GEOMORPHIC EVOLUTION OF THE NUNBIL BASIN THROUGH MORPHOMETRIC MEASURES pdf

1: Morphometric Analysis of Kadvi River Basin, Maharashtra Using Geospatial Techniques

*Geomorphic Evolution of the Nunbil Basin Through Morphometric Measures [Bhagat J.] on www.enganchecubano.com *FREE* shipping on qualifying offers. In shaping the present volume Geomorphic Evolution of The Nunbil Basin Through Morphometric Measures.*

Satellite data, topographic maps Accepted 21 June and digital elevation model DEM were used to extract various parameters at various spatial scales. Four Available online 1 July watersheds, representative of the entire Karewa Basin, were chosen for detailed studies on the basis of the researchable evidence of the complete sequence of the stratigraphic record and the preservation of Keywords: The integrated analysis of the geomorphic and morphometric data provides Tectono-geomorphology Karewa Basin evidence of the relative variations in the tectonic activity among the watersheds. Geomorphic indices Watershed suggest a relatively high degree of tectonic activity along the Pir Panjal side of the Karewa Basin. Based on the results from this study, it is Pir Panjal Range suggested that Late Quaternary climate changes, tectonic uplift and erosion of the Pir Panjal Range and Landscape evolution changing geometry of the Karewa Lake have played a key role in the evolution of the geomorphic landscape of the Kashmir Valley. Introduction manipulate, and integrate digital remotely-sensed data with several types of geospatial and non-spatial information like topog- Tectonic geomorphology describes the relationship between raphy, drainage, geology, and lithostratigraphy that in turn appre- topography and geomorphic features generated by tectonic and ciably improves the interpretation of the extracted information erosion processes Burbank and Anderson, The most related to geomorphologic, tectonic and geological processes common goal of tectonic geomorphology is to use Quaternary Bishop et al. Currently, digital elevation models deformation and active tectonics in the region. The valley exhibits DEMs are the main source for the extraction of different geomor- great internal variation in the relief and continuity of mountain phological and topographic features depending on altitude and its fronts. The relatively young and active tectonic features are sup- spatial distribution and variation Felicisimo, ; Romshoo et al. DEMs and remotely sensed satellite imagery are widely workers have already documented tectonics, active surface fault- used for morpho-tectonic analysis and for studying the role of sur- ing and historical seismicity in this Himalayan basin Ganju and face processes in landscape evolution Duncan et al. The geomorphologic analysis in morphotectonics Cheng et al. Additionally, the studies of this region are revealing as the signatures of various advancement in geomatics provides opportunities to enhance, processes related to the tectono-geomorphic evolution are clearly evident and are well preserved. Quantitative measurements and Using watershed as a basic unit in morphotectonic analysis is the the calculation of geomorphic indices have been previously tested most logical choice because all hydrologic and tectono-geomorphic as valuable tools in various tectonically active areas around the processes occur within the watershed Romshoo et al. Further, the analysis of drainage pattern can provide impor- Singh, Thus, the morphometric characteristics at the tant clues towards understanding the Quaternary tectonic activity watershed scale may contain some important information regard- of any region at both regional and local scales Goldsworthy and ing its formation and development. In addition, obtaining quantita- Jackson, It is hoped that the information generated in this study of the tectono-geomorphic processes for the Karewa Basin. The shall help to improve the understanding and interpretation of the various morphometric parameters used in this study are shown tectono-geomorphic evolution of the Karewa Basin of Kashmir in Table 1. The measurements of these parameters were calcu- Valley. Results and discussion north Kashmir in the northeast. The various studies on disposition and the geographical location of the Kashmir Nappe is morphometric analysis of drainage basins indicate that morpho- the resultant effect of the Great Himalayan Orogeny. The southern-most deformation front of Kashmir a, b. Jhelum in the northwest rather than by an emergent thrust. Burbank and Johnson revealed that Kashmir Valley is expe- riencing uplift along its southwestern margin. The valley possesses 4. Drainage density D almost complete stratigraphic record of rocks of all ages ranging from Archean to Recent Fig. Rock types, vegetation cover, amount of slope are some of , ; Kotlia et al. The drainage serve the record of past four million years in which the sedimenta- density values for the studied watersheds range from 1. The loessic sediments Table 1. The Pir Panjal side of the Kashmir Valley, with apprecia- of Dilpur Formation occur as blanket sediments to the Karewa ble Karewa deposits, descends through a long gentle slope towards Group. The drainage network is thus most day landscape of the valley. Materials and methods analysis of the four representative drainage systems indicate that the drainage patterns have undergone varied changes due to the The study area, Karewa Basin of Kashmir Valley, has been differential tectonic activities on the Pir Panjal and Great Himala- divided into twenty-four watersheds. However, only four water- yan sides of the Kashmir Valley and is also evident from the clear sheds, three on the Pir Panjal side Romushi, Dudhganga and Ningli drainage divides observed in the area. Bifurcation ratio Rb which the geologic structures do not distort the drainage pattern. However, the bifurcation ratio in the 4th the ratio between the total number of stream segments of one and 7th order in Romushi, 5th and 6th order in Ningli and 6th order order to that of next higher order. It is calculated by the formula: The lower values of bifurcation ratio determine the bifurcation ratio for various orders using Eq. The highest average bifurca- where Rc is the circularity ratio, A is the area of the basin, P is the tion ratio is found in the Lidder watershed 4. The length and frequency Dudhganga 3. In addition, the values of bifurcation ratios ranging from 3. The oval shaped basins have It is observed that the Lidder, Dudhganga and Romushi watersheds this ratio almost or near to1. The circularity ratios range from 0. However, the average 0. The circularity ratio dard which suggests that the Karewa Basins exhibits structural of the watersheds is shown in Table 1. The overall circularity ratio of complexity that shows spatial variation. Further, the small varia- the Karewa Basin is 0. Circularity ratio Rc Rivers have to accommodate periods of tectonic uplift, climate change and watershed development. River basin Stream Number of Total length of Bifurcation where H is riverbed altitude; L is distance to river source; C is a con- order u streams Nu streams in km Lu ratio Rb stant; and k is referred to as gradient index. However, practically Romushi 1 Moreover, the pattern of deviation, which is evaluated by 5 8 The relief is most pronounced in the 5 9 Major rivers across the Himalaya exhibit extremely relatively high tectonic activity. The rivers in the western and eastern SL index is calculated using the following formula: Our observa- channel slope or gradient of the reach, where DH represents the tions show that Romushi and Dudhganga Rivers have SL of change in elevation for a particular channel of the reach with and respectively, which corroborate with the major rivers respect to DL that symbolizes the length of the reach. The SL index across the Himalayan mountain range indicating high tectonic is calculated using the parameters obtained from analogue or digital activity. The SL results for the 4 watersheds are shown in Table 1. Therefore, low SL of 98 is observed in Although local gradient-index abnormality within a river could the watershed. The development of knickpoints shown as circles and the consequent river cutting is controlled by lithology and tectonic uplift. The location of the Balapur Fault after Ahmad et al. Note the Lidder watershed shows tilt perpendicular to the main stream. More- factor greater than The overall impact of the tectonic tilting is over, prior to the existence of the contemporary River Jhelum further revealed by the north-eastward shift of the master stream, 85 ka , the Karewa Lake existed in the Kashmir Valley Bhatt, River Jhelum Fig. Mountain front sinuosity index Smf geometry of the Karewa Lake. As tributaryâ€”trunk channel relief increases, tributary streams adjust to the new base level Aiken The geomorphology of mountain fronts reveals vital informa- and Brierley, The development of knickpoints cause erosion tion regarding the current and past tectonic activity occurring and bring about changes in the drainage pattern, which is also sug- along them. It is determined by the formula: It is obtained using the equation: Most active mountain fronts have Smf values ranging between Romushi, Dudhganga and Ningli watersheds Fig. Romushi, Dudhganga, Bhatt and Jamwal, This tectonic uplift was consequently Ningli and Lidder watersheds. The Smf ranges from 1. Romushi and Dudhganga watersheds with an average value of This phenomenon is elucidated by the drainage systems of the 1. Consequently tributaries to the right of the main streams the conclusions drawn about the Smf observed in the area. The Romushi, Dudhganga, and Ningli Streams are shorter compared drainage network and hill-slope morphology suggest an overall R. The distribution of the loessic sediments of the Dilpur Formation is also shown. The solid black line is the tectono-geomorphic boundary between the uplifted Pir Panjal side and the drowned Himalayan side. The front, in general, exhibits reveals that the southwest side is more active with an average dendritic to sub-dendritic drainage pattern with characteristic dee- front value of 1. Triangular facets, vertical cliffs of 2. The interplay between the various Basin Fig. Similarly, on the Himalayan side of the Basin, the Lid- landforms and deposits further emphasize the overall low to mod- der watershed Fig. A quick look at the mountain fronts on sion in shaping the mountain front of the Pir Panjal. Calculation of mountain front sinuosity index Smf a Dudhganga and b Lidder watershed. During the last glacial cycle, the Himala- the river network Dar et al. These landforms are yan glaciers reached their maxima during the global glacial maxi- present in the entire valley with varied pattern and frequency. Morphology of the Pir Panjal piedmont belt tonic activity and the changing climatic conditions in the valley. Tectono-geomorphic evolution of the Karewa Basin ages Fig. This is in concordance with view that glaciers, dri- higher-energy sediments in the basin Burbank and Johnson, ven by climate, act as dynamic agents on the surface processes and These results sug- the second phase of sedimentation designated as the Nagum For- gest that glaciation can produce greater mesoscale relief and in mation Upper Karewa Singh, The sedimentation rate in concert with the uplift, is primarily responsible for relief produc- the basin has temporally changed with the accumulation rate of tion at high altitudes Bishop et al. Mountain front and the development of triangular facets on the Pir Panjal side of the Kashmir Valley. The traces of faults after Nakata et al. The gesting increasing degree of tectonic activity along the Pir Panjal thick conglomerate beds of Shopian Member of the Nagum Forma- side of the Kashmir Basin during the upper Matuyama and lower tion shed from the faulted basin margins at about 1. The Lower Karewa 3. These conglomerate beds are uplift of the Pir Panjal side Bronger et al. The remnants of the Karewa lake towarsds the north-eastern side of the Karewa Basin are also visible. The initiation of loess at about Basin the sedimentation began about 3 Ma ago and terminated ka is associated with Pir Panjal uplift and shrinking of the Kar- around 0. Eolian processes dominated during the periods Burbank et al.

2: What has the author Bhagat Singh written

The methodology adopted to address geomorphic evolution in the Ramganga basin comprises morphometric analysis of landscape, field study of landforms and channel characteristics and TL/OSL dating of fluvial deposits.

Length of Main channel Cl This is the distance along the largest water source from the outlet to end of channel boundary. In this study, length of the main channel is measured by taking help of Arc-GIS software. The calculation comes to Channel Index ci and Valley index vi Channel index of Kadvi river is calculated by dividing mean channel length of a river by minimum areal distance. The Channel Index ci of Kadvi river is 1. Estimation of valley index is performed by taking the ratio of valley length of the river to minimum areal distance, which is 1. Rho Coefficient Rho coefficient parameter is strictly associated with drainage density to geologically progress of basin which evaluates the storage competence of drainage system and determinant of drainage improvement in a particular basin Rho coefficient value of Kadvi river is 0. Geological, geomorphological, climatic and biotic factors conclude the changes in Rho coefficient. Length of Basin Different meanings of basin length lb have been discussed by different researcher With reference to Schumm, the length of Kadvi river basin seems to be Length of the basin is dependent on shape of basin. Elongated basin is characteristic of high basin length. Sinuosity Index It is the property of stream that shows the divergence of the river course of a drainage line from the straight path. Sinuosity index highly signifies in verifying the effect of terrain features on the river path and vice versa. Kadvi basin has 1. Basin Area It is a key parameter of morphometric analysis Basin area is any area of land where rainfall water collects and drains off into a river and other water bodies. Generally, topography of landform determined basin area of the river. Schumm had set the relation between basin area of the river and total stream length. Kadvi river basin covered Basin area and shape of the basin are closely related to each other. Larger basin areas are more prone to flooding. Basin Perimeters P The perimeter of Kadvi river basin is estimated to be Basin perimeter said to be the length of the watershed boundary in which catchment region is encircled when basin perimeter associated with basin area. The departure of the basin from a true circle can be calculated. Similarly, when associated with relief it gives the general steepness of the basin. Length area Relation Lar The concept of length area relation discovered by Hack in Length area relation value is calculated with following formula Kadvi River basin has K value 3. Form factor Horton27 described form factor concept. Form factor expresses the ratio between the river basin and square of the basin length. If form factor of the basin is closer to zero is designate highly elongated shape and closer to 1 point to circular shape. Value of Rf is 0. The form factor of Kadvi river is 0. It means that Kadvi river basin having an elongated shape. Flood flows are easily spread out in an elongated basin more than the circular basin. Values closer to 1. The value of elongation ratio of Kadvi river is 0. Texture Ratio Rt Texture ratio is a highlighting component in the drainage morphometric analysis which is defined as the ratio of first order streams and perimeter of the basin. The present study shows It is dependent on various natural factors like climate, rainfall, vegetation, rock and soil type, infiltration capacity and developmental stage. Circulatory ratio Miller described circularity ratio concept in According to Miller circularity ratio means the ratio of the area of basin to the perimeter of the same basin Values of circularity ratios are between 0 in line to 1 in a circle. Variations in circularity ratios found due to relief pattern, variety in a slope of the basin. A low value of circularity ratio indicates youth stage and medium and high values shows mature and old stage of river respectively. Kadvi river basin illustrates the mature stage of development with the Rc of 0. Kadvi River basin has a highly elongated shape as per law of Miller Smith 38 has classified five classes for drainage texture i. Drainage texture of basin is depending on rainfall, vegetation cover, climatic condition, soil types, rock formation and relief of the basin. In this present work, the basin of Kadvi river reveals very fine drainage texture with a greater value which is Compactness coefficient Cc As per the law of Gravelius 44, compactness coefficient of a watershed is referred as the ratio of the perimeter of a watershed to a circumference of the circular area, which equals the slope, not on the size of a watershed. Compactness coefficient is measured by considering the formula. For a perfect circle, Compactness coefficient is measured to be unity and is directly proportional to basin length. It direct related with elongated nature of the basin. Fitness ratio Rf According to Melton47, fitness ratio is illustrated as the ratio of main channel length to the length of the watershed perimeter. For various studies fitness ration has carried out by distinguished authors It is a measure of topographic fitness ratio, for Kadvi river basin it is 0. Wandering Ratio Rw Smart and Surkan48 defined wandering ratio of main stream length to the valley length. The actual distance between the outlet of the basin and the extreme point on the ridge is the length of the valley. The wandering ratio of Kadvi river drainage basin is 1. Stream frequency Fs In , Horton invented the concept of stream frequency. According to him, stream frequency is a ratio of total numbers of streams of all orders of the basin divided by total area of the basin. Stream frequency and Drainage density are closely related to each other and designated if stream frequency increases, respectively drainage density also increases Table The steep slope and impervious soil and loose rock structure are causes of high stream frequency As well as stream frequency is also reliant on rainfall and geology of watershed. Kadvi river basin frequently covered with the hilly region so moderate stream frequency is found in this basin and it is 4. Drainage density is the ratio of the length of total streams of the basin divided by total area of the basin. Low drainage density indicates coarse drainage texture while high drainage density reveals the fine drainage texture Drainage density is classified in five categories39, very coarse for below 2, coarse for 2 to 4, moderate for 4 to 6, fine for and very fine for above 8. It is recommended coarse drainage density. High drainage density is found in a hilly region of the basin in a site of SW and S Dd is a very sensible parameter and closely related to rainfall, vegetation, soil structure, geology, rock formation, land use and land cover and some other morphometric parameters. Drainage density is positively correlated with stream frequency. This positive relation between drainage density and stream frequency develop the drainage capacity of the watershed. Constant channel maintenance The inverse of drainage density or the constant of channel maintenance as a property of landform was given by Schumm in The constant of channel maintenance indicates the relative size of landform units in a drainage basin and has a specific genetic connotation It consist the dimensions of length and therefore shows a directly proportional relation with the scale of landform unit. Constant of channel maintenance is a function of ground permeability. Relatively high constant channel maintenance is seen in alluvial and the piedmont area basin. Channel maintenance for Kadvi basin is found to be 0. Higher is the value for the constant channel, stronger the lithology control and higher the permeability8. The elements that alter the constant of maintenance other than permeability are rock type, relief, vegetation and duration of rainfall. Drainage intensity Drainage intensity illustrated by Faniran 45, that it is a ratio of stream frequency to the drainage density. This study reflects a low drainage density of l. Drainage density and drainage intensity are negatively co-related with each other. Higher drainage density indicates low drainage intensity and low drainage density shows higher intensity. Low drainage intensity proves that drainage density and stream frequency have very less effect on the basin surface by the denudational process Low surface runoff is the key characteristic of low drainage density, stream frequency, and drainage intensity, and effect of flood disaster, land sliding, and marsh land is occurring. Infiltration number The product of drainage density Dd and drainage frequency fs is termed as infiltration number. The moderate infiltration number i. When there is higher infiltration number, low infiltration and higher run off is seen, leading to the construction of higher drainage density. This also reveals the impermeable lithology and higher relief in the basin Relief ratio Schumm32 has defined the relief ratio concept. According to him, the relief ratio is a ratio of total relief of basin to the basin length of the same basin. The Relief ratio of Kadvi river basin is 0. Absolute relief Ra Absolute relief is illustrated as the elevation difference between a given location and sea level. The estimated absolute relief for the full kadvi river is mt.

3: Morphometry Governs the Dynamics of a Drainage Basin: Analysis and Implications

The Karewa Basin nestled between the Pir Panjal Range and the Great Himalayan Range, in Northwest India, has been studied to understand its tectono-geomorphic evolution on the basis of geomorphic indices and morphotectonic parameters supported by the field evidences.

ABSTRACT Morphometric analysis is of vital concern to understand hydromophological processes in a given watershed, and thus, it is a priority for assessing water resources in drainage basins. A morphometric analysis was conducted to identify the drainage properties of Wadi Wala and the 23 fourth-order sub- basins. Arc GIS software was used to measure and calculate basic, derived and shape morphometric parameters. Wala is found to be a sixth-order drainage basin, and the drainage pattern is trellis to sub-trellis in the central and lower part of the catchment, whereas it is dendritic to sub-dendritic pattern in the southern and northern parts. Tectonic uplifting and tilting, lithology, structure and rejuvenation are the major factors controlling morphological variation over the watershed. The recognized fault systems are chiefly controlling the drainage pattern, and the elongated shape of the sub-basins is attributed to dense lineaments in the central and eastern parts of the watershed. The Rb values for the entire catchment and the sub-catchments range from 2 to 7, with a mean of 4. Hypsometric integral values are high for the W. High HI values indicate that drainage basins are at the youth-age stage of geomorphic development, and they are affected by tectonic uplifting, tilting, and the dominance of hillslope process. Regression analysis reveals that R2 values, which represent the degree of control of driving parameters on HI are reasonably high for the height of local base level m and the mean height of sub-basins m. Both parameters contribute 0. Such results imply that the height of local base level m , and the mean height m are the only morphometric driving parameters which have significant control on HI values in the W. High annual soil loss and sediment load estimated recently, denote that the catchment is highly susceptible to surface erosion at present. Hence, the present study, and the resultant information would help to plan for efficient soil and water conservation measures to reduce soil erosion rates, conserve water, and to control sediment into W. Introduction A drainage basin is recognized as a fundamental hydro-geomorphic unit for watershed management [1]. Therefore geomorphometric indices and parameters have been widely employed to investigate the sustainable development of natural resources. Morphometric characteristics of a watershed are significant for assessing surface water resources and groundwater potential [2] [3]. Geomorphometric properties are also essential for proper utilization of land and water resources of a catchment for optimum production with minimal environmental hazards i. The measured bifurcation ratio Rb for example refers to the degree in which geological structure controls the drainage network, whereas, a high value of mean bifurcation ration Rbm of a drainage system indicates the runoff and other external agents that contribute to the formation of drainage networks [12] [13]. Assessment of geo-environmental hazards especially flash floods was carried out for arid watersheds which occasionally threaten small and large areas of human settlement [14] - [21]. Other applications of morphometric analysis have been conducted worldwide such as: Geology lithology and structure , morphology relief and slope , and climate precipitation and evaporation constitute a major complex of physical factors controlling the drainage pattern, density, and geometry of the fluvial system [35]. The relative influence of each factor on fluvial activity varies from one region to another, and subsequently there are noticeable differences exhibited in morphometric properties between drainage basins. Furthermore, the hydrological descriptors of drainage basins including arid catchments are positively correlated with morphometric parameters of a watershed, such as: The hydrological behavior of a drainage basin is largely determined by its geomorphic, geologic, climatic, and morphometric characteristics as defined by linear, areal and relief aspects of the basins [37] [38]. Quantitative morphometric analysis of drainage networks and other properties is traditionally tackled by geomorphologists, hydrologists, and civil engineers. In this context, Strahler [39] argued that morphometric analysis is considered a simple study approach, thus, enabling assessment of basin morphology and processes, and morphometric comparison of different basins developed in different environments. Such approaches enhance our understanding of the geomorphic evolution of drainage basins. It was also concluded in the recent past that any significant changes affecting any environmental component of the watershed, will influence other components especially those located downstream, denoting that any natural or anthropogenic geomorphic and hydrologic changes taking place, will instantly affect certain areas, and may spread to other parts of the watershed [40]. The development of powerful and cost-effective GIS and remote sensing techniques enables us to measure, calculate, and process with high accuracy basic, derived, and shape morphometric parameters of drainage basins. Further, the availability of free access digital elevation data i. The main objectives of the present study are: Wala as an agricultural watershed, and a promising catchment for future water resources development, morphometric analysis and the resultant information are significant for proper planning of soil and water conservation measures, to minimize soil erosion rates and sediment load, exploration of groundwater potential, and surface water management. Moreover, the present results can also help other investigations that may be carried out in the watershed study. Study Area The W. Wala catchment occupies the upper part of W. Mujib-Wala watershed, covering a triangular shaped catchment of Terrain elevation ranges from m b. Wala merges with W. Mujib 3 km before the wadi system discharge into the Dead Sea to m a. The climate is classified as dry Mediterranean, with relatively cold winters and hot summers, while the canyons downstream close to the Dead Sea are arid. Mean annual rainfall ranges from mm at Madaba several kilometers to the northwest of the watershed to mm at Dhiban, and mm at W. The average annual rainfall for the entire watershed ranges between and mm. Rainfall is concentrated in winter October to March. The mean annual potential evaporation at the outlet close to the Dead Sea is mm, with a mean that increases from mm in the western highlands to mm in the eastern part of the watershed. Cretaceous carbonate rocks outcrop in most of W. The oldest rocks exposed in the study area are the Massive limestone unit of Turonian age. The lower part is composed of marl, marly limestone, sand, and chert nodules, while the upper part is composed Figure 1. Location of Wadi Wala, the study area. The average thickness of this lithological unit is 67 m. The chalky unit of W. Umm Ghudran Coniacian-Santonian age overlies the Massive limestone unit. It consists of Mujib-Dhiban Chalk, brecciated dolomitic limestone. It consists of thin bedded silicified limestone and chert layers. The phosphorite formation is composed of Figure 3. This formation is 90 m thick. The chalk-marl formation reposes on top of the phosphorite formation, and ranges in thickness from 20 to m. It consists of marl and chalk with chalk limestone. The chert-limestone formation overlies the chalk-marl member. Massive chalk limestone, alternating thin bedded limestone and chert layers, and range in age from early Paleocene to middle Eocene [41]. Basaltic flows of the Pleistocene age are exposed in the upper reaches of W. Additionally, superficial deposits of Fluviatile and Lacustrine Gravels of the Pleistocene age covers parts of the deep tributaries of W. The most important aquifers in W. Wala are those restricted to Amman-W. As Sir limestone Upper Cretaceous , with mediating W. Umm Ghudran and overlying the Muwaqqar Chalk-Marl formations, forming aquicludes. This aquifer is termed A7-B1 [42] [43]. The Ministry of Water and Irrigation constructed the W. The future plan is to raise the height of the reservoir to store 26 MCM. The reservoir is intended for groundwater recharge, and to provide water to springs and pumping wells in the lower courses of the wadi. Progressive rejuvenation, down-cutting and river incision of W. Wala were the result of continuous lowering of the Dead Sea base level. The wadi profile display well? In this regard, four or five rejuvenation stages can be recognized [44] [45]. It is certain that geomorphic development, rejuvenation, and intense incision are responsible for the presence of sharp convex upward hypsometric curve and a high HI value Wala watershed and the sub-watersheds are at the youth-age stage of geomorphic evolution. Thus, they are of high susceptibility to soil erosion, deep incision, landslides activity and flooding [47]. Materials and Methods Topographic maps with a scale of 1: Then the boundaries and drainage networks of the entire W. Wala and the 23 fourth-order sub-watersheds were demarcated and digitized using Arc GIS v. Three groups of morphometric parameters: Basic parameters are basin area A , perimeter P , basing length Lb , stream order u , stream length Lu , mean stream length Lsm , maximum and minimum heights H, h , and slope Sb. The 23 sub-watersheds of W. Shape parameters are elongation ratio Re , circularity ratio Rc , and form factor Rf. The stream ordering of the entire W. Wala watershed and the 23 sub- watersheds was implemented according to Strahler [39] , and the W. Wala catchment was found to be of sixth order. The methods adopted for calculation of morphometric parameters are illustrated in Table 1, and results of computation are illustrated in Table 2, and Table S1. Regression analysis is employed to assess the interrelationship between the area of sub-watersheds and other morphometric parameters, where the basin area is considered an independent variable, and other morphometric parameters are dependent variables. In addition, the scale dependency of HI values for 10 sub-wa- tersheds was conducted to evaluate the effect of different driving parameters i. The value of R2 represents and indicator of the degree of control of these parameters on HIs. Morphometric Assessment of W. Wala Watershed Quantitative analysis was performed for W. Wala catchment and the 23 fourth- order sub-watersheds in order to evaluate the morphometric properties of the drainage networks. Twenty-one morphometric parameters were considered to characterize the watershed and to improve our understanding of drainage basin development with reference to intrinsic controlling factors such as lithology, structure and tectonics geomorphic processes and rejuvenation stages. The results of morphometric analysis for the entire catchment and the 23 sub-basins are illustrated in Table 2, and Table S1. The drainage pattern is trellis to sub-trellis in the central and lower parts of the watershed, whereas it is dendritic to a sub-dendritic pattern in the southern and northern parts. Wala catchment is classified as a sixth-order basin Figure 5. Referring to the ratio between basin area A and perimeter P 5.

4: Morphometric Assessment of Wadi Wala Watershed, Southern Jordan Using ASTER (DEM) and GIS

The Medziphema intermontane basin developed in the schuppen belt of Nagaland, Northeast India, has been studied to understand its tectonic and geomorphic evolution on the basis of field evidence.

 Abstract Mountainous rivers are the most significant source of water supply in the Himalayan provinces of India. The drainage basin dynamics of these rivers are controlled by the tectonomorphic parameters, which include both surface and subsurface characteristics of a basin. To understand the drainage basin dynamics and their usefulness in watershed prioritisation and management in terms of soil erosion studies and groundwater potential assessment and flood hazard risk reduction in mountainous rivers, morphometric analysis of a Himalayan River Supin River basin has been taken as a case study. The entire Supin River basin has been subdivided into 27 subwatersheds and 36 morphometric parameters have been calculated under four broad categories: The various morphometric parameters have been correlated with each other to understand their underlying relationship and control over the basin hydrogeomorphology. The result thus generated provides adequate knowledge base required for decision making during strategic planning and delineation of prioritised hazard management zones in mountainous terrains. The form and structure of drainage basins and their associated drainage networks are described by their morphometric parameters. Morphometric properties of a drainage basin are quantitative attributes of the landscape that are derived from the terrain or elevation surface and drainage network within a drainage basin. Application of quantitative techniques in morphometric analysis of drainage basins was initially undertaken by Horton et al. Remote sensing and Geographical Information System GIS techniques are increasingly being used for morphometric analysis of drainage basins throughout the world [9 â€" 13]. Quantitative techniques have been applied to study the morphometric properties of different drainage basins in India [14 â€" 23]. Several authors have studied morphometric properties of drainage basins as indicators of structural influence on drainage development and neotectonic activity [24 â€" 27]. In many studies morphometric analysis has been used to assess the groundwater potentiality of the basins and to locate suitable sites for construction of check dams and artificial recharge structures [28 â€" 32]. Watershed prioritisation based on morphometric characteristics has also been carried out and aids in the mapping of high flood potential and erosion prone zones [33 â€" 37]. Present study bridges the connection between surface morphometry and subsurface geology of a drainage basin to produce effective information as a part of basin management. So the objective of the present research is to study the morphometric parameters of Supin River basin and to identify the influence of the underlying geology on the morphometric parameters of the basin and finally to generate a substantial knowledge base regarding the relationship between surface morphometry and subsurface lithology for integrated basin management. The basin covers an area of The study area has three climatic zones: The region receives heavy snowfall between November and March. The rainfall varies from 1, to 1, mm annually. Location map of Supin River basin having an area of Knick points are marked as K. The basin is underlain by rocks belonging to three main geological formations: Martoli, Vaikrita, and Garhwal. The upstream portion of the Supin basin, which is mainly drained by its three major tributaries, namely, Har Ki Dun Gad, Borasu Gad, and Ruinsara Gad, is underlain by granite-gneisses and two mica schists belonging to the MCT sheet. The middle portion of the basin is underlain by rocks consisting of Greater Himalayan Gneisses Augen gneisses and porphyritic granites and phyllites, quartzites, and biotite grade schists separated by the Munsiari Thrust MT , whereas near the mouth of the basin, it consists of leucogranite Figure 2 c [46 â€" 48]. The generation of depressionless DEM is always the preparatory step for morphometric analysis of drainage basin. Depressions are data errors or result from the averaging involved in assigning elevation values to cells pixels of finite area. These spurious depressions interfere with the correct routing of flow paths during the watershed analysis, especially in areas of low relief. The Watershed process solves this problem by first locating and filling the depressions. This depressionless DEM is used to compute the flow direction and flow accumulation raster. Further simulation of these two raster produces the standard flow paths and subwatersheds. The Supin River basin has been classified into 27 subwatersheds. Only those watersheds have been considered for this study which includes streams of at least three different orders. Thereafter, 36 morphometric parameters Table 1 have been computed for the entire Supin basin, as well as for each of the subwatersheds. The morphometric parameters have been evaluated from four different aspectsâ€”drainage network, basin geometry, drainage texture, and relief. The different parameters were then correlated to understand how they interact with and influence each other. Hierarchical cluster analysis Euclidean distance has been used as the measure of association which enables the grouping of the subwatersheds into five major categories according to the four morphometric aspects. Hypsometric curve for the entire Supin River basin has been computed along with hypsometric integral HI values for all the subwatersheds. Morphometric parameters calculated for Supin River basin from four aspectsâ€”drainage network, basin geometry, drainage texture, and relief characteristics. Results and Discussion The Supin River having a length of The two major thrusts, that is, MCT and MT, cross the upstream and downstream sections of the basin, respectively. These fault zones are usually zones of weak, fractured, and brecciated zones which are easily incised by streams. Stream order-wise frequency distribution of number of streams along with their mean stream length, drainage area, and bifurcation ratio. In the following section the various morphometric parameters have been discussed with regard to the derived cluster groups Figure 3. Dendrogram showing groups having similar properties: Drainage Network Segmentation and hierarchical ordering of streams is necessary to address the hydrodynamic character of a drainage basin. Stream ordering has been done for Supin River basin following the hierarchical ranking proposed by Strahler [6]. The total stream length of Supin basin is 1, The stream length ratio varies from 1. With increasing stream order there is a decrease in stream number and a simultaneous increase in mean stream length Table 2. The RHO coefficient and bifurcation ratio values for Supin basin range from 0. The variation of between successive stream orders of Supin River basin is due to the greater number of streams belonging to lower orders indicating that the basin is still in its youthful stage of development Table 2. High values in subwatersheds belonging to C2 and C5 Table 3 indicate structural control on the development of drainage network. The value signifies the storage capacity of a basin and determines the relationship between drainage density and physiographic development of the basin. Subwatersheds belonging to C4 and C5 Table 3 ; Figure 3 a having high values of are at a greater risk of being eroded by the excess discharge during flood. Detailed result of hierarchical cluster analysis for four morphometric properties of Supin River basin drainage network, basin geometry, drainage texture analysis, and relief characteristics. Basin Geometry Basin shape is controlled by structure, lithology, relief, and precipitation and varies from narrow elongated forms with irregular basin perimeter to circular or semicircular forms. Circularity ratio of Supin basin ranges from 0. The relative spacing of channels in a drainage basin is expressed by texture ratio and drainage texture. The and values of Supin basin range from 0. High values of are found in subwatersheds located in the upper reaches of the basin, whereas low values are found in subwatersheds located near the mouth of the basin Figure 4 d. Map showing response of various basin geometry parameters in subwatersheds of Supin River basin.

5: North American Project Study Of US Water Bodies

Bhagat Singh has written: 'Health profile' -- subject(s): Homeopathy, Methods 'Introduction to data structures' -- subject(s): Data structures (Computer science).

Environmental Protection Agency, have been grouped into nine series These nine broad cate- gories were established to facilitate further development and application of en- vironmental technology Elimination of traditional grouping was consciously planned to foster technology transfer and a maximum interface in related fields. This series describes research on the effects of pollution on humans, plant and animal spe- cies, and materials. Problems are assessed for their long- and short-term influ- ences. Investigations include formation, transport, and pathway studies to deter- mine the fate of pollutants and their effects. This work provides the technical basis for setting standards to minimize undesirable changes in living organisms in the aquatic, terrestrial, and atmospheric environments This document is available to the public through the National Technical Informa- tion Service, Springfield, Virginia Environmental Protection Agency, and approved for publica- tion. Approval does not signify that the contents necessarily reflect the views and policies of the U. Environmental Protection Agency, nor does mention of trade names or commercial products constitute endorsement or recommendation for use. The Environment Committee of OECD is assisted by a number of delegate groups concerned with policy development in specific sectors of the overall environmental problem. One of these groups is the Water Management Sector Group, which in established a Steering Group on Eutrophication Control to develop a series of cooperative projects for monitoring eutrophica- tion in inland waters. The overall objective of these projects was the achieve- ment of comparability on nutrient budgets, chemical balances, and biological productivity in water bodies. A regional approach was utilized to develop four project groups designed to collect comparable data for developing evidence on the degree and extent to which nutrient loading is correctable with the eutrophic state, and to meas- ure the rate at which eutrophication is developing. The projects and partici- pating countries were: Norbert Jaworski of the U. Environmental Protection Agency the United States representative. The specific objectives of the North American Project are: Develop detailed nutrient phosphorus and nitrogen budgets for a given selected number of water bodies, Assess the chemical, physical, and biological characteristics of these water bodies, Relate the trophic state of the water body to the nutrient budgets and to limnological and environmental factors, and Synthesize, based on data from all projects, an optimal strategy for controlling the rate of eutrophication. In the United States, twenty-two water bodies were included in the pro- gram. Final reports on the limnology of each, emphasizing the objective of the Project, have been compiled by the United States investigators and are con- tained in this publication. A synthesis based on the combined data from these reports, and representing the fourth specific objective, will be published subsequently. Paul, MN D. Present water quality is good and the lake is classified as mesotrophic. Uses of the lake are nearly exclusively recreational -- swimming, boating and fishing, and many residences along the shore are second homes. Although the lake is well-known to sport fishermen, especially for its largemouth bass, until recently the lake had received no limnological attention, per- haps because of its good water quality and lack of problems. Background limnological information on Lake Weir is thus sparse. Bailey generally followed water- ways for ease of transportation; thus Lake Weir, with no navigable streams entering or leaving it, was apparently missed by these early naturalists Yount Stage data has been gathered for the lake since , and a broad-crested, fixed level weir was built in April of to prevent possible flood damage resulting from hurricanes. A bathymetric map drawn by U. Lake Weir was included in a study of 55 lakes in north central Florida by Brezonik and Shannon , resulting in the first systematic limnological study of the lake. The centroid of the lake is at 1 Figure 1. Map of Lake Weir area showing major roads, cities and water bodies. Mean monthly temperature continuous lines , total monthly rainfall solid bars and total monthly wind miles open bars for Ocala, Florida, during and Little Lake Weir is a smaller basin located to the west of the larger lake and is connected to it by an artificial waterway to accomodate the passage of small pleasure boats. The surface elevation of the lakes is The surrounding terrain consists of numerous small sand hills, and the high permeability of the soil precludes the presence of permanent surface streams in the watershed. Since piezometric maps of the watertable aquifer in the study area do not exist, the area of the watershed was calculated from topographic maps. Analysis of the topographic maps, however, revealed a more realistic estimate of 22 km2 for the watershed of both lakes, exclusive of lake surface. The surface area of the lake was found to be The climate in north central Florida is best described as humid sub-tropical, with short, mild winters and long, hot summers. Average monthly temperatures for Ocala, Florida, 25 km to the northwest, sub- stantiate this point Figure 2. Average annual rainfall in the area is approximately cm, mainly occurring in the summer months, fall and spring being rather dry Butson and Prine Summer rains usually occur as short, convective afternoon showers, while winter precipitation is usually associated with frontal activity. Wind speed is generally light to moderate, blowing from the north and west during the winter, but shifting to easterly in the summer. Hurricanes are seldom in this part of the state. Evaporation from the basin during the study period calendar year was calculated to be Evapotranspiration from the watershed was Bayley for similar latitudes in the State. Two distinct aquifers exist in the area of the lake. The upper or watertable aquifer is composed of permeable sand at shallow depth and clayey sand interbedded with some clay lenses at greater depths Hughes This shallow aquifer is underlain with a low-perme- ability sand and clay formation of Miocene origin called the Hawthorn Formation Snell and Anderson Below this confining stratum lies the permeable Eocene limestone, the Floridan aquifer, which sup- plies the State with most of its drinking water Faulkner ; Snell and Anderson The area surrounding the lake is a principal recharge area for the Floridan aquifer, and in places is covered by only a thin veneer of sand Snell and Anderson Most Florida lakes are not connected directly to the deep aquifer, as is evident 3 from their soft water Brezonik et al. The General Soil Map of Florida Beckenbach and Hammett characterizes the soil in the area as being well-drained to moderately well-drained, thick to moderately thick, acid sands of the Lakeland-Eustis-Blanton association. Because of the high permeability of the soil, land erosion is not a problem in the study area, overland flow being virtually absent except during heavy, long-duration convective storms. Approximately 55 percent of the land in the watershed is covered by mature citrus groves, and the remaining undeveloped land in the watershed is mainly forested. The area east of the lake is dominated by a pine sandhill association with some mixed hardwoods oaks, hickory and sweet gum. To the west of the lake, a scrub turkey oak association is indicative of the nutrient impoverishment of the well-drained soil. Cypress are found in marshy areas surrounding the lake, and willows can be seen on the undeveloped shoreline. The area between Lake Weir and Little Lake Weir is a marsh dominated by cattail, unbrella-grass, and sawgrass. Some of the shoreline is bordered by well-manicured lawns. An analysis of aerial photographs indicates residences in the watershed. Using an average value of 2. This amounts to a population density of Interviews with local residents reveal, however, that many of the residents are seasonal; thus the year-round population is some- what lower. The land use characteristics as determined from the aerial photographs are summarized in Table 1. The combination of hilly terrain, well-drained, high hammock soil, and the propinquity of a frost-damping deep lake make the area particularly suited for the grow- ing of citrus crops Lawrence which, besides recreation, accounts for most of the economy in the area. Many of the homes are built around the edge of the lake, and three public boat ramps and several public and private beaches provide lake access for residents and visitors. Fishing for largemouth bass and water sports are popular activities. No sewage treatment plants discharge into the lake, and the residences are served by individual septic tanks. Because of the availability of high-quality groundwater from the Floridan aquifer, lake water is used neither for drinking nor irrigation. Compared to sub-tropical Florida lakes, however, it is one of the deeper lakes in the state Kenner ; Brezonik and Shannon Land use characteristics of the Lake Weir watershed. Morphometric features of Lake Weir. Surface area main basin U m Mean depth both basins iz 6. Hypsographic curves for Lake Weir. Little Lake Weir, B and C: Lake Weir including both basins. Bathymetric map of Lake Weir, Florida. Bottom contours are in feet. The lake is of solution origin and probably resulted from the fusion of three dolines; this is a common lake form in areas of karst topography Hutchinson ; Yount The development of volume index 1. Lake volume and elevation are regulated to some extent by a fixed-level weir at the north end of the lake. Maximum and minimum lake level elevations for the period of record are At no time during the period of study was there observed evi- dence of stable stratification of the water column. The largest difference between surface and bottom temperatures observed was 2. This is a common situation in Florida lakes experiencing intense heating by the summer sun. In light of the absence of stratification of chemical parameters, and considering the long fetch of the lake, it does not appear that the water column stratifies for more than a few days at a time. The littoral areas of Lake Weir and the center of the big basin have a sandy bottom, but a loose organic ooze is found in most of the lake bottom. In areas covered by Nuphar in sheltered bays and in the bay north of Bird Island, the sediments are composed of a reddish peat. The smaller, southwestern basin of the big lake is covered by a gela- tinous muck. Organic silt deposits are found in some shallow areas. The organic muck is dark-gray to brown in color and has a faint odor of H_2S. The muck in the big lake is thin and unconsolidated, as can be seen from the depths to which a weighted pail and a narrow pipe sank at three locations: Apparent depth m Difference cm Pipe Pail 7. These data indicate that about a half meter of thin, unconsolidated sediment occurs in some areas of the lake. Table 3 gives some chemical characteristics of Lake Weir sediments. Since Lake Weir is a soft water lake, there is no CaC03 in the sediment; volatile solids should reflect its organic content.

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