CHAPTER 2: LITERATURE REVIEW

2.1 GENERAL

Review of literature is indispensable part of any research work. It provides solution of the problem by previous work done by various researchers and scientists. Flood is the most dangerous natural disaster, as worldwide known so far. It causes a huge economical impact as well as loss of life and livelihood. Estimation of discharge for open channel flow (most commonly natural rivers) is very vital hence it has been keen interest of the researchers for the decades. To understand the River Ganga behaviour, it is required to study its flow characteristics and flow behaviour. Therefore, preparation of scientific database for the River Ganga at Varanasi for mathematical modelling and its application on erosion, sedimentation and river sinuosity was done. The literature related to study of research area are presented in the following sections.

2.2 USE OF ADCP'S IN RIVER STUDY

Here, the ADCP used previously in various type of river measurements and channel measurements considered. Some literature related to the ADCP measurements are listed here to understand the importance, the accuracy level of ADCP and the use of ADCP in the river study.

Adler and Nicodemus (2001) stated that Current and stream flow data are needed for low-flow and flood forecasting, water-resources management, water quality assessment, river ecology and morphology, climate research, flood protection, and hydropower generation. The example of the acoustic Doppler equipment (ADCP) proves that an increasing demand for current and discharge data can be met at fairly low cost compared with conventional methods

Shen et al. (2010) focused on using the shear-flow dispersion theory to directly estimate the dispersion coefficient from velocity measurements obtained using an ADCP. Results based on the ADCP method were found to be in good agreement with the ADE estimates indicating that storage zones play an important role in the estimated dispersion coefficients, especially at high flows. The ADCP method appears to be an excellent alternative to the traditional tracer-based method if care is taken to avoid spurious data and multiple datasets are used to compute a distance-weighted average or other appropriate measure that represents reach-averaged conditions.

Garcia et al. (2007) has made a unique set of observations of stratified flow phenomena in the Chicago River using an upward-looking ADCP during the period November 20, 2003 to February 1, 2004. The ADCP was configured to continuously collect high-resolution water velocity and echo intensity profiles in the Chicago River at Columbus Drive. During the observation period, 28 gravity current events were identified, lasting a total of 77% of the time. Sixteen of these events were generated by underflows from the NB and 12 of these events were generated by overflows from the NB. They used the first time ADCP technology to continuously monitor gravity currents in a river.

Gordon (1989) proposed a new moving-boat method for rapidly measuring river discharge using an ADCP. The method uses an ADCP to measure current profiles and boat velocity along transects across a river. Measurements from the River Elbe, near Hamburg, Germany, are presented to illustrate the method and its associated uncertainties. An ADCP measures profiles of current velocity relative to the boat and the velocity of the boat relative to the bottom. Missed data near the surface and bottom are the largest source of error unless the data are corrected by assuming model profiles. With correction, the error in estimation of total discharge is dominated by flow in the shallow water at the sides of the river; for the River Elbe, the total error appears to be about 5%.

Muste et al. (2004) proposed several methods for enhancing the significance of the ADCP velocity distribution profiles collected from moving boats and proposes complementary software to further process and visualize the ADCP data for better support of hydraulic investigation requirements. Velocities enhanced using the optimum tested post-processing algorithms are used to further determine depth-averaged velocities, velocity components in river coordinates, and river discharge estimates.

Nystrom et al. (2007) tested the ability of ADCP's to measure turbulence, profiles measured with two pulse to pulse coherent ADCPs in a laboratory flume were compared to profiles measured with an acoustic Doppler velocity meter, and time series measured in the acoustic beam of the ADCPs were examined. The four-beam ADCP measured the Reynolds stress profile accurately away from the bottom boundary, and these measurements can be used to estimate shear velocity. Estimates of Reynolds stress with a three-beam ADCP and turbulent kinetic energy with both ADCPs cannot be computed without further assumptions, and they are affected by flow in homogeneity. Neither ADCP measured integral time scales to within 60%.

Oberg and Mueller (2007) work done U.S. Geological Survey and other international agencies have collaborated to conduct laboratory and field validations of acoustic Doppler current profiler (ADCP) measurements of stream flow. Results of these analyses show that broadband ADCP stream flow measurements are unbiased when compared to the reference discharges regardless of the water mode used for making the measurement. Measurement duration is more important than the number of transects for reducing the uncertainty of the ADCP stream flow measurement.

Rennie et al. (2002) developed a new technology to measure the apparent velocity of bed load (v_a) using an acoustic Doppler current profiler. The technique involves estimating the bias in bottom tracking due to a moving bottom. Variance was due to both real temporal variability of transport and measurement error. The mechanisms that produce this variability are discussed and preliminarily quantified.

Wewetzer et al. (1999) working of ADCP data sets acquired from the macro tidal Tay Estuary, eastern Scotland, the principles of field deployment, data acquisition and forms of output are critically summarised. The improved understanding of three-dimensional water and suspended sediment dynamics in coastal and estuarine waters is crucial to, inter alia, the sustainable management of effluent discharges and, in more general terms, They were predicted on the basis of the Tay case study, that ADCP measurements afford significant opportunities to refine understanding of geomorphological processes in a variety of aquatic environments worldwide.

2.3 RIVER STUDY WITH HELP OF MODELS

River is of a keen interest for the researchers from the decades. Various researchers were shows the various relationship of the river parameters with the help of river models i.e. physical model, numerical model or computer based model, because it is not possible to measure the river continuously due to its large appearance, so the model based study is adopted for the predicting and forecasting of the any river based activity, which is very useful for the human life. In this section the literature is divided in two sub sections as one related to the physical model study of some rivers/open channels and the other is related to the numerical and soft computing models for the rivers/open channel studies.

2.3.1 Physical Model Related

Anderson et al. (2010) described a three-dimensional unsteady model of the combined system and its application to real-time predictions of physical conditions over the corridor. Comparisons between model simulations and observed values show average differences of 3 cm for water levels and 12 cm/s for a long-channel currents in the St. Clair River (compared to mean current values of 1.7 m/s) for the period of September 2007 to August 2008. Simulations reveal a spatially and temporally variable circulation in Lake St. Clair as well as significant changes in flow rate and distribution through the St. Clair Delta not accounted for in previous models.

Bai and Wang (2011) presented theoretical model for river evolution including riverbed formation and meandering pattern formation. Based on nonlinear mathematical theory, the nonlinear river dynamic theory is set up for river dynamic process. As an application of this theory, the dynamical stability of the constant curvature river bend is calculated for its coherent vortex disturbance and response. In addition, this paper discusses the nonlinear evolution of the river peristaltic process under a large-scale disturbance, showing the nonlinear tendency of river dynamic processes, such as river filtering and butterfly effect.

Guymer et al. (1998) presented results from a series of laboratory experiments conducted on a large scale channel with sinuous plan form geometry. Those used to obtain the magnitude of the longitudinal dispersion coefficient. A constant trapezoidal cross-section and a variable cross-sectional "natural" shape under different discharges have been studied. A comparison between observed and predicted distributions from a simple routing procedure emphasizes the need for an improved method for incorporating the effects of longitudinal variations in cross-sectional shape.

De Rose et al. (2008) investigated in Victoria, Australia, with the aim of developing predictive models of channel geometry for large-scale spatial modeling applications. Spatial variation in hydraulic geometry relations within and between river basins remains largely unexplained. The W/D ratio characteristically decreases with increasing distance along the lower reaches of most rivers and this has contributed to the lower than expected value for the width exponent.

Schappi et al. (2010) expressed hydraulic modelling of the riverbed and the floodplain area. The aerial survey only the elevation of the water surface is recorded; information about the riverbed topography cannot be obtained from the DTM. The accuracy of the algorithm was tested by comparing the interpolated elevation of the exposed part of the gravel bar to measurements obtained from an aerial survey. The mean height difference is in the order of about 9 cm. Further the interpolated grid was used for a two dimensional flow simulation and the resulting water level was compared to the one recorded in the original DTM.

Schulze at al. (2005) stated that based on the Manning-Stickler equation, a simple algorithm to model temporally and spatially variable flow velocity was developed with the objective of improving flow routing in the global hydrological model of Water- GAP. Results show that flow velocity can be modeled satisfactorily at selected river cross-sections. It turned out that it is quite sensitive to river roughness, and the results can be optimized by tuning this parameter. After the validation of the approach, the tested flow velocity algorithm has been implemented into the Water GAP model. A final validation of its effects on the model results is currently performed.

Uddin and Rahman (2012) had made an attempt has been made to investigate the flow patterns and to estimate the rate of bank erosion in a bend along the Jamuna

River. The three dimensional (3D) flow velocities were measured using Acoustic Doppler Current Profiler (ADCP). It is found that the near bank velocity is amplified by 1.1 to 1.3 times as compared with the section averaged velocity. Based on the flow processes, a simplified erosion prediction model is developed and applied to estimate the rate of erosion at a selected bend. Finally the predicted results have been compared with the observed data at the bend and all the available data at other bends along the Jamuna River.

Zhu and Zhou (2009) proposed hydrological forecast. The model was applied to forecast annual runoff of Dahuofang Reservoir in China. They indicated that the forecast precision is improved with rough set and the model can effectively reflect the non-linear relations between the runoff and factors and provide an effective and adaptable method to solve forecast problems related to complex factors selection and minimal inference rule set generation.

2.3.2 Regression/Numerical and Soft Computing Models Related

Ainsworth et al. (2011) explored the potential use of functional regression analysis and the closely related functional principal component analysis for studying the relationship between river flow (continuously monitored) and salmon abundance (measured annually). They derive joint confidence region for the functional regression coefficient function and discuss its use relative to the more commonly used point wise confidence intervals. The analysis points to a substantial negative correlation between early spring river flow and marine survival of the sockeye salmon that subsequently migrate down the inlet.

Akbari et al. (2009) used different soft computing technique for Flood Flow Forecasting. Proposed approach was applied to a flood flow forecasting case example and the results are compared with those forecasted using initially available and reconstructed models. Results show that the modified model outperforms the initial FRB model. Reconstructed model performs slightly better than the modified model; however, the reconstruction may not be justified in a real time flood forecasting system, considering the limitations on the available lead time.

Bolshakov et al. (2013) discussed the application of linear and symbolic regression to forecast and monitor river floods. Main tasks of the research were to find an analytical model of river flow and to forecast it. Genetic programming is used in the task of symbolic regression. To train the model, historical data of the Daugava River monitoring station near Daugavpils city were used. Several regression scenarios were discussed and compared. Models obtained by the methods discussed in the research show good results and applicability in predicting the river flow and forecasting of the floods.

Buijsman and Ridderinkhof (2007) worked on unique, five-year long data set of ferry-mounted ADCP measurements in the Marsdiep inlet, the Netherlands, obtained between 1998 and 2003. A least-squares harmonic analysis was applied to the water transport, (depth-averaged) currents, and water level to study the contribution of the tides. The amplitudes of all non-astronomic constituents are largest during spring tides, strongly distorting the water level and velocity curves.

Guerrero and Lamberti (2011) did an 8-km-long and 250-m-wide reach of the Po River (Italy) surveyed with two vessels, aiming to investigate the channel morphology and flow field characterizing this major Italian river and to provide data for the calibration of a numerical model. To evaluate the friction velocity by using moving-vessel measurements, the vertical variance of velocity profiles as an alternative to logarithmic fitting of ADCP profiles was estimated. In particular, a correlation between the friction velocity and small-scale bed forms (4–5 m mean wavelength) was observed.

Islam et al. (2001) proposed a simple one-parameter neural network model, General Regression Neural Network for forecasting chaotic time series. The approach employs the theory of phase-space to reconstruct the evolution trajectory of motion, which is used as the input. The nearer projected state is weighted heavier than the remotely projected state, a reasonable approximation in the phase-space. The performance of the GRNN is first verified on an artificial chaotic time series and then on a real hydrological time series.

Duan et al. (2004) reported the development of an enhanced two-dimensional (2D) numerical model for the simulation of flow hydrodynamics and mass transport in meandering channels. The hydrodynamic model was based on the solution of the depth-averaged flow continuity and momentum equations where the density of flow varies with the concentration of transported mass. The comparison of the simulated velocity and water surface elevation with the measurements indicated that the inclusion of the dispersion terms has improved the simulation results. A laboratory experiment study of dye spreading in a sine-generated channel, in which dye was released at the inner bank, centreline, and outer bank, respectively, was chosen to verify the mass transport model. The simulated concentration field indicated that the Schmidt number can be used as a calibration parameter when dispersion is computed using a 2D approach with a simplified turbulence model.

Kim et al. (2012) presented algorithms used in calculating longitudinal dispersion coefficients using ADCP data driven by either vertical or transverse velocity gradients in large river, and describes software components capitalizing on these ADCP measurement capabilities to provide the longitudinal dispersion coefficients based on in-situ measurements. The paper clearly provides the promise of ADCP data and the associated analytical algorithms for estimating longitudinal dispersion coefficients. They also compared longitudinal dispersion coefficients obtained with the theoretical formula using ADCP with those from the other available alternative empirical formulas, and found that empirical formula overestimated the longitudinal dispersion coefficient in large river. Therefore, further use of the software and the embedded procedures can uniquely support in-situ measurement campaigns designed to document important aspects of the dispersion processes and formulation of reliable knowledge that circumvent the empirical approaches of the past.

Lai and Shen (1991) developed a computer model RICE for simulating ice processes in rivers. In the river-hydraulics component, the flow condition was determined from one-dimensional unsteady flow equations. The formation of ice cover was formulated according to existing equilibrium ice-jam theories, with consideration to the interaction between the ice cover and the flow. The undercover ice accumulation was formulated according to the critical velocity criteria. The thermal growth and decay of the ice cover is simulated using a finite-difference formulation applicable to composite ice covers consisting of snow, ice, and frazil layers.

Mueller et al. (2007) ADCPs presented laboratory, field, and numerical model evidence of errors in ADCP measurements caused by flow disturbance. A state-of-the-art three-dimensional computational fluid dynamic model is validated with and used to complement field and laboratory observations of flow disturbance and its effect on measured velocities. His results show that near the instrument, flow velocities measured by the ADCP were neither the undisturbed stream velocity nor the velocity of the flow field around the ADCP. The velocities measured by the ADCP were biased low due to the downward flow near the upstream face of the ADCP and upward recovering flow in the path of downstream transducer, which violate the flow homogeneity assumption used to transform beam velocities into Cartesian velocity components.

Nagata et al. (2000) presented a numerical analysis of river channel processes with bank erosion. The model can be used for investigating both bed deformation and bankline shifting in 2D plan form. The model was applied to examine the morphological behavior of experimental channels. On the basis of the numerical findings, the paper clarifies the influence of hydraulic variables on the location of bank erosion and bed scouring. The model also was used to investigate the effect of alternate bars on bank erosion and to investigate the development of channel meandering from an initially straight channel.

Song et al. (2012) studied the depth-averaged shallow water equations with dispersion stresses were solved by the SU/PG scheme among the various numerical methods of the FEM. The simulation results obtained by the proposed model with dispersion terms matched quite well with the ADCP data, whereas the model without dispersion terms produced excessive velocities at both banks, and the commercial RMA-2 model yielded uniform span wise velocity distributions at all sections. It was also found that the pressure gradient term was the primary factor that triggered velocity redistribution. As the Froude No. increased, the convective acceleration that formed along the channel curvature was activated as a secondary factor in velocity redistribution, whereas the viscous stress term lost its influence.

Tayfur et al. (2011) predicted mean and bankfull discharge. They employed four methods regression, fuzzy logic (FL), artificial neural networks (ANNs), and genetic algorithm (GA)-based nonlinear equation—for predicting mean discharge and bank-full discharge from cross-sectional area. This has important implications for predicting bankfull rates at ungauged sites. On the other hand, the sensitivity analysis results also showed that GA-based method has poor extrapolation capability for predicting mean discharge data.

Eslamian et al. (2010) worked on component Regression method for estimation of low index. It was attempted to estimate the low flow index (7Q10), the 7-day, 10-year low flow, using principal component regression (PCR) based on physiographic and hydrologic variables. The components chosen through the two approaches correspond to each other well. To evaluate the efficiency of the developed PCR in modeling 7Q10, calibration and verification were pursued. The results approve the efficiency of model in predicting 7Q10 in the region under study.

Wondzell et al. (2007) developed state and transition models (STMs) to evaluate the effects of natural disturbances and land-use practices on aquatic and riparian habitats. Models were run for 120 years with the current disturbance regime to illustrate changes associated with Euro-American settlement, and then run for an additional 50 years under the historical disturbance regime to illustrate the potential for passive recovery. Results suggested that Euro-American settlement dramatically changed riparian vegetation and channel conditions, which resulted in substantial declines in habitat quality. Overall, our results underestimate the effects of human land uses on streams and overestimate the rate of recovery under passive restoration because the models do not yet include the effects of many management activities, especially those resulting from forest harvest and roads.

2.4 DISCHARGE MEASUREMENT

Discharge plays very significant role in the river study, so its measurement is most important. Regular basis measurement of discharge in any river flow is very dangerous as well as very uneconomical, so for the measurement of the discharge, many researchers proposed various empirical methods to measure the discharge. Direct measurement of discharge with the help of empirical relation is quite close to the real value of the discharge so this technique of discharge measurement was adopted. In this section the previous literature related to the discharge measurement by numerical model and stage height relationship are listed.

Ali et al. (2010) checked the accuracy of chow's regression and stochastic methods was analyzed for estimating instantaneous peak discharge in central Alborz region, Iran. The best distribution was chosen to estimating instantaneous peak discharges for 2, 5, 10, 15, 20, 25, 30, 50 and 100 years return periods. Instantaneous Peak discharges for above return periods were estimated using chow's regression and Stochastic methods, and were compared with the best fitted distributions results using probabilities indices such as MSE and MBE. His results showed that chow's regression method is better than stochastic method for estimating instantaneous peak discharge in central Alborz region.

Bhatt and Tiwari (2008) estimated peak steam flow through channel geometry. The gauged records are also of short length (generally 15–30 years), therefore, development of robust models is necessary for estimation of stream flows. Stream geometry parameters for 42 river sites in central-south India were used; calibration equations were developed with data for 35 stations and tested on data for the remaining seven stations. The relationships developed between mean discharge and channel geometry parameters provide an alternative technique for estimation of mean annual channel discharge.

Chen et al. (2010) proposed Neural Network (ANN) modelling for outflow estimation of ungauged catchment. The Artificial Neural Network (ANN) model is suitable because it has various mathematical compositions capable of simulating a nonlinear structural system to establish the flow discharge in a catchment. In this study, the rainfall–runoff behavior of the gauge stations will be replicated in an ANN model. From the research work, it is revealed that the relevant spatial information can be obtained easily and precisely, which will help future studies on more related dimensions.

Choo et al. (2011) proposed a method to estimate river discharge using hydraulic characteristics, such as hydraulic radius, bed slope, depth, etc. As a result, the proposed method showed results more approximate to measured discharge. An analysis of discrepancy ratio distribution revealed that non-dimensional errors lied within the ranges of -0.2 to 0.23. This indicates that river discharge estimated using the proposed method showed some improvements in accuracy, compared with river discharge estimated using the conventional stage discharge curve equation or inverse roughness coefficients.

Engeland and Hisdal (2009) compared low flow estimates in ungauged catchment. The regression method was based on a relationship between the low flow index and an optimal set of catchment descriptors, established using stepwise linear regression for homogeneous sub regions. A comparison of the two methods in 21 independent catchments indicates that the regression method generally gives better estimates of Q_C in ungauged catchments than does the HBV model, particularly in those catchments with the lowest Q_C values.

Jung et al. (2011) worked on uncertainty in urban flooding analysis be considering hydro- climatic projection. While longer term floods frequency change above 25 year floods is dominated by natural variability. This result indicates that, under expected climate change conditions, adaptive urban planning based on the conservation scenario could be more effective in less developed Johnson catchment than in the already developed Fanno catchment.

Lee and Cheong (2009) in this study the stage height difference was considered to derive the rating curve and the index velocity was considered to derive the mean velocity equation which discharge results from these equations were compared with the measured discharge collected in the Samrangj in station where tidal current effects are dominant. The new rating curves allow superior in predicting discharge more precisely in tidily affected river as compared to existing equation. The discharge estimated using the mean velocity from the index velocity is in best agreement with the measured discharge data.

Lee et al. (2014) had investigated the implementation of a rigorous uncertainty analysis protocol to measurements conducted with Stream Pro ADCP operated with the stationary method. The implementation example illustrates that the standardized uncertainty analysis framework can be successfully applied for hydrometric measurements. Elements and framework of the uncertainty analysis presented in this paper can be applied to other instruments that estimate stream discharge using a section-by-section method.

Svetlikova et al. (2009) did work on modeling and forecasting of discharge and rainfall time series in the area of the Klastorske Luky wetland. The models tested were the linear ARMA models, the nonlinear TAR models, TAR with exogenous component and TAR combined with Long Memory models. The Monte Carlo method was applied for discharge prediction. The results obtained could help ecologists in making decisions on wetland management, improving the ecological conditions in the analysed wetland, and planning future eco-technical measures.

Vougioukas et al. (2011) had given innovative river discharge monitoring system which uses a H-ADCP attached to a mechatronic system that provides vertical motion to different depths. Five experiments were performed, and in two experiments the proposed method performed roughly the same as the standard index velocity method. In the other three experiments the proposed method performed much better and the difference between the discharges was as large as 10%. The results indicate that a vertically moving H-ADCP can be used to calculate river discharge more accurately in complex flow environments.

Wharton and Tomlinson (1999) worked on flood discharge measurement. This paper reports on channel-geometry equations which have been developed and applied in four developing, tropical countries as part of hydrological investigations for road design and flood risk assessment (Java), irrigation and hydropower development (Burundi), design of all-weather roads (Ghana), and rehabilitation of railway bridges (Tanzania). The applications demonstrate the benefits of the channel-geometry method in situations where, data on catchment characteristics are limited or may not offer the most appropriate basis for flood discharge estimation.

2.5 GRAIN SIZE RELATED STUDIES

Sediment size in any open channel flow/river flow is very important parameter to define the flow pattern, without taking it in consideration the study related to the open channel flow/river flow gives more errors. Here some literature are listed to discuss the effect of sediment size on the flow pattern of the open channel/river flow.

Adiyiah et al. (2014) worked on the distribution of the sediment grain size particles and the corresponding distribution of six heavy metals in three sediment fractions (> 0.5 mm, 45 µm - 0.5 mm and < 45 µm) of Lake Markermeer in the Netherlands. The results showed low and uneven grain-size distribution throughout the sediment cores probably due to disturbances from wave action. The highest concentrations of the heavy metals were found in the finest grain-size (< 45 µm) due to larger surface area and higher adsorption capacity.

Guerrero et al. (2011) made an effort to compare different methods for suspended sediment investigation using the backscattering power of acoustic Doppler current profilers (ADCPs). Preliminary results concerning the concentration and grain size distribution are consistent with the results of other methods. The quantity and texture of suspended sediments of the Paraná River were found to be consistent with instrument limits in terms of backscattering sensitivity. The wash load did not affect the sound propagation, and sound adsorption due to suspended did not perturb the sand concentration assessment.

Guerrero et al. (2012) tried to validate a method of investigating the grain size distribution of suspended sediments using acoustic Doppler current profilers (ADCPs) and to compare different calibration strategies of the ADCP backscattering power, which can be correlated with the concentration of corresponding sediments. The reliability of the method was given by a laboratory validation of monitored concentrations and known grain size distributions. The context of hid research was introduced in a discussion of the topic of river sediment transport measurement using ADCPs.

Julien and Wargadalam (1995) solved four governing equations (flow rate, resistance to flow, secondary flow, and particle mobility) to analytically define the downstream hydraulic geometry of non-cohesive alluvial channels as a function of water discharge, sediment size, Shields number, and streamline deviation angle. Three-part analysis was consisting of calibration, verification, and validation of the proposed hydraulic geometry equations. Field and laboratory observations are in very good agreement with the calculations of flow depth, channel width, mean flow velocity, and friction slope.

Jung et al. (2013) studied tend to increase in the downstream direction for most natural rivers but their increasing rates show relative differences. It is widely known that most natural rivers exhibit width increasing at a greater rate compared to depth, indicating the formation of wide and shallow rivers. It is found that the two types of rivers show different spatial patterns in their relationships between suspended sediment concentration (C) and flow discharge (Q). Considering that the flow discharge increases downstream in general, the rivers showing the aligned C-Q relationships are exposed to greater imbalance of spatial distribution of sediment fluxes, and hence supposed to be less stable compared to the other type of rivers.

Meunier and Metivier (2005) explored the influence of grain size and floodplain length on transport equations in a microscale braided stream. One-hundred and fifty-nine experiments were conducted with varying slope, water discharge, input sediment discharge, grain size and floodplain length. In the present experiments, the input flux tends to reduce the bed load rate by forcing the river to braid, and this reduction increases with grain size and decreases with floodplain length. This suggests that the braiding process is significantly enhanced with coarse material but that dispersion of the sediment wave occurs to counteract this influence.

Wang et al. (2003) compared with the sand grain size of the other sand seas, central Taklimakan Sand Sea has some of the finest sands seen globally. With the development of the dunes and evolution of the dune morphology, the grain size distributions of the dune sands varied under the actions of the wind regimes, time scale and underlying sediment.

2.6 RIVER PATTERN STUDY

Rivers are the most important resources that the nature gives to human, its study of flow pattern is most important for the effectively use of the resources, so that the losses due to this may be minimised. Erosion and sedimentation are the most common phenomenon which are observed in every river, so it becomes important to understand efficiently the management of the both phenomenon. Here some relevant literature are listed to understand the river pattern of flow.

Arved et al. (2010) worked on the morphology of bed stability. Digital elevation models (DEMs) of river channels, built by interpolation between samples of topographic survey points, are widely used to represent surfaces and to derive land-surface parameters. These reaches represent a diversity of channel forms, substrate and hydraulic properties. DEMs from triangulation with linear interpolation revealed consistently the best results and this method are recommended for geo-morphological and ecological studies of multiple reaches. The main advantage over point kriging and radial basis function is better representation of channel margins and bed forms without introduction of break lines, while it out performs natural neighbors in honoring measured points.

Bawa et al. (2014) documented the spatial morphological variability and its natural and anthropogenic controls for the Yamuna River, a major tributary of the Ganga

River, India. The relationship between stream power and channel morphology in these reaches was integrated with sediment load data to define the maximum flow efficiency (MFE) as the threshold for geomorphic transition. This analysis supports the continuity of river processes and the significance of a holistic, basin-scale approach rather than isolated local scale analysis in river studies.

Gatti et al. (2006) studied with simultaneous hydrological and current data. This dilution zone extends as far as 5.271E in longitude (45 km from the Rhone river mouth). At longitude 5.131E (37km from the Rhone river mouth), the dilution zone is 40 meter deep and spreads over 0.0751 latitude (8 km). The analysis of moored ADCP time series reveals that such eastward currents occur there about 18% of the time and that diluted waters from the Rhone reach the Station d'observation Fixe (SOFI) site between 3.9% and 8.4% of the time.

Gelfenbaum and Jaffe (2003) described erosion and sedimentation associated with the 17 July 1998 Papua New Guinea tsunami. Observed within two months of the tsunami, distinct deposits of a layer averaging 8-cm thick of gray sand rested on a brown muddy soil. The sandy layer deposited by the tsunami began 50–150 m inland from the shoreline and extended across the coastal plain to within about 40 m of the limit of inundation; a total distance of up to 750 m from the beach. As much as 2/3 of the sand in the deposit originated from offshore. Across most of the coastal plain the deposit thickness and mean grain size varied little. In the along-shore direction the deposit thickness varied with the tsunami.

Guymer and West (1992) did comparison with earlier published results for a cross-section further downstream in the same estuary suggests that changes in the channel width, cross-sectional shape, and bends probably contribute significantly to a longitudinal variation of dispersion coefficient values. A comparison of the values of the longitudinal dispersion coefficients with those obtained from a solution of governing transport equations emphasizes the need for a better understanding of the spatial and temporal variation of the values of the vertical and transverse eddy diffusion coefficients.

Kaguchwa et al. (2013) used secondary current theory in investigating the role of phase shift angle between the secondary current and the channel axis displacement in stability analysis of a river channel. The secondary currents are generating in planes perpendicular to the primary direction of motion. The secondary currents form a helical motion in which the water in the upper part of the river is driven outward, whereas the water near the bottom is driven inward in a bend.

Kashyap et al. (2012) employed a three-dimensional Reynolds-Averaged Navier-Stokes (RANS) model to investigate the effects of curvature ratio and aspect ratio on bend flow with respect to a high curvature (R=B ¼ 1.5) base case in a 135° bend. The values of R=B and B=H also affect the structure of the cross-stream flow. The primary cell of cross-stream circulation splits into two clockwise-rotating cells at low R=B values and the cell situated closer to the inner wall induces strong ejections of vorticity. At high R=B values, a secondary counter-clockwise rotating cell forms at the outer bank. At lower B=H values, the primary cell splits into two clockwise-rotating cells. This study shows that the position and size of regions of high bed shear stress, and thus the capacity of the flow to entrain sediment, depend strongly on bend curvature.

Kim and Muste (2012) introduced unifying software that enables users to extract additional information from ADCP measurements. The study provided the underlying algorithms on which the software was based and illustrates the multidimensional visualization and processing capabilities of the software. Among the software features were: velocity representation in horizontal and vertical planes, 1D/2D/3D velocity plotting at reach scale, time and spatial averaging, gridded velocity interpolation, and velocity-derived quantities relevant to river hydrodynamics (bed shear stress, longitudinal dispersion coefficient, and turbulence quantities).

Koussis and Jose (1998) revisited the problem of estimating the longitudinal dispersion coefficient 'D' from readily measurable bulk hydraulic variables. Comparison of predicted with observed values of 'D' showed the new optimized formula providing closer estimates than the established formula of Fischer, with, respect to both mean accuracy and deviations from the mean, achieving in 14 of the 24 cases studied predictive accuracy of 0.5.

Lewin and Ashworth (2013) worked on application of holistic terminologies is complicated by recognition of within-type and transitional-type variety, a confusingly varied use of terms, and a coverage of pattern characteristics that form any large rivers is incomplete. Six types of geomorphological connectivity are described that range from coupled, through to partially-coupled and decoupled. The interplay between geomorphological and hydrological connectivity in large rivers is shown to determine habitat status and therefore ecological diversity.

Lewin and Ashworth (2014) stated large floodplains have multiple and complex negative relief assemblages in which depressions fall below local or general floodplain surfaces at a variety of scales. We show that transitional zones marginal to active channels significantly diversify form complexes, and we demonstrate the diachronous nature of zonal processes and the complex nature and pace of depression modification and infilling. Four less well-understood sets of coupled phenomena are assessed: (i) floodplains associated with discontinuous river banks, (ii) the scales and types of scroll bar generation,(iii) factors underlying the contrasts between meander and braid plain surface relief, and (iv) the generation and function of large floodplain wetlands and lakes.

Marion and Zaramella (2006) conducted a series of tests carried out in a very large flume containing a meandering water-formed sand bed channel to measure the longitudinal dispersion coefficient at various locations around a meander. These experimental observations are compared with experimental data obtained from meandering channels with smooth, fixed sides and regular cross-sectional shapes. All the data has been compared against predictions from two current modeling approaches. Finally, the significance of the two competing mechanisms in curved channels is discussed with regard to their relative influence on longitudinal mixing.

Naib and Sanders (1997) investigated and derived the generalized laws of degradation and spreading of the boundaries of a submerged round jet discharging under oblique and vertical impingements into a channel. The experimental results have been analyzed and compared with Glauret's theory for a radial wall jet as a first approximation neglecting gravity forces when small compared with turbulent forces. The research provides practical information for determining an efficient form of stilling basin for high velocity discharge from pipe outlets

Pannone et al. (2012) proposed a stochastic Lagrangian approach for the analytical derivation of a longitudinal dispersion coefficient that accounts for both transverse and longitudinal flow field variability in straight-axis open channels characterized by longitudinal large-scale bed heterogeneity. It was due to longitudinal bed irregularities over a wide range of representative lengths, from the simple grain roughness to large undulations (up to order of kilometers), possibly related to topographical discontinuities or to extended and inhomogeneous depositional processes carried out by natural or anthropogenic agents.

Sin and Seop (2010) worked to determine the shear stress distribution in a meandering channel, the large scale (1:12) physical modeling study was conducted in the following phases: 1) model construction 2) data collection 3) data analysis, and 4) conclusion and technical recommendations. According to the laboratory data analysis, shear stress from a Preston tube is the most appropriate shear stress calculation method. In case of the Preston tube, data collection was performed directly on the surface of the channel. Other shear stress calculation methods were based on ADV (Acoustic Doppler Velocity) data that were not collected directly on the bed surface. Therefore, the shear stress determined from ADV.

Sindlinger et al. (2005) compared the variability in ABI both spatially and temporally using the data obtained from the SWAMP and SEAMAP cruises. The ADCP data were averaged over 2 m and 4m vertical bins from 16 to 56m below sea surface. Spectral and Empirical Orthogonal Function analyses were performed on subsets of the ABI data for which 10-14 day time series were available and showed 2-3 day periodicity near-surface, corresponding to spatial scales of 101-102 km. During summer 2001, the mesoscale circulation along the subtropical continental margin in the north eastern Gulf was found to be the principal forcing factor for low frequency ABI variation. Increased backscatter observations are also correlated with offshore flow from the continental margin to the deep ocean, particularly when the offshore flow is close to a river delta.

Ahmed and Fawzi (2009) worked on meandering and bank erosion of the River Nile of Egypt and its environmental impact between Sohag and El-Minia, Egypt. The study depends on using Landsat imagery acquired on 1987– 2000 and field observations. Field observations, remote sensing, and GIS analysis and sinuosity index were used in this study to investigate river meandering and the associated processes of erosion of river bank and islands, deposition of sediments and formation of new islands. The present conditions of river meandering and the associated processes of erosion and deposition accelerated with human activities have its impact on the environment. It had recommended regularly monitoring the river banks and islands and measuring the rates of erosion and deposition. Sand bars and subsurface islands should be monitored and identified with flash lights to mitigate navigation problems.

Westenbroek et al. (2006) worked on measurements and calculations in order to estimate shear stress and shear velocity on the Lower Fox River, Wisconsin. Velocity profiles were generated using an acoustic Doppler current profiler (ADCP) mounted on a moored vessel. Summaries of the estimated values for bottom shear stress, shear velocity, and coefficient of friction are presented.