A

Project Report on

" MULA RIVER LONGITUDINAL PROFILE USING DUMPY LEVEL "

Submitted,

Under DBT Star College Scheme,

Department of Biotechnology,

Government of India.

Submitted By

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CERTIFICATE

This is to certify that the work incorporated in the dissertation entitled "Mula River Longitudinal Profile Using Dumpy Level "Submitted by Mr. Bale Tushar Tukaram, Mr. Sonawane Ganesh Ramesh, Mr. Shenolge Rohit Ramesh, Mr. Jagdhane Akash Shamrao, Mr. Kale Promod Keshav, Mr. Kank Swapnil Nivruti and Mr. Wagmare Nitin Balasaheb under DBT Scheme, Department of Biotechnology, Government of India is carried out under my supervision and guidance at the Department of Geography , Mula Education Society's, Arts, Commerce and Science college, Sonai, Tal- Newasa Dist. Ahmednagar, during the academic year 2020-2021.

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Declaration

We hereby declare that the work done in this Project entitled "Application of Dumpy Level for Rural Planning" is submitted to Department of Geography, MES, Arts, Commerce and Science College Sonai. This project is completed under the DBT Star College Scheme and the supervision of Dr. R.V. Wagh, Mr. Sharad K. Auti and Mr. Shoukat Z. Fakir The works is original and not submitted in part or full by me or any other to this or any other University.

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MULA RIVER LONGITUDINAL PROFILE USING DUMPY LEVEL

INTRODUCTION: large amount of water flow in going particular direction as per it gravity and slope is known as river. There are number of the river system in the Maharashtra. Mula is one of it. Mulariver is tributary of the Godavari river in Ahmednagar district.Ahmednagar is the largest district of Maharashtra State in respect of area, popularly known as "Nagar". It is situated in the central part of the State in upper Godavari basin and partly in the Bhima basin and lies between north latitudes 18°19' and 19°59' and east longitudes 73°37' and 75°32' and falls in parts of Survey of India degree sheets 47 E, 47 I, 47 M, 47 J and 47 N. It is bounded by Nashik district in the north, Aurangabad and Beed districts to the east, Osmanabad and Solapur districts to the south and Pune and Thane districts to the west. The district has a geographical area of 17114 sq. km., which is 5.54% of the total State area. The district is well connected with capital City Mumbai & major cities in Maharashtra by Road and Railway. As per the land use details (2011), the district has an area of 134 sq. km. occupied by forest. The gross cultivable area of district is 15097 sq.km, whereas net area sown is 11463 sq.km.It is divided in to 14 talukas namely Ahmednagar, Rahuri, Shrirampur, Nevasa, Shevgaon, Pathardi, Jamkhed, Karjat, Srigonda, Parner, Akole, Sangamner, Kopargaon and Rahata. The district has 14 Panchayat Samitis, 9 Nagar Parishads, and 1 Municipal Corporation, 19 cities, 1600 villages and 1311 Gram Panchayats. The population of the district is 4,543,159 as per 2011 census with density of 265 persons per sq. km. There are 18 towns and 1600 villages in the district, out of which 2 villages are not habited. The Ahmednagar district has 7 Sub-divisions as mentioned below.The District has an area of 17,048 sq.kms. and a population of 45,43,159 persons as per 2011 Census. While the area of the District accounts for 5.54 percent of the total area of the State, the Districts population constitutes 4.04 percent of the total population of the State. The density of population is 266 persons per sq. km. Among the 35 Districts of the State, the District ranks 1st in terms of area, 6th in terms of population and 22nd in terms of density; its urban / metropolitan population is 379,845 of which 195,467 are males and 184,378 are females. According to data released by Census India 2011, the average density is 266 density per Sq.km. Average literacy of Ahmednagar in 2011 were 79.05% compared to 75% in 2001. The male and female literacy were 86.82% and 70.89% respectively. With regards to Sex Ratio, it stood at 939 per 1000 male compared to 2001 census figure of 940. The average national sex ratio in India is 852 as per Census 2011. In 2011 census, child sex ratio is 852 girls per 1000 boys compared to figure of 884 girls per 1000 boys of 2001 census data.Ahmednagar railway station belongs to Solapur Division of Central Railway zone of the Indian Railways. Ahmednagar has rail connectivity with Pune, Manmad, Kopargaon, Shirdi, Daund, Goa, Nashik and other metro-cities like New Delhi, Mumbai, Chennai, Kolkata, Banglore, and Ahmedabad. Ahmednagar is well connected by roads with major cities of Maharashtra and other states. Ahmednagar has 4 lane road connectivity to Aurangabad, Parbhani, Pune, Nashik, Beed, Solapur, Osmanabad. National Highway 222 from Kalyan to Nirmal near Adilabad in Telangana passes through the city. The Maharashtra State Road Corporation (MSRTC) and different private transport operators provides bus service connecting the city to all parts of the state.The District as a whole is monotonously covered by Deccan-Trap basaltic lava flows. The lava flows are almost horizontal in disposition but local gentle tilting, undulations and minor flexures are sometimes seen. But for these, no major faulting or folding is seen in the area. The basalts are generally, covered by a thin mantle of black soil of recent origin. Other recent deposits such as river alluvium, sands, gravels, silts and calcareous known as kankar are also found in the river basins. Trap rocks are generally barren of any economically useful and important minerals. However, being hard, dense and durable, they are extensively used as building material and road metal. The pinkish coloured vesicular variety is amenable to cutting into blocks of desired sizes. Kankar, on burning yields good lime, is locally used for the manufacture of lime especially around Ahmednagar city. Minerals of economic value are not found in the district. Mud used for making bricks, sand and metal stone used for construction purpose are the only important minerals found in Ahmednagar district.Minerals are classified into two groups as Major minerals and Minor minerals. Minor mineral has been defined under section 3 (e) of Mines and Minerals (Regulation and development) Act, 1957. They include building stones, gravel, ordinary sand, limestone lime burning, boulders, kankar, murum, brick earth ordinary clay used for, bentonite, road metal, slate, marble, stones used for making household utensils etc. Therefore, all other minerals not defined as minor minerals in the said Act are treated as major minerals. They include coal, manganese ore, iron ore, bauxite, limestone, kyanite, sillimanite, barites, chromite, silica sand, fluorite, quartz, sand used for stowing purposes in coal mines and many other minerals used for industrial purpose.The mining operations for minor minerals were carried out in unscientific manner in Maharashtra since there were no guidelines for extraction of minor mineral. Identifying this fact in exercise of powers conferred by Section 15 of Mines & Minerals

(Development & Regulation) Act, 1957 (67 of 1957) and of all other powers enabling it in that behalf, the Revenue & Forest Department, Government of Maharashtra framed the Maharashtra Minor Mineral Extraction (Development and Regulation) Rules, 2013. • Since, prior Environmental Clearance has now become mandatory for mining of minor minerals irrespective of the area of mining lease after the matter of Deepak Kumar etc. Vs. State of Haryana and Others as per Hon'ble Supreme Court dated the 27th February, 2012 in I.A. No.12-13 of 2011 in Special Leave Petition (C) No.19628-19629 of 2009, Ministry of Environment, Forest & Climate Change (MoEF& CC) had issued Office Memorandum No. LllOll/47/2011-IA.II (M) dated 18th May 2012; henceforth as per this O.M. all mining projects of minor minerals would require prior environmental clearance irrespective of the lease area. • Mining projects with Lease area less than 5 ha are categorized as category 'B2' and projects with lease area 5 Ha and above and less than 50 ha are categorized as category 'B' whereas projects with lease area of 50 ha and above are categorized as category 'A'. • Policy on Environmental Clearance for mining leases in cluster for minor minerals in the matter of sand mining was directed by the Hon‟ble National Green Tribunal (NGT); vide its order dated the 13th January, 2015 also S.O.3977(E) notification dated 14th Aug 2018 by Ministry of Environment, Forest and Climate Change. 10 • The Central Government had constituted the District Level Environment Impact Assessment Authority (D.E.I.A.A.), for grant of Environmental Clearance for Category ‟B2‟ Projects for mining of minor minerals, for all the districts in the country as per the latest amendment S.O. 141 (E) &S.O.190(E) dated 15th January 2016 & 20th January 2016 in exercise of the powers conferred by sub-section (3) of Section 3 of the Environment (Protection) Act, 1986 (29 of 1986) and in pursuance of the notification of the Government of India in the erstwhile Ministry of Environment and Forest number S.O. 1533 (E), dated the 14th September. • Direction for preparation of District Survey Report for Sand Mining or River Bed Mining of other Minor Minerals was made in the Notification dated 15th January 2016 and its amendments dated 25th July 2018 by MoEF& CC along with detailed procedure & format for preparation of District Survey Report. • To make certain identification of areas of aggradations or depositions where mining can be allowed and identifying areas of erosion rate of replenishment and allowing time for replenishment after mining in that area is the foremost objective of the preparation of District Survey Repor.The Revenue & Forest Department, Government of Maharashtra, had set the revenue collection targets for entire Maharashtra State and accordingly it was distributed to every district for every financial year wise. Accordingly, every district tries to achieve the targets given by Revenue Department. The details of the target set by Revenue Department and against which revenue collected in Ahmednagar District is tabulated below for last 10 years.Sediment transport is the movement of organic and inorganic particles by water. In general, greater the flow more sediment will be conveyed. Water flow can be strong enough to suspend particles in the water column as they move downstream, or simply push them along the bottom of a waterway. Transported sediment may include mineral matter, chemicals and pollutants, and organic material. Another name for sediment transport is sediment load. The total load includes all particles moving as bed load, suspended load, and wash load.Bed load particles travel with water flow by sliding or bouncing along the bottom. Bed load is the portion of sediment transport that rolls, slides or bounces along the bottom of a waterways. This sediment is not truly suspended, as it sustains intermittent contact with the streambed, and the movement is neither uniform nor continuous (fig. 4.0). Bed load occurs when the force of the water flow is strong enough to overcome the weight and cohesion of the sediment. While the particles are pushed along, they typically do not move as fast as the water around them, as the flow rate is not great enough to fully suspend them. Bed load transport can occur during low flows (smaller particles) or at high flows (for larger particles). If the water flow is strong enough to pick up sediment particles, they will become part of the suspended load. While there is often overlap, the suspended load and suspended sediment are not the same thing. Suspended sediment are any particles found in the water column, whether the water is flowing or not. The suspended load, on the other hand, is the a mount of sediment carried downstream within the water column by the water flow. Suspended loads require moving water, as the water flow creates small upward currents (turbulence) that keep the particles above the bed. the size of the particles that can be carried as suspended load is dependent on the flow rate (Fig. 16). Larger particles are more likely to fall through the upward currents to the bottom, unless the flow rate increases, increasing the turbulence at the streambed. In addition, suspended sediment will not necessarily remain suspended if the flow rate slows.The wash load is the portion of sediment that will remain suspended even when there is no water flow. The wash least is a subset of the suspended load. This load is comprised of the finest suspended sediment (typically less than 0.00195 mm in diameter). The wash load is differentiated from the suspended load because it will not settle to the bottom of a waterway during a low or no flow period. Instead, these particles remain in permanent suspension as they are small enough to bounce off water molecules and stay afloat. However, during flow periods, the wash load and suspended load are indistinguishable. Turbidity in lakes and slow moving rivers is typically due the wash load. When the flow rate increases (increasesing the suspended load and overall sediment transport), turbidity also increases. While turbidity cannot be used to estimate sediment transport, it can approximate suspended sediment concentrations at a specific location.

Logitudinal Profile: Rivers are **linear systems which show a gradient of characters along their length**. Ideally the longitudinal profile of a river is concave with a steep upper portion near the source, giving way to reaches of progressively less gradient as the mouth is approached.The longitudinal profile characterizes average stream slopes and depths of riffles, pools, runs, glides, rapids and step/pools. The average water surface slope is required for delineating stream types and is used as a normalization parameter for dimensionless ratios (Figure A-12). The water surface slopes of individual bed features (facet slopes) can be compared using longitudinal profile data (e.g., riffle facet slope vs. pool facet slope). In addition, the longitudinal profile can be used to obtain maximum depth of individual bed features and bed feature spacing. The average water surface slope is measured between two bed features of the same type (e.g., top of riffle to top of riffle) over a distance of 20 to 30 bankfull channel widths. To calculate average slope, divide the change in water surface elevation by the stream length between the two features. Longitudinal profiles require basic surveying skills and equipment. Because longitudinal profiles cover a large distance (20 to 30 bankfull channel widths), multiple instrument setups are often required. Longitudinal profiles are measured in the downstream direction. Typically, a 300-foot tape is laid along the centerline of the channel (not Thalweg) to obtain stream length stationing. If the flow velocity or depth does not allow the tape to be stable at the channel mid-point, then station the tape along one side of channel at low flow edge of water. An elevation measurement and the associated distance along the tape (station) are taken at major breaks in the bed topography and generally at the start, mid-point and end of features (e.g., start, mid-point and end of riffle). Four types of features are measured at each station: 1. Thalweg (deepest part of channel) (THL), 2. Water Surface (WS), 3. Bankfull (BKF) (if a good indicator), and 4. Low Bank Height (LBH) (if the lowest bank height is greater than bankfull stage to indicate degree of incision). The Thalweg and water surface measurements should reflect bed elevation and water surface slope changes as the stream progresses through a bed feature sequence (e.g., riffle, run, pool, glide). Note the stationing of the cross-section locations along the profile. An example profile survey with survey notes and a plotted profile.Setup the instrument with a clear line of sight to a benchmark. The first setup should reference (backsight) a benchmark (BM) of known elevation. Approximate the number and location of each setup needed based on potential line-of-sight limitations. The instrument should be placed at an elevation higher than the highest feature required for the survey. 2. Backsight (BS) the benchmark (place the rod on the benchmark and obtain a rod reading). Determine the height of the instrument (HI). HI = BM elevation + BS rod reading. 3. Starting at the upstream end of the reach, position a 300-foot tape along the centerline of the channel if flow permits or along edge of water to obtain stream length stationing. 4. Place the rod at the Thalweg at station 0 on the tape. Obtain the rod reading and record the value in the foresight (FS) column as shown in Table A-5. Record water surface, bankfull and lowest bank height measurements (if lowest bank height is greater than bankfull stage) perpendicular to the tape at station 0 as shown in Figure A-12. (Note: LBH in Figure A-12 at station 0+00 is the same as BKF). 5. Continue the same sequence downstream to the start, mid-point and end of major bed features and repeat the same measurements at the new stations. 6. At cross-section intersection locations, note the distance (station) on the longitudinal profile tape. When using multiple instrument setups, take a measurement on top of both cross-section end points to obtain common elevations of the cross-section and longitudinal profile. 7. Profile your entire reach (20 to 30 bankfull channel widths is normally used as a minimum longitudinal profile length guideline). 8. Plot the longitudinal profile (Figure A-13). 9. Plot the cross-section location and the corresponding bankfull elevation on the longitudinal profile (Figure A-13). 10. Draw a line through the water surface data points of the same bed feature (e.g., top of riffle to top of riffle) to represent the average water surface slope. Draw a best-fit line through the bankfull data points. 11. Determine the average water surface slope and enter into forms (Worksheet A-1 and Worksheet A-3). Determine bankfull slope and enter into Worksheet A-2. Note: The average water surface slope and the bankfull slope should be parallel.Average Water Surface Slope (S): Elevation of water surface over stream length at the same position above bed features for several riffle/pool or step/pool sequences (e.g., elevation difference from the top of riffle to top of next riffle over the length of the stream). This value will normally approximate the average bankfull slope. Average Bankfull Slope (Sbkf): The elevation difference of bankfull indicators along the stream length. The elevation differences are obtained from a best-fit line drawn between bankfull indicators along the longitudinal profile, which is generally parallel and similar to the average water surface slope (S). Define the monitoring reach. This must be accomplished before surveying the longitudinal profile and the cross-sections. See Section IV.B.1 for general guidelines. Your longitudinal profile should extend the length of the monitoring reach, beginning at a stable channel feature (e.g., riffle) upstream of the impoundment. Your profile should always begin upstream of the uppermost cross-section and should continue to the lowermost cross-section and include survey shots at the thalweg of all monumented cross-sections.Willows exhibited a heavy rust infection, perhaps due to drought stress. Fairly recent disturbance was indicated by the large percentage of bare soil present; annual plant species provide the dominant vegetative cover, perhaps due to flooding or heavy recreational use. Impacts of past grazing were shown by the presence of indicator species like yarrow and cinquefoil. The cut off meander may be responsible for the drying of adjacent willow stands. The USFS Ecology Team conducted plant community sampling within this reach area (comparable plots 96736 through 96738). Ecological status ratings ranged from low to moderate for yarrow and skyline bluegrass dominated community types. The Lemmon's willow/Kentucky bluegrass type was not analyzed. Data developed as part of the present study (Table 4.6) indicates that the area is dominated by mid and early successional status ratings. Vegetation in the area is adjusting to past disturbances (livestock grazing and recreation) and current fluvial processes. Analysis and Summary: Part of the instability of this reach is due to sediment entering the upstream portion of the reach from a tributary to the east. This tributary carried a substantial amount of coarse sediment during the 1997 floods, when it plugged a culvert on the Blue Lakes road. Extensive deposits of coarse material from this flood are found on the meadow downstream of the road crossing. Much of this material also entered the West Fork, and likely contributed to channel dynamics. Sediment produced in the watershed of this tributary appears to be derived primarily from natural sources, as the upper portions of the watershed have extremely steep hill slopes in volcanic rock types. Though the tributary is influencing the morphology of this reach to some extent, analysis of historical aerial photographs suggests that modifications of the West Fork may be primarily responsible. Sometime between 1963 and 1993, a new channel formed in the lower portion of this reach (see section 5.3.1.4 for a discussion of the aerial photo analysis). The new channel formed is much straighter than the old channel, and may have induced incision upstream, resulting in streambank instability and the production of large quantities of sediment. This incision has resulted in a meander cutoff in the lower portion of Reach WF15. The headcut appears to have advanced to the middle of Reach WF15, where it has been checked by a large beaver dam (see Reach WF15). Large gravel bars are apparent throughout Reach WF14 following the formation of this new channel, though these bars are not apparent in the 1963 photograph prior to channel formation. Straight channels are very uncommon in natural settings, suggesting that the new channel formed after 1963 may have previously been a man-made structure such as an irrigation ditch or road.Part of the instability of this reach is due to sediment entering the upstream portion of the reach from a tributary to the east. This tributary carried a substantial amount of coarse sediment during the 1997 floods, when it plugged a culvert on the

Blue Lakes road. Extensive deposits of coarse material from this flood are found on the meadow downstream of the road crossing. Much of this material also entered the West Fork, and likely contributed to channel dynamics. Sediment produced in the watershed of this tributary appears to be derived primarily from natural sources, as the upper portions of the watershed have extremely steep hill slopes in volcanic rock types. Though the tributary is influencing the morphology of this reach to some extent, analysis of historical aerial photographs suggests that modifications of the West Fork may be primarily responsible. Sometime between 1963 and 1993, a new channel formed in the lower portion of this reach (see section 5.3.1.4 for a discussion of the aerial photo analysis). The new channel formed is much straighter than the old channel, and may have induced incision upstream, resulting in streambank instability and the production of large quantities of sediment. This incision has resulted in a meander cutoff in the lower portion of Reach WF15. The headcut appears to have advanced to the middle of Reach WF15, where it has been checked by a large beaver dam (see Reach WF15). Large gravel bars are apparent throughout Reach WF14 following the formation of this new channel, though these bars are not apparent in the 1963 photograph prior to channel formation. Straight channels are very uncommon in natural settings, suggesting that the new channel formed after 1963 may have previously been a man-made structure such as an irrigation ditch or road. Another important aspect of the geomorphology of this reach is the importance of beaver. Beaver dams provide temporary grade control and serve the useful role of storing delivered sediment, increasing flow access to floodplain surfaces, and raising local groundwater elevations (more discussion of this in Reach WF15). However, beaver dams have a limited lifetime. Lack of dam maintenance by beaver can result in a failure that results in head cut propagation upstream and delivery of a wave of sediment downstream. That sediment can cause localized aggradation and increased bank stress. These effects are especially pronounced in this reach because it is entrenched. If the channel was not so deep, water would flow around beaver dams onto the adjacent meadow during floods and erosive power would be relatively low. In the current incised condition, even larger floods are contained entirely Upper Carson River Watershed Stream Corridor Assessment June 2004 Page 96 within the streambanks and large hydraulic drops and high erosive power are concentrated around beaver dams. Thus the risk of failure of dams in the current incised condition is increased. It should also be noted that the production of sediment within this reach has likely had impacts on downstream reaches. Downstream of Reach WF14, the West Fork enters a confined canyon that has high sediment transport capability. Most of the sediment produced in this reach has therefore probably been delivered directly to the upstream end of

Reach WF10, which may partly explain observed dynamism in that reach. This suggests that stabilization efforts in Reach WF14 should have a relatively high priority. Restoration and management objectives in this reach should be to increase streambank stability and reverse the effects of channel incision. There are several potential restoration options to meet these objectives. One option, which would likely be controversial, would be to introduce additional beavers with the objective of increasing the number of dams constructed. If beavers remained in the area to maintain the dams, sediment would be stored behind the dams, streambanks would be stabilized, and the streambed would eventually be raised. The introduction of beaver has been successful in meeting similar objectives in other locations (Muller-Schwarze and Sun 2003; Naiman et al. 1988). Although there appears to be ample forage to support beavers in Faith Valley, there is some uncertainty as to whether viable longterm populations can be sustained. If beavers were to abandon the area, it is likely that any dams constructed would eventually fail, resulting in additional erosion. This options therefore has a degree of uncertainty and risk, although the cost would be low. Another option would be to restore the historic channel in the lower part of the meadow. Our preliminary assessment is that this project is feasible, and would meet the objective of raising the channel bed. However, this is a large-scale construction project, and additional analysis of feasibility and costs would be required to accurately assess risk, costs and benefits. The final option is to stabilize streambanks using similar biotechnical techniques to those recommended for lower reaches on the West Fork. This option would cost relatively little, and probably provides the highest cost-benefit ratio. Implementation of this alternative should be associated with photo monitoring to evaluate trends in channel condition and the success of revegetation and stream bank stabilization. On the continents, except in the most arid regions, precipitation exceeds evaporation. Rivers are the major pathways by which this excess water flows to the ocean. Over the continental United States the average annual rainfall is about 75 centimeters. Of this, about 53 centimeters is returned to the atmosphere by evaporation and transpiration. The remaining 22 centimeters feeds streams and rivers, either directly (by landing in the channels or running off across the surface) or indirectly, by passing through the shallow part of the Earth as groundwater first.This 22 centimeters represents an enormous volume of water: 5.2 x 108 cubic meters per day (1.4 x 1011 gallons per day). 1.2 Rivers are also both the means and the routes by which the products of weathering on the continents are carried to the oceans. Enormous quantities of regolith are produced on the land surface by weathering, and most of this material is transported by rivers to the sea, either as particles or in solution. The other two principal agents that transport this material to the ocean, glaciers and the wind, are minor in comparison. 1.3 Rivers and streams (which term you use is a flexible matter of scale) are channelized flows of water on the Earth's surface. The term overland flow is used for non-channelized flows of water, usually less than a few centimeters deep but very widespread. There is a pronounced dichotomy between non-channelized flow and channelized flow. Have you ever walked up a small stream channel to see what happens to it? Its termination is almost always well defined. 1.4 Rivers are enormously diverse, in: • size: varies by many orders of magnitude • geometry: highly variable • substrate: bedrock or sediment • sediment type: sediment size ranges from mud to gravel • stage of development: young, with rugged topography and rapid change, to old, with gentle topography and slow change • climate: ephemeral and flashy to very steady.hian and adjoining Piedmont and Coastal Plain provinces, with different kinds of stream profiles and in geologically different terrane, were selected for study. In each of the areas measurements were made of stream length, drainage area, channel slope, channel cross section, and size of material on the stream bed. More than 100 localities were examined, on streams whose drainage areas range between 0.12 and 375 square miles. The measurements are compared on a series of scatter diagrams and relations among some of the variables that affect channel slope are discussed. The data for the streams studied indicate that the slope of a stream at a point on the channel is approximately proportional to the 0.6 power of a ratio obtained by dividing the median size of the material in the stream by the drainage area of the stream at the same point. This relation means that for a given drainage area the channel slope is directly proportional to a power function of the size of rock fragments on the bed, and for a given size of bed material the channel slope is inversely proportional to a power function of the drainage area. It is also shown that the ratio of depth to width decreases downstream in all streams studied. Streams in areas of softer rocks such as shale or phyllite tend to have deeper cross sections than streams in more resistant rocks, such as sandstone. A very uniform relation between stream length and drainage area exists in all the streams studied, such that length (measured from a locality on the stream to the source along the longest channel above the locality) increases directly as the 0.6 power of the drainage area. This rate of increase is not affected, except locally and for short distances, by the geology of the basin. As a consequence of this relation and the one expressed above between slope, size of bed material, and drainage area, it is shown that for a given size of bed material, channel slope is inversely proportional to channel length. The measurements of rock-fragment size made at all the localities indicate that variations in size are large. The average median size of the bed material ranges from a few millimeters in some streams to over 600 millimeters in streams on the east side of the Blue Ridge. In the latter streams many boulders are several meters in diameter. In some streams the size is the same, upstream and downstream. In others it increases in a downstream direction. In others it decreases downstream. Because for a given stream length the slope is roughly proportional to a function of rock-fragment or particle size, the differences in the longitudinal profiles from one area to another are related to differences in particle size along the channel. Differences in channel cross section probably also affect the profile, but this factor is not analyzed. imple equations. One, a logarithmic equation, applies where the particle size remains constant. This equation is H=k loge L-I-C where H is the fall from the drainage divide, L is the length from the drainage divide and k and C are constants. It is a straight line on semilogarithmic graph paper. The other equation applies where the particle size changes systematically in a downstream direction and has the general form H— L(.+0 +C, when n does not equal —1 n+ 1 where H is the fall from the drainage divide, L is length and k, n, and C are constants. When C is zero this is a simple power equation and plots as a straight line on logarithmic graph paper. The two equations provide a wide variety of curves which are easily derived and offer a simple method of comparing many stream profiles. Because the size of the bed material has been demonstrated to have an important effect on stream slopes and may show systematic changes along the stream, an attempt is made to analyze the factors that control the changes. Detailed size-distribution analyses, in which stream-bed samples were separated into lithologic components, were made in areas where the sources of the bed material are known. These studies show that coarse material enters the stream wherever the valley walls are steep and composed of bedrock. The size of bed material in a stream at any place is determined partly by the distance from such a source, partly by the initial size of the material, and partly by the relative resistance of the material to abrasion and breakage. The tendency of coarse boulders to form a lag concentrate near their source is an important factor related to the steep profiles in steep-walled valleys and gorges. The reduction of bedrock by chemical weathering and soil formation leads to gentle stream slopes and low divides between the headwater streams of some bedrock areas. It is concluded that stream profiles are nicely adjusted to carry away the products of erosion of their basins, at rates determined by the initial relief, time, and the geology of the basins. Inasmuch as the longitudinal profiles are themselves indicative of the relief of an area and are intimately related to its topography, a geomorphological analysis of a region based on a comparison of long stream profiles is of value. Such an analysis, which is suggested but not developed here, may lead to modifications of some of our ideas on the development of land forms in the Central Appalachians.ETHODS OF STUDY AND DEFINITIONS TOF FACTORS MEASURED Inasmuch as expressions for measurable elements of a river system are used throughout the report, it is desirable that they be explained at the outset. Measurements made at more than 100 localities constitute the data for analysis of the factors controlling stream profiles. Several standard measurements were made at each locality; the most important are listed in table 8. The measurements described below relate to a single locality, or to a point on a stream channel. Area.—The term area refers to the drainage area above the particular locality, including the drainage basin of the principal stream and of all the tributaries which enter it above the locality (fig. 9 and list of symbols, p. 49). In practice, area is measured on topographic maps, or in a few cases on aerial photographs, by use of a planimeter. -. Area, A, in square miles Measurement locality Length, L, in miles, measured along stream MAP Length, L, in miles A °LL I=slope, S. In feet per mile LONGITUDINAL SECTION Flood plain Width, IV, in felt Cross section area, C, in square feet Depth, D, = Qw CROSS SECTION AT LOCALITY FIGURE 9.—Plan, longitudinal section, and cross section of hypothetical river valley showing the measurements made at each of the localities studied. As only two traverses are made with the planimeter at each locality, the measurement is not precise. Area is expressed in square miles. Length.—The term length denotes the distance from a locality on a stream to the drainage divide at the head of the longest stream above it. The measurement is generally made on maps or aerial photographs with a map measure, along the stream channel and following meanders and bends; but in a few drainage basins it was made by tape traverse. Length is measured in miles. Fall.—The fall is the vertical distance, or differreach of the stream channel at a locality, expressed in feet per mile. Measurement of slope is subject to considerable inaccuracy because of many local irregularities. Ideally, the measurement is the tangent to the longitudinal profile at a locality on the stream channel. Generally, the profile when measured in detail is not a smooth curve but is broken by pools and riffles. Near the foot of a pool the bed of the channel rises, and at low flow the surface of the water is very nearly horizontal. Channel slopes were measured in the field over distances of 200 to 500 feet at every locality studied, using a 200 foot tape and hand level. It was found, however, that the desired tangent to the profile could be better approximated by a map measurement. The measure finally adopted for use in the analysis is simply the vertical distance between the contour above the locality and the contour below the locality, in feet, divided by the horizontal distance along the channel between them, in miles. For very steep slopes the measurement includes several contours. As would be expected, the map measurements approximate the field measurements on steep slopes (over 100 feet per mile) but depart erratically from them on gentle slopes. Channel cross section. — Measurements of the channel cross section were made at every locality. Like slope, this element is subject to many local irregularities. Presenting an additional difficulty is the fact that it is in many places impossible to determine what is the height of the flood plain above the stream, and whether or not a plain at one place represents the same surface as a similar plain at another place. The method used is rather time consuming and yields figures which are valid for one specific point on the channel but may not be typical of a whole reach near the point. A tape is stretched across the stream, from the edge of the flood plain adjacent to the channel to the edge of the opposite flood plain. Crosssectional area of the channel is measured by setting up a stadia rod at one end of the tape on the flood plain, and measuring the elevation of the stream bed with a hand level at intervals of 2 to 10 feet along the tape. The cross profile of the channel is plotted on graph paper, and the area measured. The width is defined as the distance between the two edges of the flood plain. 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The operator walks along the line of bobbins FIGURE 10.—Plan of typical river cross section showing method of laying out grid for size-distribution analysis of material on stream bed. Dashed lines indicate successive positions of line of bobbins. and successively picks up and classifies whatever material his finger first touches on the bottom directly beneath each bobbin. The classification is made with a meter rule divided into size-class intervals on a logarithmic scale. Only one axis of the boulder or pebble is measured, the intermediate axis. When 20 boulders, pebbles, or pinches of sand have been classified, the tape is moved a regular distance to another position, until grid points have been occupied over the entire stream width. An assistant keeps a tally, or tally is kept on a mechanical counter, such as is used in microscopic methods, mounted on the chest of the operator. 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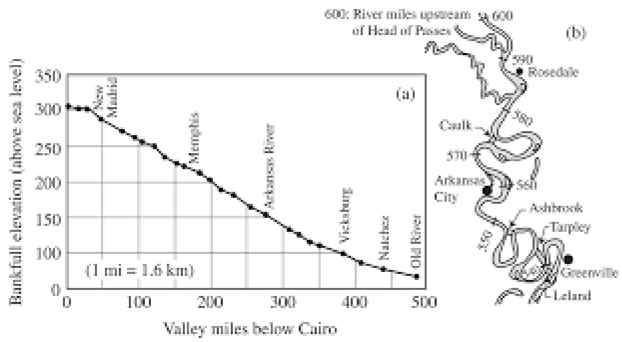
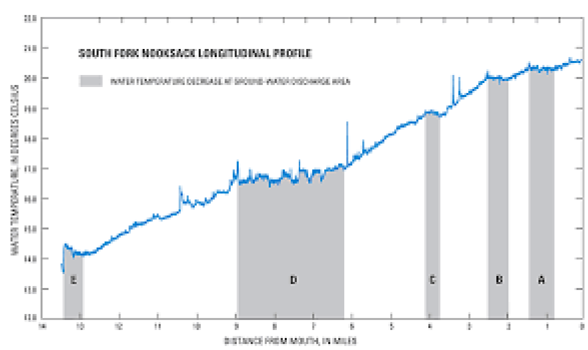
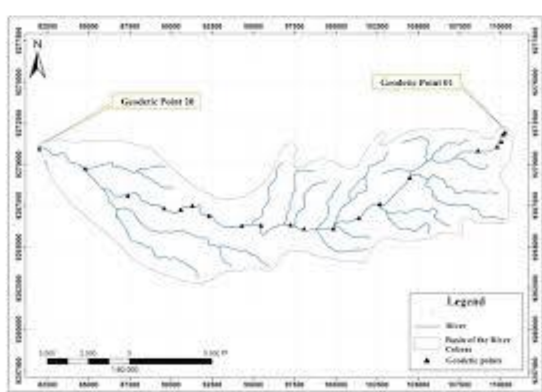
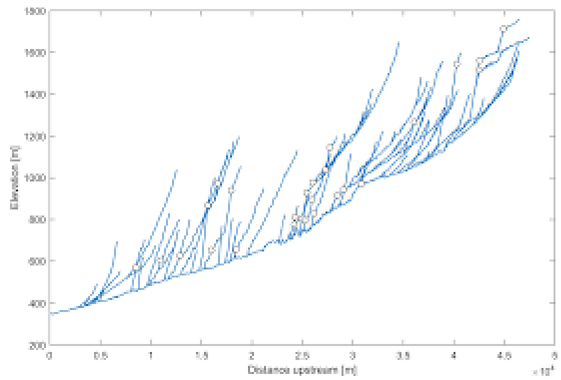
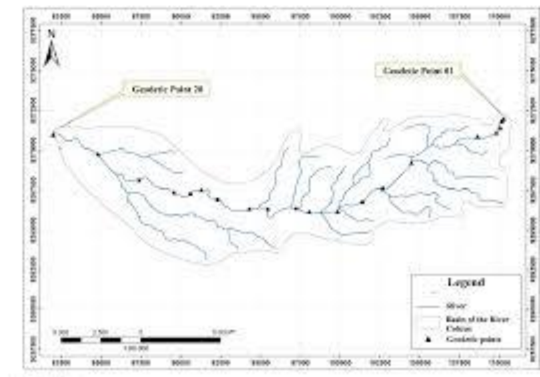






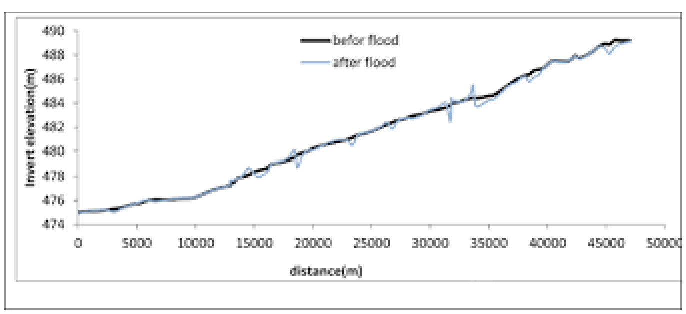


Elevation [m]
Distance upstream [m]

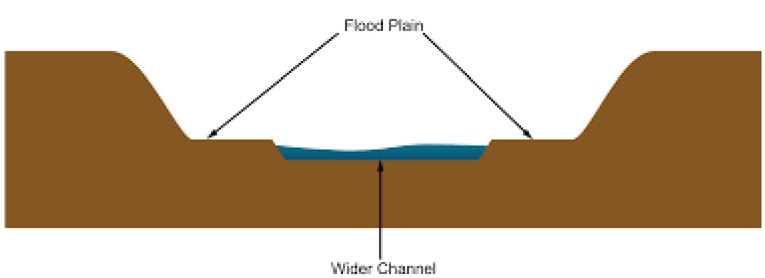


Legend

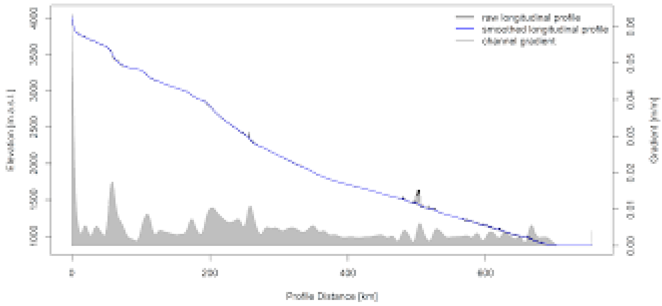
V-Shaped Valleys
Middle Course
Fluvial Deposition
Source Zone
Transition Zone
Floodplain Zone

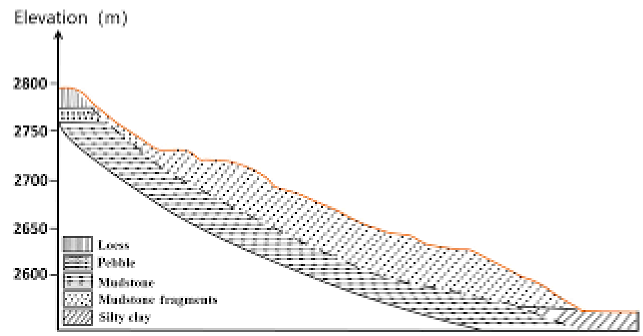


befor flood
after flood
Invert elevation(m)
distance(m)
490
488
486
484
482
480
478
476
474
0
5000
10000
15000
20000
25000
30000
35000
40000
45000
50000

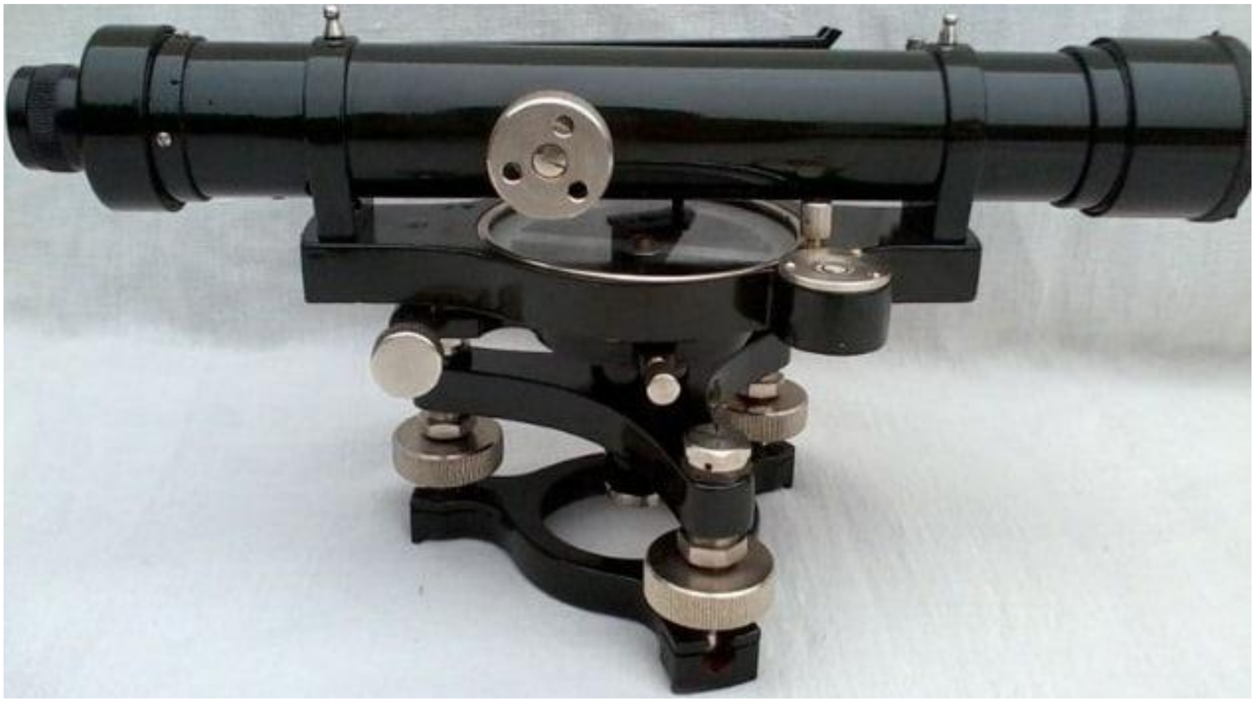


Flood Plain
Wider Channel





Dumpy level: This is a survey instrument. It is one of the important surveying instrument in the field of the ground survey. The dumpy level is an **optical instrument used for surveying and levelling operations**. It comprises of a telescope tube, firmly held between two collars and adjusting screws. The complete instrument is staged by the vertical spindle. The telescope placed on the dumpy level can be rotated amongst the horizontal plane.Dumpy level is commonly used leveling instrument to locate the points in same horizontal plane. It is also called as automatic level or builder's level. Elevations of different points and distance between the points of same elevation can be determined by dumpy level. The telescope is fixed to its supports in dumpy level and hence it cannot be rotated in vertical axis. It is invented by William Gravatt in 1832.

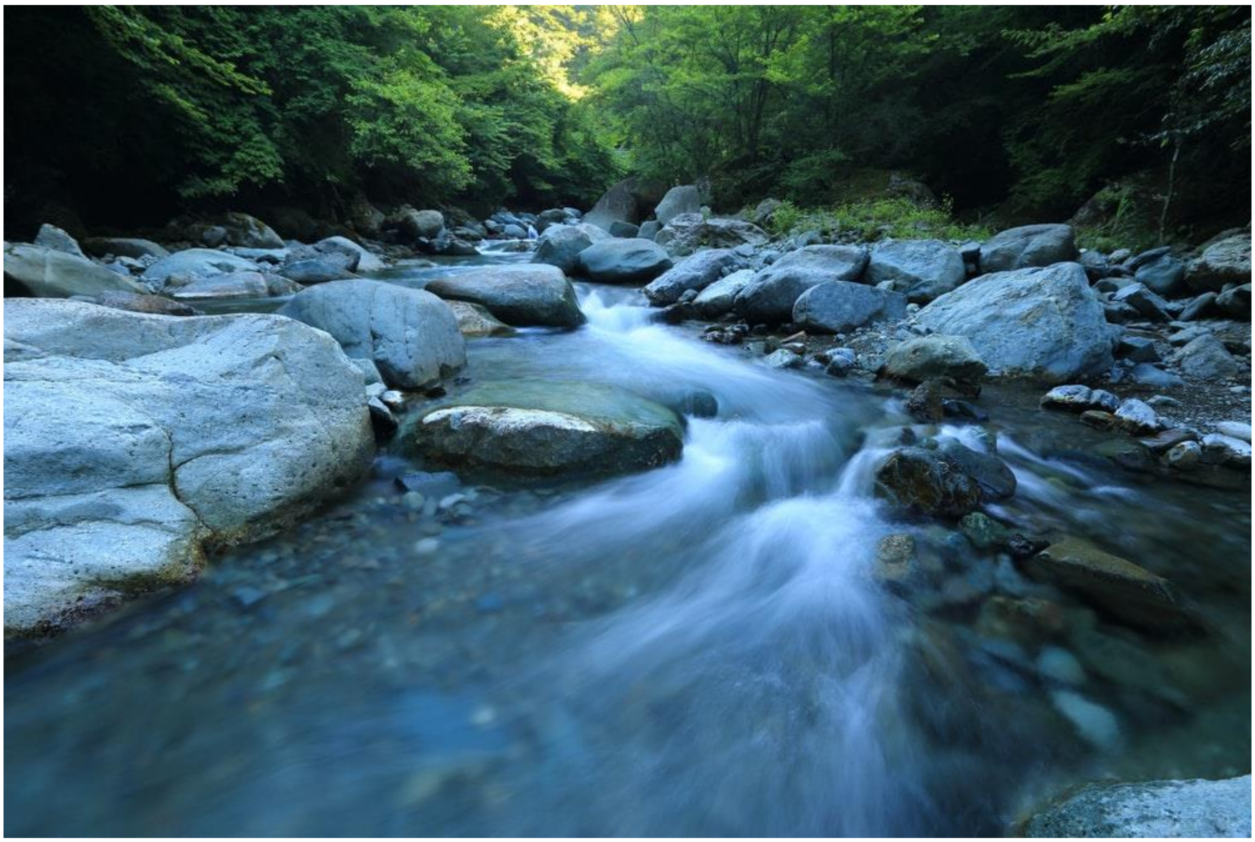


An art of determining the relative height of different points on, above or below the surface.Levelling is of prime importance to an engineer for the purpose of planning, designing and executing the various engineering projects such as roads, railways, canals, dams, water supply and sanitary schemes etc. The success of any engineering project is based upon the accurate and complete levelling work of the project

The Indus originates in the northern slopes of the Kailash range in Tibet near Lake Manasarovar. It follows a north-westerly course through Tibet. It enters Indian territory in Jammu and Kashmir. It forms a picturesque gorge in this part. Several tributaries - the Zaskar, the Shyok, the Nubra and the Hunza join it in the Kashmir region. It flows through the regions of Ladakh, Baltistan and Gilgit and runs between the Ladakh Range and the Zaskar Range. It crosses the Himalayas through a 5181 m deep gorge near Attock, lying north of the Nanga Parbat and later takes a bend to the south west direction before entering Pakistan. It has a large number of tributaries in both India and Pakistan and has a total length of about 2897 km from the source to the point near Karachi where it falls into the Arabian Sea. The main tributaries of the Indus in India are Jhelum, Chenab, Ravi, Beas and Sutlej.The Brahmaputra originates in the Mansarovarlake, also the source of the Indus and the Satluj. It is slightly longer than the Indus, but most of its course lies outside India. It flows eastward, parallel to the Himalayas. Reaching NamchaBarwa (7757 m), it takes a U-turn around it and enters India in Arunachal Pradesh and known as dihang. The undercutting done by this river is of the order of 5500 metres. In India, it flows through Arunachal Pradesh and Assam, and is joined by several tributaries.The Ganga (Ganges) rises from the Gangotri Glacier in the Garhwal Himalayas at an elevation of some 4100 metres above the sea level under the name of Bhagirathi. This main stream of the river flows through the Himalayas till another two streams – the Mandakini and the Alaknanda – join it at

DevPrayag, the point of confluence. The combined stream is then known as the Ganga. The main tributaries of the Ganga are Yamuna, Ram Ganga, Gomati, Ghaghara, Son, Damodar and SaptKosi. The river after traversing a distance of 2525 kms from its source meets the Bay of Bengal at Ganga Sagar in West Bengal.The River Yamuna originates from the Yamunotri glacier, 6387m above mean sea level (msl), at the Banderpoonch peak in the Uttarkashi district of Uttarakhand. The catchment of the river extends to states of Uttar Pradesh,Himachal Pradesh, Haryana, Rajasthan and Madhya Pradesh and the entire union territory of Delhi. The river flows 1367 km from here to its confluence with the River Ganga at Allahabad. The main tributaries joining the river include the Hindon, Chambal, Sind, Betwa and Ken. The annual flow of the river is about 10,000 cumecs. The annual usage is 4400 cumecs, irrigation accounting for 96% of this.The Narmada or Nerbudda is a river in central India. It forms the traditional boundary between North India and South India, and is a total of 1,289 km (801 mi) long. Of the major rivers of peninsular India, only the Narmada, the Tapti and the Mahi run from east to west. It rises on the summit of Amarkantak Hill in Madhya Pradesh state, and for the first 320 kilometres (200 miles) of its course winds among the Mandla Hills, which form the head of the Satpura Range; then at Jabalpur, passing through the 'Marble Rocks', it enters the Narmada Valley between the Vindhya and Satpura ranges, and pursues a direct westerly course to the Gulf of Cambay. Its total length through the states of Madhya Pradesh, Maharashtra, and Gujarat amounts to 1312 kilometres (815 miles), and it empties into the Arabian Sea in the Bharuch district of Gujarat.TheTapi is a river of central India. It is one of the major rivers of peninsular India with the length of around 724 km; it runs from east to west. It rises in the eastern Satpura Range of southern Madhya Pradesh state, and flows westward, draining Madhya Pradesh's historic Nimar region, Maharashtra's historic Khandesh and east Vidarbha re-gions in the northwest corner of the Deccan Plateau and South Gujarat before emptying into the Gulf of Cambay of the Arabian Sea, in the State of Gujarat. The Western Ghats or Sahyadri range starts south of the Tapti River near the border of Gujarat and Maharashtra. The Tapi River Basin lies mostly in northern and eastern districts Maharashtra state viz, Amravati, Akola, Buldhana, Washim, Jalgaon, Dhule, Nandurbar, Malegaon, Nashik districts but also covers Betul, Burhanpur districts of Madhya Pradesh and Surat district in Gujarat as well. The principal tributaries of Tapi River are Purna River, Girna River, Panzara River, Waghur River, Bori River and Aner River. The river with second longest course within India, Godavari is often referred to as the Vriddh (Old) Ganga or the Dakshin (South) Ganga. The name may be apt in more ways than one, as the river follows the course of Ganga's tragedy. The river is about 1,450 km (900 miles) long. It rises at Trimbakeshwar, near Nasik and Mumbai (formerly Bombay) in Maharashtra around 380 km distance from the Arabian Sea, but flows southeast across south-central India through the states of Madhya Pradesh, Karnataka, Orissa and Andhra Pradesh, and empties into the Bay of Bengal. At Rajahmundry, 80 km from the coast, the river splits into two streams thus forming a very fertile delta. Some of its tributaries include Indravati River, Manjira, Bindusara and Sabari. Some important urban centers on its banks include Nasik, Bhadrachalam, Rajahmundry and Narsapur. The Asia's largest rail-cum-road bridge on the river Godavari linking Kovvur and Rajahmundry is considered to be an engineering feat.The Krishna is one of the longest rivers of India (about 1300 km in length). It originates at Mahabaleswar in Maharashtra, passes through Sangli and meets the sea in the Bay of Bengal at Hamasaladeevi in Andhra Pradesh. The Krishna River flows through the states of Maharashtra, Karnataka and Andhra Pradesh. The traditional source of the river is a spout from the mouth of a statue of a cow in the ancient temple of Mahadev in Mahabaleshwar. Its most important tributary is the Tungabhadra River, which itself is formed by the Tunga and Bhadra rivers that originate in the Western Ghats. Other tributaries include the Koyna, Bhima, Mallaprabha, Ghataprabha, Yerla, Warna, Dindi, Musi and Dudhgangarivers.TheCauveri (also spelled Kavery) is one of the great rivers of India and is considered sacred by the Hindus. This river is also called Dakshin Ganga. The headwaters are in the Western Ghats range of Karnataka state, and flows from Karnataka through Tamil Nadu. It empties into the Bay of Bengal. Its waters have supported irrigated agriculture for centuries, and the Cauveri has been the lifeblood of the ancient kingdoms and modern cities of South India. The source of the river is Talakaveri located in the Western Ghats about 5,000 feet (1,500 m) above sea level. It flows generally south and east for around 765 km, emptying into the Bay of Bengal through two principal mouths. Its basin is estimated to be 27,700 square miles (71,700 km^2), and it has many tributaries including Shimsha, Hemavati, Arkavathy, Kapila, Honnuhole, LakshmanaTirtha, Kabini, Lokapavani, Bhavani, Noyyal and Famous Amaravati.The Mahanadi River system is the third largest in the peninsula of India and the largest river of Orissa state. The basin (80º30’–86º50’ E and 19º20’–23º35’ N) extends over an area approximately 141,600 km^2 , has a total length of 851 km and an annual runoff of 50×109 m^3 with a peak discharge of 44740 $m^3 s^{-1}$. The basin is characterized by a tropical climate with average annual rainfall of 142 cm (NWDA, 1981) with 90% occurring during the SW-monsoon. The river begins in the Baster hills of Madhya Pradesh flows over different geological formations of Eastern Ghats and adjacent areas and joins the Bay of Bengal after divided into different branches in the deltaic area. The main branches of River Mahanadi meet

Bay of Bengal at Paradip and Nuagarh (Devi estuary). The tidal estuarine part of the river covers a length of 40 km and has a basin area of 9 km^2 . Based on physical characteristics, the estuary has been characterized as a partially mixed coastal plain estuary.



Watching a river flow by is often a peaceful experience, as it goes by of its own accord. But there is actually a lot of science behind why a river flows how it does and what will change a river's flow over time. Before any type of bridge can be built or property, whether commercial or domestic, that will potentially affect the river, a survey needs to be done to evaluate the impact these structures will have.

In the past, Landform Surveys has surveyed rivers largely to do a flood risk assessment, either before or after flooding has occurred. This involves looking at the structure of the physical environment of the river (which means getting into the river itself!) as well as the area surrounding the river. This includes careful evaluation of both banks and the channel of the river. There isn't set parameters for how large of an area will be surveyed as the topography of each river is different and each potential new structure will have different considerations.

When a river survey occurs, it is the duty of the surveyor to provide an accurate report of the potential impact of any development or engineering works. This isn't always the result that a developer necessarily wants as developments can negatively impact a river and increase the risk of flooding. By doing a river survey though it is also possible to look at alternatives to come up with a solution that is mutually beneficial for all.

It's not just buildings or bridges that can make a difference to the flooding possibilities of a river. Even the addition of flood defences, drainage or utilities, nearby roads and erosion prevention, while good intentioned can be detrimental if not evaluated properly.

As rivers flow through both city and countryside, changes to river environments affect both urban and rural communities alike. Even if the effect isn't felt in the area surrounding where the works would be done, depending on the properties of the river, it is possible that the effects will be felt up or downstream. This is particularly true of the addition of dams, or new drainage and utilities.

River surveys are particularly important when a potential bridge is going to be built. While a bridge may not affect the flow of a river when the water level is normal, surveyors have to look at what the effects would be when the river is at different levels and under different circumstances. This can include levels of debris that might build up around the bridge as well as different levels and durations of flooding.

So surveying a river and getting accurate data around the impact of potential works is important to keep flooding at a minimum and communities and properties safe. If you're looking to commission a flood risk assessment or bathymetric survey, get in touch.To conduct a river survey, or hydro-graphic survey, engineers use their expertise along with sophisticated equipment to create a highly accurate map of a river. These surveys must take the effect of tides, temperature, currents and waves into account.

This hydro-graphic surveying data is then used by hydraulic engineers to perform various tasks, such as:

- **Hydraulic modeling**
- **Determining water quality parameters**
- **Aquatic habitat analysis**
- **Flood studies**

Hydro-graphic surveys allow mapping of both the river surface, the depth of water, as well as the river bottom. The survey may include both cross-sections and contour maps.

The data and mapping can be used to determine water velocities and their effects of fish and other aquatic species. In addition, hydrographic surveying may also include obtaining information on soil and silt at the river bottom.

Generally, three phases comprise a surveying project the survey itself, compiling the data, and using the data to support a project.

Some of the state-of-the-art equipment used to conduct water surveying includes Global Positioning System (GPS) locating devices, Light Detection and Ranging (LIDAR) devices and depth sounding equipment. Huge amounts of data are accumulated during the surveying project, and this data must be processed and analyzed for its final use with various types of specialty software.

Surveying engineering is sometimes part of the due diligence process and would typically be needed prior to the start of design. Chokhavatia Associates are experts in civil engineering and surveying, including hydro-graphic surveying procedures.

Chokhavatia Associates have the state-of-the-art equipment necessary to conduct extensive river surveys. CA engineers have vast expertise in using the survey equipment to accumulate the necessary measurements and data for hydro-graphic surveys.

In addition, CA have appropriate software and experienced professionals to utilize the river survey for a variety of project types. Their hydro-graphic surveys have been used for floodplain studies, river discharge measurements, benthic habitat mapping, monitoring sediment changes, and planning for dredging operations.

CA's hydro-graphic survey data can be exported to the necessary CAD or GIS files for use in preliminary and final project design as well. Chokhavatia Associates' software also computes volume quantities, creates electronic charts and generates river contours. Chokhavatia Associates provides quality assurance to ensure data consistency to meet all hydro-graphic specifications. Chokhavatia Associates makes every effort to provide complete customer satisfaction and river surveys meeting the highest technical standards.

REFERENCE:

1.River of India : Sunil Vaidyanathan, 2011
2. River Journey : Clearance Jonk,2017.
3. The River : Peter Heller, 2010
4. River Dynamics :Canbrudge University Press, April,2020
5. Fundamentals of Fluvial Geomophology, Ro Charlton, 2008
6. Rivers of India :RadhakantBharati, 2008
7. Geography of River System: BiplabTripathy, 2012
8. The Lost River : Michel Danino, 2010
9. The Politics of Water Resource Development in India: John R.Wood.
10. Narmada Valley :Adil Khan, 2010
11. Rural Development in India: Abdul Azeez, 2007
12. Rural Development Programmes in India : S.B. Golahat, 2004
13. River Science : National Research Council, 2007

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