and 0.77 cubic meters per second respectively. Table 5 shows difference simulated discharge of the model SWAT with difference information input solar radiation. Table 6 Shows difference measured discharge and simulated discharge with difference information input wind speed Fig. 7. Shows variance simulated discharge with alteration data input rainfall. The trend is increased suddenly.

Table 5 Difference simulated discharge of the model SWAT

Difference Average				
Average Solar Radiation (MJ/(m ² /Day))	Average Simulated Discharge (m ³ /s)	Average Measured (m ³ /s)	Measured Discharge and Simulated Discharge (m ³ /s)	Percent Variable Simulated Discharge
Solar × 1.22 = 22.19	0.59279278	0.498653719	0.0943	3.91236%
Solar + 1.73 = 12.92	1.224635	0.498653719	0.7267	114.75%
Solar = 18.45	0.5704326	0.498653719	0.0723	0

Fig. 9 Result simulated discharge

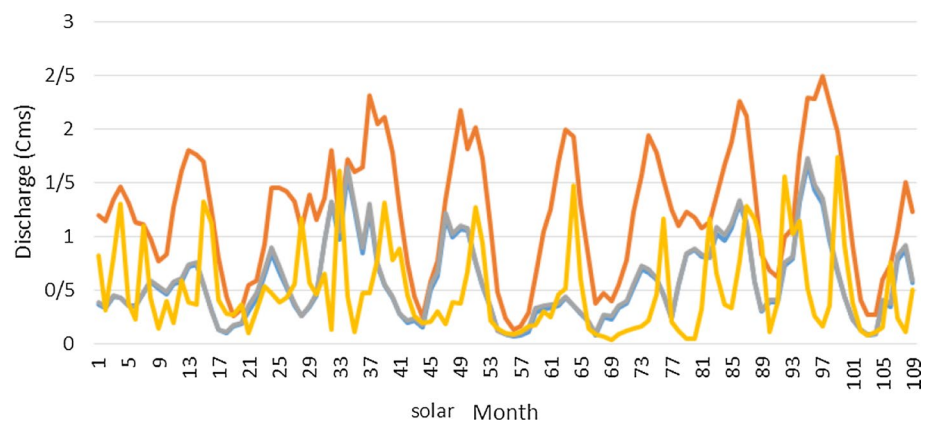


Fig. 10 Simulated discharge average monthly

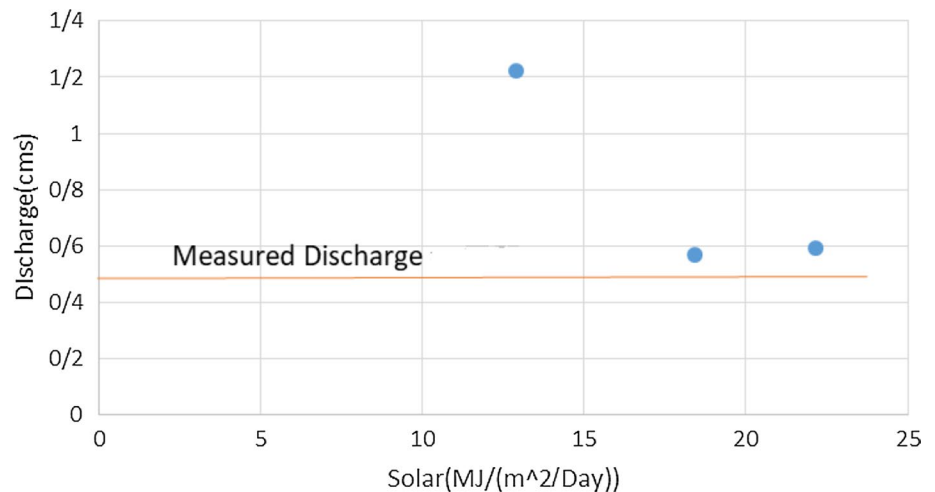


Table 6 Difference simulated discharge with changing information input humidity

Difference average				
Average Humidity (%)	Average Simulated Discharge (m ³ /s)	Average Measured Discharge (m ³ /s)	Measured Discharge and Simulated Discharge (m ³ /s)	Percent Difference Simulated Discharge
Rh=0.4596	0.5704233	0.498962	0.0732	0
Rh×1.2=0.5512	0.69474212	0.498962	0.19564	21.82%
Rh×0.7=0.3223	0.30842516	0.498962	0.1926	-46.02%

Table 7 Difference measured discharge and simulated discharge

Difference Average				
Average Wind Speed (m/s)	Average Simulated Discharge (m ³ /s)	Average Measured Discharge (m ³ /s)	Measured Discharge and Simulated Discharge (m ³ /s)	Percent Variable Simulated Discharge
Wind×0.73=1.79	1.2898396	0.498953716	0.7923	127.15%
Wind×1.6=3.86	1.23933723	0.498953716	0.7423	119.33%
Wind=2.56	0.5704233	0.498953716	0.0720	0

Fig. 11 Result simulated discharge average monthly

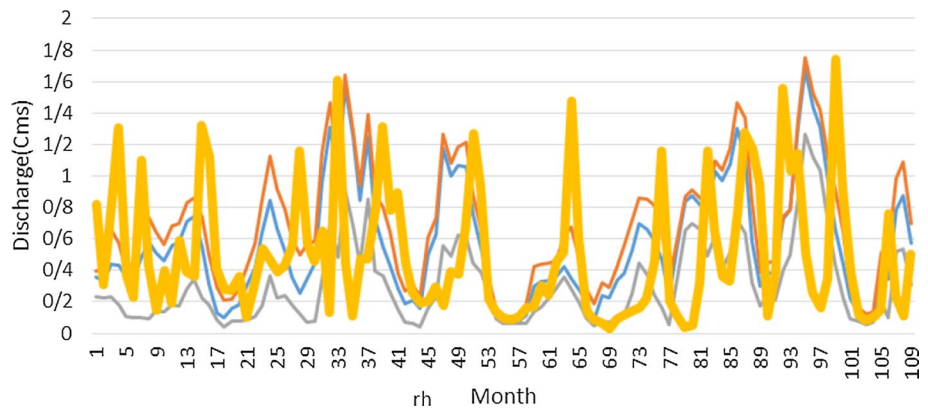
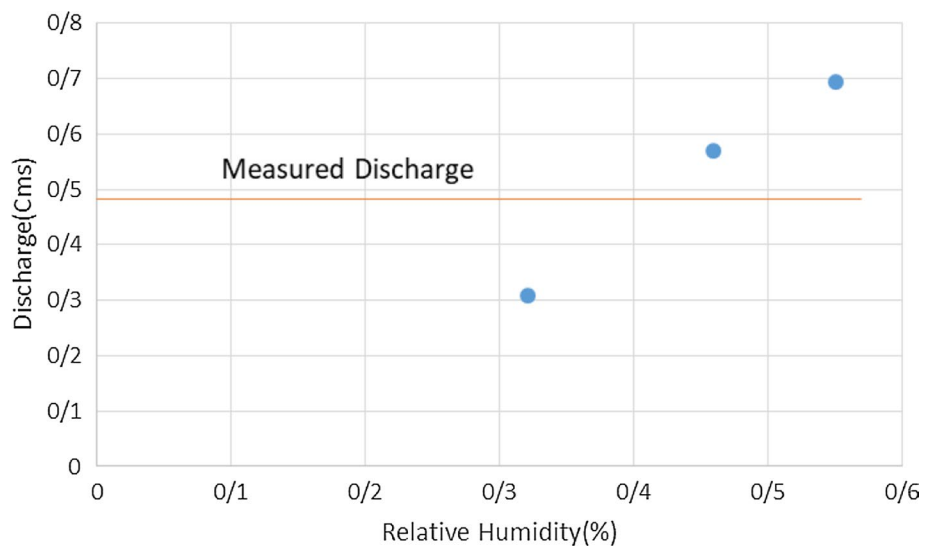


Fig. 12 Simulated discharge with difference information input humidity



Humidity effect

By a 22% intensification and a 33% decline in the input relative moisture, the medium monthly overflow would change from 0.5704 to 0.6947 and 0.3084, individually. These 21.79% rise and 45% decline are determined in the Table 7 and Fig. 11 and 12. By a 22% rise and 33% decline in input relative moisture, the replicated overflow was 38.29% higher and 39.122% lesser than medium quantified monthly overflow, individually. Figure 11 Shows result simulated

discharge average monthly with difference information input relative Humidity. Table 8 shows variance simulated discharge with alteration data input temperature and temperature is increased then discharge is decreased and temperature is decreased then discharge is increased.

Wind Speed

By a 52% rise and a 33% decline in input wind rapidity, the obtained medium monthly overflow would be 1.34 and

Table 8 Difference simulated discharge with difference information input temperature

Difference average				
Temperature(C)	Average Simulated Discharge (m ³ /s)	Average Measured Discharge (m ³ /s)	Measured Discharge and Simulated Discharge (m ³ /s)	Percent Variable Simulated Discharge
T×0.67 = 7.7627383	0.79410479	0.498953716	0.2963	39.29%
T×1.53 = 16.635586	0.242062693	0.498953716	0.2572	-57.63%
T = 11.08966	0.5704233	0.498953716	0.0723	0

Fig. 13 Simulated discharge with difference information input wind speed

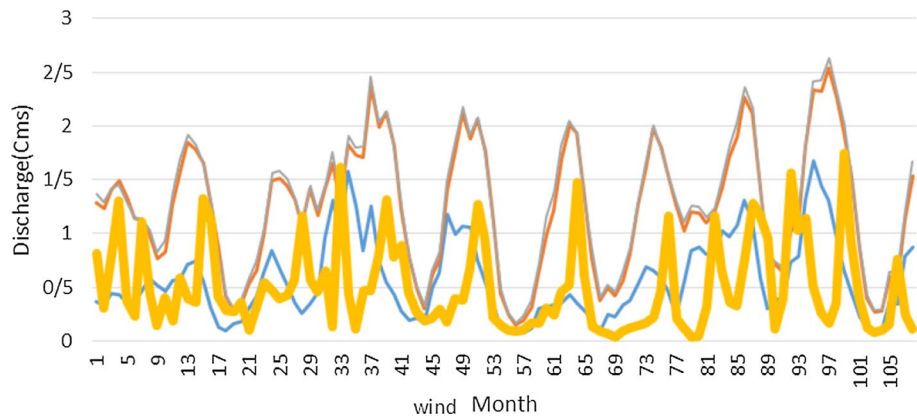
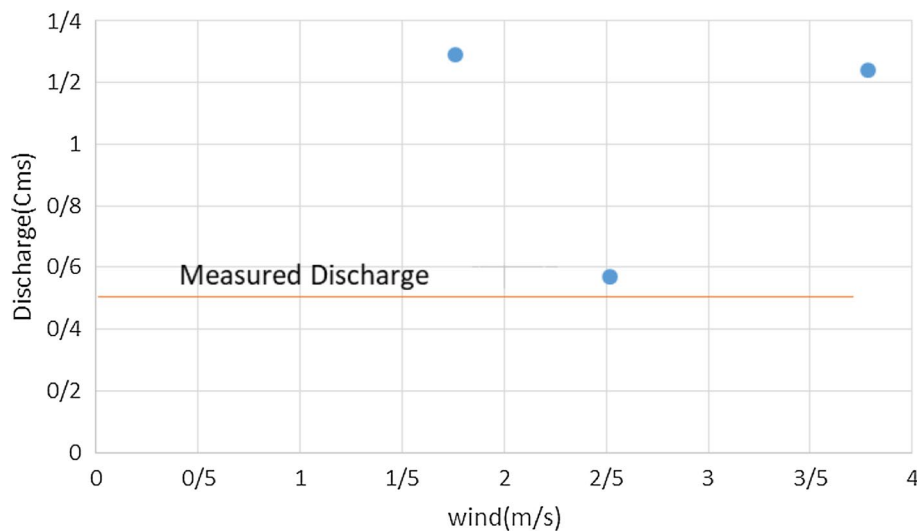


Fig. 14 Simulated discharge with difference information input wind speed



1.36 cubic meters per second. The replicated standards are 0.76 and 0.82 developed than the experimental medium monthly runoff (Figs. 13, 14 and Table 6).

Temperature

by a 53% rise and a 33% decline in the input temperature, the medium monthly overflow diverse after 0.5704233 to 0.242062699 and 0.79410473, that is, a 58.66% rise and a 38.36% decline in the monthly overflow. The Replicated consequences are 53% minor and 62.03% higher than the Measured Average Monthly Runoff. But scarce revisions considered the employment-off amongst current and deposit objectives throughout prototypical calibration procedures. It was planned a novel multi-objective calibration technique that includes together current and deposit experimental data into a probability purpose depend on the Talar watershed inference. Contrasted with the only-objective technique, the multi-objective method recovers the appearance of residue reproductions deprived of meaningfully damaging the appearance of current reproductions, and decreases the indecision of current components, particularly current absorption components.

Results

1. By 13.52% rise in the CN, the Simulated Medium Monthly Overflow would 2.57% adjacent to the quantified medium overflow. by a 1.53% rise in the coarseness factor of basin, the Replicated overflow define 0.012% closer to the Measured Discharge
2. SWAT software is a good tool to estimate Average Monthly runoff using the rainfall, temperature and other required data. A 33% decline in the medium monthly rainfall, solar energy, qualified moisture, wind and temperature would origin a 65.39% decline, 115.68% rise, 46.02% decline, 126.23% rise and 39.36% rise, individually. It is apparent that the rainfall and the comparative moisture face the greatest declines. The greatest intensification in overflow was a purpose of wind, then solar energy and lastly temperature.
3. by a 53% rise in the Medium Monthly rainfall, a 22% rise in the radiation and comparative moisture and a 53% rise in airstream and temperature, the measurement of displayed overflow would face a 129.59% rise, 3.9098% rise, 21.89% rise, 117.33% rise and 57.64% decline, individually. Rainfall then airstream and relative moisture origin the greatest intensifications. The least runoff sensitivity is related to the solar radiation.
4. The prototypical was confirmed for its ability to recover simulation of discharge. Discharge is consistent variable quantity which shows a main part on water obtainabil-

ity, ecological preservation and eco-hydrological operational of a watershed. So as to examine their spatial-temporal changing aspects, hydrological mockups are assessment instruments. But, to diminish uncertainties of the prototypical approximations, good quality dispersed experimental information established are essential for realist forecasting. The goal of this investigation is to use SWAT in a demonstrative basin of Talar basin, and to assess the properties of applying together release and soil dampness information's on the prototypical doubts and forecasts. For stream flow, the standards of the Nash–Sutcliffe prototypical efficiency (NS) amongst instrument positions fluctuated from 0.73 to 0.94 in the calibration stage for the yearly period stage, and amongst 0.58 and 0.81 in the monthly period stage. In the justification stage, NS standards fluctuated from 0.63 to 0.79 for the yearly period stage and amongst 0.66 and 0.79 for the once-a-month period stage. Consequences were impacted by sensitivities of components to flow management and objective purposes.

Discussion

Key findings

This study inspected the part showed by environment and land use variations on discharge for the Talar watershed (North of Iran) over the period 2006–2017. examining discharge until 2017 shows that discharge is methodically impacted by climate and land cover shapes in future. Climate Change and flora alteration show a significant part in discharge by alteration within rainfall erosivity and land use, correspondingly. Rainfall erosivity in forthcoming environment under the production of rationalizing Nationwide Middles for Environmental Forecast information and under dissimilar circumstances will be much more than that of the present dated. These consequences display that rainfalls with less period and more concentration will happen. Therefore, simultaneousness of modification in rainfall shapes with land cover alteration will lead to a numerous intensification in soil loss degree and other features in forthcoming period contrasted to the present period. The consequences show that discharge has been carefully connected to land use alteration and that numerous situations of environment alteration have considered a subordinate part in the progress of corrosion. Environment variation is an ordinary procedure and nearly obvious. Therefore, if land use alteration can be measured, and with the presence of future environment alteration, discharge can be importantly measured. The present investigation is fundamentally an assessment of the watershed society accomplished in Talar watershed in Mazandaran province (Iran). At this historical, an inspection of the data composed

from the procedure in the Talar watershed, similarly assesses the proceedings done Watershed. In an evaluation group, the purpose of leading the usage of a watershed society plan and categorizing imaginable specialties or weakness by worsening to difference optimistic watershed association plans with unsuccessful watershed society plans. It can be enclosed the technique for the quantifiable and qualitative usage of the arrangement components. This examination was focused with the aim of measuring the consequence of alluvial rock dams on the hydrological point of Talar watershed. Assessing the present watershed procedure follows to comprehend how effective the watershed procedure has been in its frequent dimensions. The significances of this examination can be used to explain local growth in the explanation of spread and events, and in general, the generous and measurement of load in the instruction basin. The significances of research show that the usage of watershed association in watersheds has showed a important portion in monitoring superficial runoffs.

Conclusions

Hydro-climatic excesses, for example humid and overflows, have most probable enlarged owing to climatically alteration and could due to simple effects on socio-financial, organizational and ecological areas. It was premeditated greatest hydraulic plans, for example barricades, it was distinct the excess of the streams. If the stream presences any situation to quantify the profit, the hydraulic mockups can be used to guesstimate it. SWAT is widely-used high-tech mockups. This investigation contemplates the understanding of the excess approximation for streams, by the SWAT prototypical; depend on changes in such meteorological parameters as rainfall, cosmological energy, airstream, moisture and temperature. The gained significances require that by 30.46% decay in the normal scheduled rainfall, brightness, qualified moisture, airstream and temperature, it was usual ermined 64.73% decay, 115.14% rise, 45.99% decrease, 126.58% rise and 40.15% rise in exhibited excess, independently. The wind speed and the solar energy are the most sensitive and temperature is the smallest penetrating parameters in the overflow approximation. These consequences signify “acceptable” and “very good” performances for discharge. While there is still some quantity of ambiguity, the practice of balancing information, for example soil dampness, to adjust and confirm the SWAT model package prototypical is beneficial, particularly when discharge information is infrequent, as for some watersheds in the humid region. Evaluation of the water usage efficacy is the important to efficiently accomplish agronomic water resource. SWAT prototypical routine in simulating the hydrogeological management has been assessed for the Talar watershed,

Mazandaran province (Iran) applying different soil shapes. The consequences of the calibration process show a deteriorating of the routine if a collective number of soil units are measured. Discharge presented a respectable routine and was consequently additional utilized in the validation process. The shaped map displays that some sub-basins are constantly considered by a high quantity of runoff. The runoff exposure map, comprehended examining the yearly maps shows the same sub-basins as high disposed to runoff. Exclusive these zones, considered by high development, short runoff periods could happen, rising the peak current downriver and accordingly the flood hazard. This explanation denotes an appreciated instrument for supervision application strategies and deterrent goal schedules for those zones more disposed to runoff efficiency. The overall method here used can be accepted in many other minor watersheds categorized by Talar (Mazandaraan Province, Iran) environment.

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Data availability All the data, including the experimental measurements, the data used for formulating empirical relations, and the code processing the data that support the findings of this study, are available from the corresponding author upon reasonable request.

Declarations

Conflict of interest There is no conflict of interest.

Consent to publish All authors agree to publish this manuscript. There is no conflict of interest.

Ethical approval The present Study and ethical aspect was approved by Department of Irrigation, College of Agriculture, Isfahan University of Technology, 8415683111 Isfahan, Iran And Department of Environmental Health Sciences, Faculty of Communication, Arts and Sciences, Canadian University Dubai, Dubai, P. O. Box 117781, United Arab Emirates.

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References

- Abdollahi S, Madadi M, Ostad-Ali-Askari K (2021) Monitoring and investigating dust phenomenon on using remote sensing science geographical information system and statistical methods. *Appl Water Sci* 11(7):111. <https://doi.org/10.1007/s13201-021-01419-z>
- Abunada Z, Kishawi Y, Mittelstet A (2020) The application of SWAT-GIS tool to improve the recharge factor in the DRASTIC framework: case study. *J Hydro* 592:125613. <https://doi.org/10.1016/j.jhydrol.2020.125613>
- Amoakowaah Osei M, Kofitse Amekudzi L, Dotse Wemegah D, Preko K, Serwaa Gyawu E, Obiri-Danso K (2019) The impact of climate and land-use changes on the hydrological processes of Owabi catchment from SWAT analysis. *J Hydro* 25:100620. <https://doi.org/10.1016/j.ejrh.2019.100620>
- Alavinia M, Nasiri Saleh F (2010) Comparison of HSPF and SWAT Model to simulate Sediment; (Case Study: Watershed Abro). Fifth national congress on civil engineering ferdowsi university of mashhad (In Persian)
- Akram MS, Mirza K, Zeeshan M, Ali M, Ahmed L (2018) Geotechnical investigation and prediction of rock burst, squeezing with remediation design by numerical analyses along headrace tunnel in swat valley, Khyber Pakhtunkhwa. *Pakistan Open J Geo* 8(10):965–986. <https://doi.org/10.4236/ojg.2018.810058>
- Apostel A, Kalcic M, Scavia D (2020) Simulating internal watershed processes using multiple SWAT models. *Sci Total Environ* 759:143920. <https://doi.org/10.1016/j.scitotenv.2020.143920>
- Behdari Nejad B (2011). Estimation of erosion, sedimentation and nutrient loss in Gorganrood catchment with SWAT model. A thesis presented for a degree master of science (M.Sc) in soil physics and conservation (In Persian).
- Chu TW, Shirmohammadi A (2004) Evaluation of the SWAT model's hydrology component in the piedmont physiographic region of Maryland. *Tran ASAE* 47(4):1057. <https://doi.org/10.13031/2013.16579>
- Derakhshannia M, Dalvand S, Asakereh B, Ostad-Ali-Askari K (2020) Corrosion and deposition in Karoon River Iran based on hydro-metric stations. *Int J Hydrol Sci Technol* 10(4):334. <https://doi.org/10.1504/IJHST.2020.108264>
- Eslamian S et al (2018a) Saturation. In: Bobrowsky P, Marker B (eds) *Encyclopedia of engineering geology*. Encyclopedia of earth sciences series. Springer, Cham. https://doi.org/10.1007/978-3-319-12127-7_251-1
- Eslamian S et al (2018b) Water. In: Bobrowsky P, Marker B (eds) *Encyclopedia of engineering geology*. Encyclopedia of earth sciences series. Springer, Cham. https://doi.org/10.1007/978-3-319-12127-7_295-1
- Fatahi Nafchi R, Samadi-Boroujeni H, Raeisi Vanani H, Ostad-Ali-Askari K, Brojeni MK (2021a) Laboratory investigation on erosion threshold shear stress of cohesive sediment in Karkheh Dam. *Environ Earth Sci* 80(19):1–15. <https://doi.org/10.1007/s12665-021-09984-x>
- Fatahi Nafchi R, Yaghoobi P, Reaisi Vanani H, Ostad-Ali-Askari K, Nouri J, Maghsoudlou B (2021b) Eco-hydrologic stability zonation of dams and power plants using the combined models of SMCE and CEQUALW2. *Appl Water Sci* 11:109. <https://doi.org/10.1007/s13201-021-01427-z>
- Fatahi Nafchi R, Raeisi Vanani H, Noori Pashae K, Samadi Brojeni H, Ostad-Ali-Askari K (2022a) Investigation on the effect of inclined crest step pool on scouring protection in erodible river beds. *Natural Hazards* 110(3):1495–1505. <https://doi.org/10.1007/s11069-021-04999-w>
- Fatahi Nafchi R, Yaghoobi P, Raeisi Vanani H, Ostad-Ali-Askari K, Nouri J, Maghsoudlou B (2022b) Correction to: Eco-hydrologic stability zonation of dams and power plants using the combined models of SMCE and CEQUALW2. *Appl Water Sci* 12(4):55. <https://doi.org/10.1007/s13201-021-01563-6>
- FrizzelleFournier CAR, Luther EJ (2021) Using the soil and water assessment tool to develop a LiDAR-based index of the erosion regulation ecosystem service. *J Hydro* 595:126009. <https://doi.org/10.1016/j.jhydrol.2021.126009>
- Gholami SH (2003) The simulation of daily sediment yield by using distributed SWAT model in mountainous catchments (Amameh Catchments). *J PAJOUHESH-VA-SAZANDEGI*. 16(4):28–33
- Golian M, Katibeh H, Singh VP, Ostad-Ali-Askari K, Rostami HT (2020) Prediction of tunnelling impact on flow rates of adjacent extraction water wells. *Q J Eng Geol Hydrogeol* 53(2):236–251. <https://doi.org/10.1144/qjegh2019-055>
- Hao FB, Zhang XS, Yang ZF (2004) A distributed non-point source pollution model: calibration and validation in the yellow river basin. *J Environ Sci* 16(4):646–650
- Javadinejad S, Eslamian S, Ostad-Ali-Askari K, Mirramazani SM Zadeh LA, Samimi M (2018) Embankments. In: Bobrowsky P, Marker B (eds) *Encyclopedia of engineering geology*. Encyclopedia of earth sciences series. Springer, Cham. https://doi.org/10.1007/978-3-319-12127-7_105-1
- Javadinejad S, Eslamian S, Ostad-Ali-Askari K (2019a) Investigation of monthly and seasonal changes of methane gas with respect to climate change using satellite data. *Appl Water Sci* 9(8):180. <https://doi.org/10.1007/s13201-019-1067-9>
- Javadinejad S, Ostad-Ali-Askari K, Jafary F (2019b) Using simulation model to determine the regulation and to optimize the quantity of chlorine injection in water distribution networks. *Model Earth Syst Environ* 5(3):1015–1023. <https://doi.org/10.1007/s40808-019-00587-x>
- Javadinejad S, Eslamian S, Ostad-Ali-Askari K (2021) The analysis of the most important climatic parameters affecting performance of crop variability in a changing climate. *Int J Hydrol Sci Technol* 11(1):1. <https://doi.org/10.1504/IJHST.2021.112651>
- Khaleghi MR, Gholami V, Ghodusi J, Hosseini HH (2011) Efficiency of the geomorphologic instantaneous unit hydrograph method in flood hydrograph simulation. *CATENA* 87(2):163–171. <https://doi.org/10.1016/j.catena.2011.04.005>
- Kondo T, Sakai N, Shimizu Y (2021) Verifying the applicability of SWAT to simulate fecal contamination for watershed management of Selangor River. *Malaysia Sci Total Environ* 774:145075. <https://doi.org/10.1016/j.scitotenv.2021.145075>
- Lei Y, Zhonggen W, Shengjun C (2015) Study on real water-saving in agricultural region based on improved SWAT model. *Phys Numer Simul Geo Eng* 20:59
- Leong Tan M, Gassman WP, James Haywood J (2020) A review of SWAT applications, performance and future needs for simulation of hydro-climatic extremes. *Adv Water Res* 143:103662. <https://doi.org/10.1016/j.advwatres.2020.103662>
- Mwendera EJ, Feyen J (1992) Estimation of depression storage and Manning's resistance coefficient from Random roughness measurements. *Geo* 52(3–4):235–250. [https://doi.org/10.1016/0016-7061\(92\)90039-A](https://doi.org/10.1016/0016-7061(92)90039-A)
- Omani N, Tajrishy M, Abrishamchie A (2007) Streamflow simulation using of SWAT and GIS model. Seventh International Seminar of River Engineering, Shahid Chamran University of Ahvaz (In Persian)
- Ostad-Ali-Askari K (2022a) Developing an optimal design model of furrow irrigation based on the minimum cost and maximum irrigation efficiency. *Appl Water Sci* 12(7):144. <https://doi.org/10.1007/s13201-022-01646-y>
- Ostad-Ali-Askari K (2022b) Management of risks substances and sustainable development. *Appl Water Sci* 12(4):65. <https://doi.org/10.1007/s13201-021-01562-7>
- Ostad-Ali-Askari K, Shayan M (2021) Subsurface drain spacing in the unsteady conditions by HYDRUS-3D and artificial neural

- networks. *Arab J Geosci* 14(18):1936. <https://doi.org/10.1007/s12517-021-08336-0>
- Ostad-Ali-Askari K, Shayannejad M (2021a) Quantity and quality modeling of groundwater to manage water Resources in Isfahan-Borkhar Aquifer. Environment, Switzerland
- Ostad-Ali-Askari K, Shayannejad M (2021b) Computation of sub-surface drain spacing in the unsteady conditions using Artificial Neural Networks (ANN). *Appl Water Sci* 11(2):21. <https://doi.org/10.1007/s13201-020-01356-3>
- Ostad-Ali-Askari K, Shayannejad M (2020c) Impermanent changes investigation of shape factors of the volumetric balance model for water development in surface irrigation. *Model Earth Syst Environ* 6(3):1573–1580. <https://doi.org/10.1007/s40808-020-00771-4>
- Ostad-Ali-Askari K, Shayannejad M, Ghorbanizadeh-Kharazi H (2017a) Artificial neural network for modeling nitrate pollution of groundwater in marginal area of Zayandeh-rood River Isfahan Iran. *KSCE J Civil Eng* 21(1):134–140. <https://doi.org/10.1007/s12205-016-0572-8>
- Ostad-Ali-Askari et al (2017b) Deficit Irrigation: Optimization Models. In: Handbook of drought and water scarcity, Management of drought and water scarcity, vol 3, 1st edn. Chapt 18. Taylor & Francis Publisher, Imprint, CRC Press, pp 373–389. <https://doi.org/10.1201/9781315226774> eBook ISBN: 9781315226774
- Ostad-Ali-Askari K, Shayannejad M, Eslamian S, Navabpour B (2018b) Comparison of solutions of Saint-Venant equations by characteristics and finite difference methods for unsteady flow analysis in open channel. *Int J Hydrol Sci Technol* 8(3):229. <https://doi.org/10.1504/IJHST.2018.093569>
- Ostad-Ali-Askari K, Su R, Liu L (2018a) Water resources and climate change. *J Water Clim Change* 9(2):239–239. <https://doi.org/10.2166/wcc.2018.999>
- Ostad-Ali-Askari K, Ghorbanizadeh-Kharazi H, Shayannejad M, Zareian MJ (2019) Effect of management strategies on reducing negative impacts of climate change on water resources of the Isfahan-Borkhar aquifer using MODFLOW. *River Res Appl* 35(6):611–631. <https://doi.org/10.1002/rra.3463>
- Ostad-Ali-Askari K, Ghorbanizadeh-Kharazi H, Shayannejad M, Zareian MJ (2020) Effect of climate change on precipitation patterns in an arid region using GCM models: case study of isfahan-borkhar plain. *Nat Hazards Rev* 21(2):04020006. [https://doi.org/10.1061/\(ASCE\)NH.1527-6996.0000367](https://doi.org/10.1061/(ASCE)NH.1527-6996.0000367)
- Phiri WK, Vanzo DD, Nyambe IA (2021) A pseudo-reservoir concept in SWAT model for the simulation of an alluvial floodplain in a complex tropical river system. *J Hydro* 33:100770. <https://doi.org/10.1016/j.ejrh.2020.100770>
- Pirnazar M, Hasheminasab H, Karimi AZ, Ostad-Ali-Askari K, Ghasemi Z, Haeri-Hamedani M, Mohri-Esfahani E, Eslamian S (2018) The evaluation of the usage of the fuzzy algorithms in increasing the accuracy of the extracted land use maps. *Int J Global Environ Issues* 17(4):307. <https://doi.org/10.1504/IJGENVI.2018.095063>
- Pourabdullah M, Tajrishy M (2006) Erosion catchment model with SWAT & rusle model (Case Study: Emameh Sub-Catchment). Seventh international conference of civil engineering (In Persian)
- Raeisi Vanani H, Shayannejad M, Reza A, Tudeshki S, Ostad-Ali-Askari K, Eslamian S, Mohri-Esfahani E, Haeri-Hamedani M, Jabbari H (2017) Development of a new method for determination of infiltration coefficients in furrow irrigation with natural non-uniformity of slope. *Sustain Water Res Manage* 3(2):163–169. <https://doi.org/10.1007/s40899-017-0091-x>
- Rostamian R, Mousavi S, Heidarpour M, Afyuni M, Abaspour K (2006) Application Of SWAT 2000 Model for Estimating Runoff and Sediment in Beheshtabad, Subbasin Of Northern Karun. A Thes Present Degree Mast Sci (M. Sc) Geology Faculty Agric 12(46):1–2009
- Saadati H (2003) Effect of land use on simulating daily discharge flow using SWAT mathematical model (Case Study: Talar Catchment Area). A thesis presented for the degree of master in watershed management. Tarbiat Modares University. Natural science faculty (In Persian)
- Salehi-Hafshejani S, Shayannejad M, Samadi-Boroujeni H, Zarraty AR, Soltani B, Mohri-Esfahani E, Haeiri-Hamedani M, Eslamian S, Ostad-Ali-Askari K (2019) Determination of the height of the vertical filter for heterogeneous Earth dams with vertical clay core. *Int J Hydrol Sci Technol* 9(3):221. <https://doi.org/10.1504/IJHST.2019.102315>
- Santhi C, Arnold JG, Williams JR, Dugas WA, Srinivasan R, Hauck LM (2001) Validation of the swat model on a large rower basin with point and nonpoint sources 1. *JAWRA* 37(5):1169–1188
- Sandeep Dash S, Sahoo B, Singh Raghuvanshi N (2020) How reliable are the evapotranspiration estimates by Soil and Water Assessment Tool (SWAT) and Variable Infiltration Capacity (VIC) models for catchment-scale drought assessment and irrigation planning? *J Hydro* 592:125838. <https://doi.org/10.1016/j.jhydrol.2020.125838>
- School J, Abbaspour KC, Srinivasan R, Yang H (2008) Estimation of freshwater availability in the West African sub-continent using the SWAT hydrologic model. *J Hydrol* 352(1–2):30–49. <https://doi.org/10.1016/j.jhydrol.2007.12.025>
- Shayannejad M, Ghobadi M, Ostad-Ali-Askari K (2022) Modeling of surface flow and infiltration during surface irrigation advance based on numerical solution of Saint-Venant equations using Preissmann's scheme. *Pure Appl Geophys* 179(3):1103–1113. <https://doi.org/10.1007/s00024-022-02962-9>
- Shrestha KN, Akhtar T, Daggupati P (2020) Can-GLWS: canadian great lakes weather service for the soil and water assessment tool (SWAT) modelling. *J Great Lake Res* 47(1):242–251. <https://doi.org/10.1016/j.jglr.2020.10.009>
- Soil Conservation Service (1964) Chapter 17: Flood routing, Section 4, Hydrology, National engineering handbook. U.S. Department of Agriculture. U. S. Gov't Printing Office, Washington, D.C.
- Soil Conservation Service (1972) Section 4: hydrology in national engineering handbook. SCS. Soil Conservation Service Engineering Division. 1986. Urban hydrology for small watersheds. U.S. Department of Agriculture, Technical Release 55.U
- Talebzadeh M (2009) Daily sediment load estimation using the SWAT model and artificial neural network. Talar Watershed Tarbiat Modares University Natural Science Faculty, Case Study (In Persian)
- Talebmorad H, Ahmadnejad A, Eslamian S, Ostad-Ali-Askari K, Singh VP (2020) Evaluation of uncertainty in evapotranspiration values by FAO56-Penman-Monteith and Hargreaves-Samani methods. *Int J Hydrol Sci Technol* 10(2):135. <https://doi.org/10.1504/IJHST.2020.106481>
- Talebmorad H, Abedi-Koupai J, Eslamian S, Mousavi SF, Akhavan S, Ostad-Ali-Askari K, Singh VP (2021) Evaluation of the impact of climate change on reference crop evapotranspiration in Hamedan-Bahar plain. *International Journal of Hydrology. Sci Technol* 11(3):333. <https://doi.org/10.1504/IJHST.2021.114554>
- USDA Soil Conservation Service. (1972). National engineering handbook section 4 hydrology, Chapter 4–10.
- USDA Soil Conservation Service. (1983). National engineering handbook section 4 hydrology, Chapter 19.
- Wallace CW, Flanagan DC, Engel BA (2018) Evaluating the effects of watershed size on SWAT calibration. *Water* 10(898):1–27. <https://doi.org/10.3390/w10070898>
- Wanders N, Karssenber D, de Roo A, de Jong SM, Bierkens MFP (2014) The suitability of remotely sensed soil moisture for improving operational flood forecasting. *Hydrol Earth Syst Sci* 18(6):2343–2357. <https://doi.org/10.5194/hess-18-2343-2014>
- Werneck FP (2011) The diversification of eastern South American open vegetation biomes: historical biogeography and perspectives. *Quat Sci Rev* 30:1630–1648. <https://doi.org/10.1016/j.quas-cirev.2011.03.009>

- Xue C, Asce M, B.C., Wu, H., (2014) Parameter uncertainty analysis of surface flow and sediment yield in the Huolin basin. *China J Hydrol Eng* 19:1224–1236. [https://doi.org/10.1061/\(ASCE\)HE.1943-5584.0000909](https://doi.org/10.1061/(ASCE)HE.1943-5584.0000909)
- Yamini Priya R, Manjula R (2021) A review for comparing SWAT and SWAT coupled models and its applications. *Mater Today Proc.* <https://doi.org/10.1016/j.matpr.2021.02.414>
- Yang J, Reichert P, Abbaspour KC, Xia J, Yang H (2008) Comparing 1150 uncertainty analysis techniques for a SWAT application to the chaohe basin in China. *J Hydrol* 358:1–23. <https://doi.org/10.1016/j.jhy-drol.2008.05.012>
- Zettam A, Taleb A, Sauvage S, Boithias L, Belaidi N, Sánchez-Pérez JM (2017) Modelling hydrology and sediment transport in a semi-arid and anthropized catchment using the swat model: the case of the Tafna river (Northwest Algeria). *Water* 9(3):216. <https://doi.org/10.3390/w9030216>
- Zhang D, Chen X, Yao H, Lin B (2015) Improved calibration scheme of SWAT by separating wet and dry seasons. *Ecol Model* 301:54–61. <https://doi.org/10.1016/j.ecolmodel.2015.01.018>
- Zhang X, Liang F, Srinivasan R, Van Liew M (2009) Estimating uncertainty of streamflow simulation using Bayesian neural networks. *Water Res* 45:1–16. <https://doi.org/10.1029/2008WR007030>

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