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Flow Characterization of Water Bodies: A Review

[1] Rucha V.Moharir, [2] Krishna Khairnar, [3] W.N.Paunikar

[1] G.H.Raisoni College of Engineering, Nagpur-440016, India

[2, 3] CSIR-National Environmental Engineering Research Institute (CSIR-NEERI), Nagpur-440020, India

Abstract - Flow characterization plays an important role as it affects the ecosystem and the nearby environment. The present work based on the fact that the flow affects the natural factors containing physical, social as well as environmental issues. This paper reviews various applications on water bodies on the context of various flow patterns. Existing work has tended to focus around the analysis of flow characterization. The paper concluded that the flow has several impacts on the water bodies regarding their characterization.

Keywords **- Flow, water bodies, environment, flow characteristics.**

1. Introduction

The paper is based on the estimation of flow with respect to water bodies. Low flows as well as high flow profiles are point out in this paper. The characterization of flow deals with the analysis of flow patterns by considering whether the flow is laminar, turbulent or in transition state. Laminar flow is experienced by a fluid having high viscosity. The turbulent flow is recognized where the fluid flows in disorganized way similarly when the fluid shows their path between these two medium that are laminar and turbulent flow patterns called as transition flow. Seasonal variations are also discussed in the existing work. The flow behavior changes according to seasons, for instance in the rainy season the water level rises with the increase in velocity which ultimately raises the flow rate. The different impact of such flows on the environment and their effects are also deliberated in the present paper. The physico-chemical parameters are analyzed and their impacts on the water bodies are mentioned in the present work. The flow characterization plays a very vital role in the frame of water bodies as the flow behavioral changes causes an impact on the ecological society.

The objectives of this paper are to assess the effects of flow characteristics on ecological society, to analyse their impact on the selected sampling stations, to examine the high and low flow rates at the respected sites and their impact on ecology. This information is needed to analyse the significance of the flow on the aquatic environment, and to provide a scientific basis for betterment of the natural river sources.

2. Case Studies

2.1 Characteristics of Water and Water Bodies in the Natural Environment: Yuri. S. Dolotov and I.S. Zektser

This study explained the peculiarities of surface water in different natural environments, i.e. oceans and seas of different types, atmosphere, coastal and estuarine zones and river systems of different groups, lake basins, artificial reservoirs and swamps.

In this study some important points such as atmospheric water, surface water including oceans, interior seas, coastal zones and estuaries are taken into consideration. The flow regime plays a vital role in the context of the water parameters. This paper indicates the need of these parameters with respect to flow pattern.

The characterization of water and the water bodies plays a significant role in the environment as it affects the environment so it is a basic need to find out whether these parameters are causing ill effects to the environment or not. The brief explanation is mentioned in this paper according to the betterment for the environment as concluded by Yuri. S. Dolotov and I.S. Zektser.

2.2 Flow Characterization in the Santee Cave System in the Chapel Branch Creek Watershed, Upper Coastal Plain of South Carolina, USA: Amy E. Edwards, Devendra M. Amatya, Thomas M. Williams, Daniel R. Hitchcock, and April L. James

This study uses measurements of total suspended solids, dissolved calcium and magnesium, volatile suspended solids, pH, alkalinity, specific conductance, stable isotopes (d18O, d2H), dye tracing, and stage elevation

measurements from both the Santee Cave spring and Lake Marion to characterize the flow regime and surface-groundwater connection in the Santee Limestone (SL) aquifer in the Chapel Branch Creek (CBC) watershed in South Carolina. The hydrology and water quality of the CBC watershed is impacted significantly by its karst terrain and the shallow carbonate aquifer of the regional SL formation.

The two main types of flow which is applied to karst aquifers are diffuse and conduit as reported by Shuster and White, 1971; Atkinson, 1977; Gunn, 1986; also referred in the literature as slow and fast flow, respectively. Diffuse flow occurs when the voids in the aquifer matrix are poorly connected and typically result in a system with slow groundwater movement and longer periods of water storage as explained by Fiorillo, 2009. Conduit flow results when voids in the aquifer become well developed and possess high connectivity and thus having less water storage and more rapid response of recharge to discharge as per notified by Fiorillo, 2009.

In this study dye tracing method is used to determine connections between recharge and discharge areas in karst aquifers to obtain information about the response SL aquifer at the Santee Cave system during times of low and high lake elevations.

The goal of this study is to characterize flow in the watershed using water chemistry; hydrologic, dye tracer and stable isotope data collected in the Santee Cave system and nearby spring seeps during the period 2008–2009. The specific objectives of this study are testing of two hypotheses: (1) the discharge from SL to CBC is predominantly a diffuse flow component from the matrix with slow surface-groundwater connection and (2) the aquifer water table at Santee Cave is influenced by stage elevations of the lower flooded portion of CBC.

In this work three qualitative dye traces based on visual inspection were carried out in the Santee Cave system. The first two traces were carried out on August 28; 2008. By using an Infinities Water Level Data Logger, Stage data at Santee Cave Spring (CS) were collected at 15-minute intervals. Water quality measurements were estimated on a predominantly monthly basis during various flow conditions. The results obtained from this study indicate that the flow at CS and the spring seeps was recharged predominantly from diffuse flow from the matrix, with a slow response of surface water infiltration to the conduit. In this study, ‘‘slow’’ indicates that surface water did not respond with immediate (storm event) movement from the surface, into the aquifer matrix, and then discharged from spring seeps in the CBC watershed. The analysis of geochemical, hydrologic and stable isotopic data collected within the CBC watershed in 2009 confirmed the first hypothesis that the discharge via CS from the Santee Limestone to CBC is predominantly recharged by a diffuse flow component from the matrix with slow surface-groundwater connection stated by A.E. Edwards et al..

2.3 Low Flow Characterization of a Coastal River in Ghana: E. O. Bekoe, F. Y. Logah, K. Kankam-Yeboah, B. Amisigo

Low stream flow statistics, according to K. G. Ries III and P.J Friesz, implies the probable availability of water in streams during the period when conflicts between water supply and demand are most likely to arise. Due to this, low stream flow statistics are needed by the state, regional and local agencies for water-use management, planning and regulatory activities for a variety of water resources application. These activities contains (i) developing environmentally sound river-basin management plans, (ii) siting and permitting new water withdrawals, inter-basin transfers and effluent discharges, (iii) determining minimum stream flow thresholds for the maintenance of aquatic biota and (iv) land use planning and regulation. Continuous water supply also demands continuous abstraction from the surface and from the ground water bodies. In abstracting water from rivers, consideration should be given to the minimum flow needed to sustain the stream. Also, it is essential to mention the reliability of streams to water supply during the dry seasons where the amount of river flow is low.

The study area which is selected for this work is Ayensu river basin which is part of the Coastal river system of Ghana with an area of approximately 171 km^2 and length of 98km^2as per WARM. It lies between latitudes 5^{o}20”N to 6^{o}05”N and longitude 0^{o}30”W to 0^{o}50”W. According to E. O. Bekoe et al. the main tributary of the river is Akora. The basin is located in two climatic regions; i.e. the wet Semi-Equatorial in the northern. The required data used for the study was the mean daily stream flow data series collected from the Ayensu basin at the Okyereko river station in Ghana.

The establishment and determination of minimum flow of streams is not only important to water users, but also very crucial for planning water supplies, managing water quality, assessing the impact of prolonged droughts on aquatic ecosystems, among others. Low flow study is necessary since it educates stream users on the desirable minimum flow needed to sustain in stream uses. Hydrological assessment is dependent on stream flow data and predictions for the future are based on historical data or information. It is therefore essential that adequate resources are set for the establishment of reliable monitoring stations to collect both hydrological data and

meteorological data and also to enhance scientific research in stream flow studies in the river basins of Ghana. Thus, promoting sustainable water supply for irrigation, drinking, aquaculture, fisheries, mining and manufacturing industries, ecological balance and socio-economic development of the country as stated by E. O. Bekoe et al..

2.4 Seasonal Variability of Physico-Chemical Characteristics of the Haldia Channel of Hooghly Estuary, India: Y Sadhuram, V V Sarma, T V Ramana Murthy and B Prabhakara Rao

Hooghly River is a part of the Ganges and serves as a navigable waterway to Haldia and Calcutta ports. Tidal erect is noticeable in the river up to nearly 200km from the mouth at Sagar Island. The tidal variation at the mouth is from 6.1m at springs to 0.22m at neaps. The salinity intrusion is confined to 70km from the mouth even during the dry season. The fresh water discharge ranges from a peak value of 4250m^3 to almost zero in the dry season. The average values of fresh water discharge are 3000m^3 during monsoon season (June-September) and 1000m^3 during a dry season (November-May).

Physico-chemical characteristics of the Haldia channel of Hooghly estuary have been studied during winter, summer and post-monsoon seasons. Salinity at surface varied from low values under ebb tide conditions and high values under tide conditions during summer. Salinity values are lower during post-monsoon season. Strong currents exceeding the required value were observed during peak ebb and tide conditions irrespective of the season. Longitudinal eddy diffusion coefficient (Kx) was estimated during summer and post-monsoon seasons respectively. The vertical eddy diffusion coefficient ("v) was noted during post-monsoon season.

In the study area, the reference density is suggested for dry and low discharge conditions for modeling circulation in the estuary. Values of pH, DO and BOD are within the threshold limits of the estuarine environment. In spite of high concentrations of nutrients, seasonal variation of these parameters attributed to the biological intake and replenishment of nutrients coinciding with phytoplankton blooms showing their involvement in the biogeochemical cycle. High values of Total Suspended Matter (TSM) were noticed both at the surface and bottom in the study region showing the impact of fresh water and sediment transportation which is reported by Y Sadhuram et al..

3. Conclusion

Flow analysis plays a significant role as evidenced by the various studies mentioned above. Flow characterization is done on the water bodies such as rivers, bays, estuaries, tributaries. The flow variability deals with bathymetric data, density variations, external forcing such as tidal elevations, external current and some other relevant conditions. The present work is very beneficial for analyzing flow patterns on the various water bodies. Most of the work reviewed in this paper is based on the concept of fluid behavior. This paper gives an idea about how the flow is affecting the natural water bodies and their impacts on the environment. For the various studies reviewed in this paper, the main focus of analytical interest has been in flow field predictions, flow behavior pattern, external forcing and river discharge. In all of the studies reviewed, the flow parameters were taken into consideration.

References

[1] A.E. Edwards, D.M. Amatya, T.M. Williams, D.R. Hitchcock and A.L. James (2013),“ Flow characterization in the Santee Cave system in the Chapel Branch Creek watershed, upper coastal plain of South Carolina, USA” Journal of Cave and Karst Studies, v. 75, no. 2, pp 136-145.DOI: 10.4311/2011ES0262

[2] Atkinson, T.C., (1977), “Diffuse flow and conduit flow in limestone terrain in Mendip Hills”, Somerset (Great Britain): Journal of Hydrology, v. 35, pp 93–100.

[3] E. O. Bekoe, F. Y. Logah, B. A. Amisigo and K. KankamYeboah (2010),“Climate variability and change and its impacts on water resources in Ghana”. pp 37.

[4] E. O. Bekoe, F. Y. Logah, K. Kankam-Yeboah, B. Amisigo,(2012),“Low Flow Characterization of a Coastal River in Ghana”, International Journal of Modern Engineering Research (IJMER) Vol. 2, Issue. 5, pp-3210-3219.

[5] Fiorillo, F., (2009), “Spring hydrographs as indicators of droughts in a karst environment” Journal of Hydrology, v. 373, pp 290–301.

[6] Gunn, J., (1986), A conceptual model for conduit flow dominated karst aquifers in Gunay, G., and Johnson, A.I., eds., Proc. Ankara Symposium, ‘‘Karst water resources’’, July 1985, IAHS Publication, v. 161, pp 587–596.

[7] K. G. Ries III and P.J Friesz (2000), “Methods for Estimating Low Flow statistics for Massachusetts Streams”.

[8] Shuster, E.T., and White, W.B., (1971), “Seasonal fluctuations in the chemistry of limestone springs: a possible means for characterizing bcarbonate aquifers”, Journal of Hydrology, v. 14, pp 93–128.

[9] WARM (1998), Water Resources Management Study; Information in the Coastal basin system (Final Report). Ministry of Works and Housing, Accra.

[10] Y Sadhuram, V VSarma, T V Ramana Murthy and B PrabhakaraRao, (2005), “Seasonal variability of physico-chemical characteristics of the Haldia channel

of Hooghly estuary, India". J.Earth Syst.Sci., 114, No.1,pp 37-49.

[11] Yuri. S. Dolotov and I.S. Zektser,"Characteristics of Water and Water Bodies in the Natural Environment, Types and Properties of Water",Vol.1