Geospatial Analysis of Fishery Resources in West Kameng District of Arunachal Pradesh

Ravindra Posti and Deepjyoti Baruah*

ICAR-Directorate of Coldwater Fisheries Research, Bhimtal-263136, Nainital, Uttarakhand

ABSTRACT

The spatial assessment of the aquatic resources of a region is of immense support in understanding the range of land use patterns in framing strategies and developing action plans for fisheries improvement especially in hill locked districts of the Indian Himalayan Region. The basic morphometry of the aquatic resources of West Kameng district of Arunachal Pradesh in the Eastern Himalayas revealed that the river Kameng was the major river drainage system and flowed a distance of 118.36 km, having a combined length of 6683.93 km with stream frequency of seventh order. The upland lakes were 102 in numbers and covered an area of 306.62 ha situated within the altitude range of above 4000m MSL. The maximum numbers of upland lakes (94.11%) were within the 1-2 km of the nearest transport lines. Eight categories of Land Use Land Cover (LULC) were classified for the district where forest area covered (71.13%) of the total area followed with wasteland (19.53%), shifting cultivation (5.38%), human habitation (0.38%) agricultural land (0.31%), grassland, (0.07%) water bodies (0.88%) and snow area (2.31%). The slope class developed from DEM showed 25.06 per cent of the total geographic area fall under 0-20 degree slope class as compared to slope class 20-40 degree (56.28%) and the slope class above 40 degree covering 18.66 per cent area. The aquaculture suitability site of the district based on the altitude showed three crucial zones and was categorized as most suitable, moderate and least suitable with the slope classes.

Key Words: Coldwater, Eastern Himalayas, Fish, Resources and Spatial analysis.

INTRODUCTION

The state of Arunachal Pradesh in eastern Himalayas is the largest state in the North eastern region of India with an area of 83,743 km² and shares its international boundaries with Bhutan in the west, China in the north and Myanmar in the east. At present, the state is administratively divided into 25 districts and inhabited by 28 major tribes and 110 sub-tribes, having their own distinct and diverse culture, dialects and lifestyles (Baruah and Singh, 2018).The district of West Kameng lies approximately between 91° 30' to 92° 40' East longitudes and 26° 54' to 28° 01' North latitudes covering 8.86% of total geographical area of the stateand divided into nine administrative circles *viz.,* Dirang, Nafra, Thrizino, Bhalukrong, Jamiri, Rupa, Kalaktaang, Balimau and Bomdila (Census, 2011). The climate of the district is largely influenced by the nature of these terrains varying from sub-tropical in the south to temperate and alpine in the north, leading to a wide range of aquatic resources (National Wetland Atlas, 2012) in the form of dendritic snow fed streams and rivers and high altitudinal lakes. These resources becomes further important due to the presence of 21 species of fishes belonging to 2 orders, 4 families and 14 genera therein (Bagra, 2009; Das and Bordoloi, 2013). The identification, mapping and inventory of these varied natural resources can be very useful in developing decision support system by the application of recent advances made in remote sensing and geographical information system technologies. Similarly, the land cover represents an important factor in geographical analysis reflecting the interaction and dynamism between socio-economic activities and regional environmental changes. The application

*Corresponding Author's Email: djbaruah11@gmail.com

of geo informatics henceforth has the greatest advantage in capturing the satellite image as the synoptic view it provides can be better perceived on the image than on the ground (Nayak *et al*, 2018). This approach has been marked for the first time through a fisheries assessment undertaken in the West Kameng district by using GIS resulting into identifying and evaluating potential suitability area for aquaculture and fisheries development. It is expected that the datasets produced in this communication at GIS environment will serve to frame strategic action plans for the policy makers in judicious utilization of the natural resources for food, source of livelihood and employment to the mountain dwellers in Eastern Himalayas.

MATERIALS AND METHODS

The study was conducted during 2019-2020 in West Kameng district, located between 27° 10' N and longitude 92° 50' E in the Eastern Himalayas of State Arunachal Pradesh(Fig.1). The political boundaries of the district were identified and demarcated using the toposheets from Survey of India and data provided by North-Eastern Space Application Centre (NESAC), Shillong. The satellite images processed from Digital Globe Quick Bird and ASTER data were imported on to the system and were subsequently geo-referenced, digitized and mapped using suitable geo processing tools of Arc GIS v 10.8. The classification scheme of NRSA, 1995 was adopted for making eight major land use land cover classes. The DEM and slope map of the study area was obtained from USGS (https://www.usgs.gov) and classified into different elevation classes by employing the spatial analyst tools of the Arc GIS v 10.8.Similarly, the road network was digitized and was used as an input feature class using the same software. The SRTM DEM is utilized to prepare topographic, slope and delineation of the drainage map of the basin using the hydrology tool of Arc GIS 10.8.The extracted DEM was used to calculate stream orders

throughout its length and number flowing in West Kameng district.

RESULTS AND DISCUSSION

Upland rivers and stream orders

The river Kameng was the major drainage in the district flowing for the distance of 118.36 km with very steep slopes in the upper section of the river valley. The river Kameng originated from Rupa block and flowed through Jamiri block and finally joined the river Dirang and Bichum in Thrizino block. In this study, the Kameng river basin was divided into three regions: (a) the upstream region was highly characterized as trout zone (b) the midstream region was characterized for mid-hill carps and mahseer and (c) the downstream region was the major agricultural region and suitable for carp and catfishes.The first step in drainage basin analysis was the labelling of streams orders and it was estimated that the river Bichom, river Dirang and river Kameng were of fifth, sixth and seventh order respectively. The combined length of the river systems together with their tributaries in the district was estimated 6683.93 km. Overall, 57.65% and 25.43% of the streams occurred in the first and second order respectively (Fig.2).The stream order analysis showed dendritic drainage patterns and coarser drainage texture. The first order and second order streams flowed mostly within the altitude range from 3000-4000 meter and can be considered as potential ground for trout farming and trout angling (Table1) and followed with third order streams. The lower order stream (here the sixth and seventh order) was generally advised not to be considered for establishing a trout farm due to the chances of getting the drainage overflowed with excess water causing a flood situation. Therefore, the sites along the first, second or third order streams were selected for construction of trout raceways and ova houses based on the gradient in the West Kameng district and provided other environmental conditions were conducive.

Table1: Stream order and stream length.

Sr. No	Order No.	Total Number	Total length in (km)
1	1st Order	6409	3457.90
2	2nd Order	2828	1576.00
3	3rd Order	1789	939.55
4	4th Order	74	327.12
5	5th Order	12	196.53
6	6th Order	4	152.03
7	7th Order	1	34.80

Upland lakes

Upland lakes formed an important geographical component of Eastern Himalaya as a source for the development of aquaculture and eco-tourism for revenue generation. From the geospatial analysis, it was found that the district of West Kameng has 102 numbers of upland lakes covering an area of 306.62 ha. The distribution of the upland lakes situated according to the altitudinal regime is depicted in Fig. 3.Size classification of the lakes in this study showed 49 per cent of lakes are of small size of 0-1 ha area followed with 18 per cent lakes of below 2 ha area. Altitudinal analysis of distribution pattern of lakes has shown that most of the small lakes were in the higher altitudinal range above 5000 m in the glacial region. Further, the road buffer analysis showed that all of the upland lakes were scattered within the range of 1-2 km from their nearest road transport lines (Fig. 4). The road connectivity provides herewith the necessary information on the feasibilities of transportation of critical inputs in the form of fish seeds, feeds, and individuals to frame strategic plans for the development of these wetlands on fisheries perspectives.
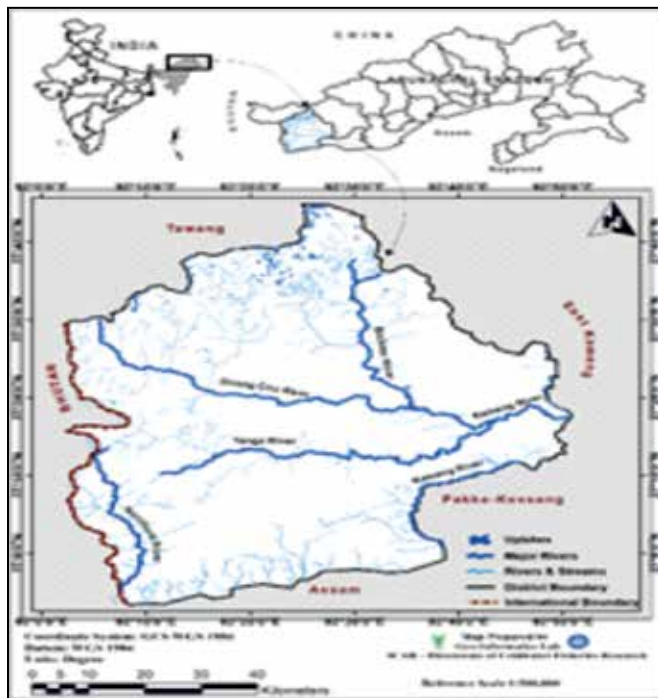

Fig. 1: Location map and aquatic resources of West Kameng district
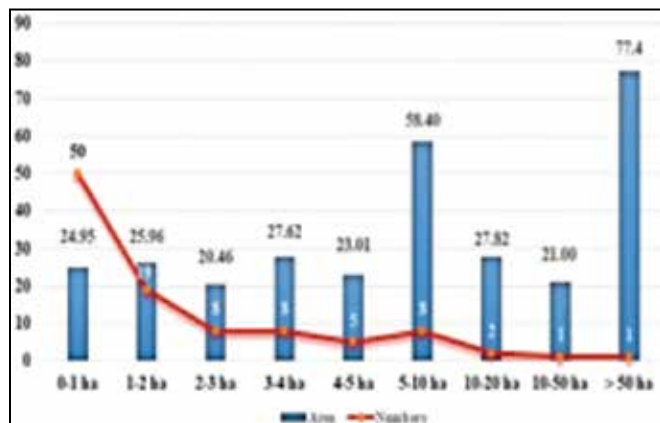

Fig. 2: Stream Order in West Kameng District

Fig. 3: Size distribution of upland lakes in West Kameng district
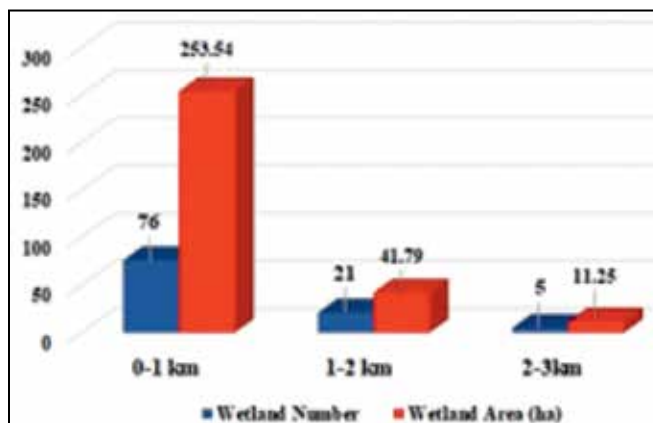

Fig. 4: Distribution of upland lakes to road accessibility in West Kameng district

Land use and land cover

Information on land use and land cover allowed a better understanding of the land utilization aspects for planning and management activities as it was considered as an essential element for modelling and understanding the earth's feature system. Eight categories of LULC were classified for West Kameng district (Table2).The land cover categories selected for determining the suitability of aquaculture and fisheries development in the district were the agricultural land, wasteland and the glacial area.
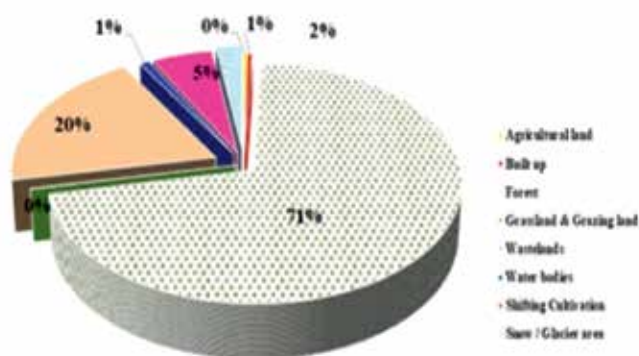

Fig. 5 indicates that the major land area was covered with reserved forest which cannot be converted to fisheries due to restriction in forest clearance. The land use and land cover map gave comprehensive clear depiction to the decision makers and planners for determining future planning of agricultural and fisheries development in order

to maintain land potentials. Satellite data for the larger geographical areas enabled to quantify the natural resources in short time for further usage for development and planning.

Digital elevation model and Slope

A digital elevation model (DEM) is defined as any digital representation of the continuous variation of relief over space (Burrough, 1986), where relief refers to the height of earth's surface with respect to the datum considered such as Mean Sea Level (MSL). The DEM studies infer herewith that the West Kameng district was classified into five different elevation gradients (Table 3). The elevation class ranging from below 1000 m to 2000 m MSL of the total geographic area can be considered as the carp zone. The elevation class ranging from 2000m to 3000m MSL of the total geographic area can be considered as mid hill carp zone. The elevation class ranging from 3000m to 4000m MSL of the total geographic area can be considered as exclusive trout zones where no other fishes will probably survive due to colder climatic conditions (Fig. 6).

The percentage share of different slope degree classes of the study area was represented herewith by a colour map (Fig. 7).The slope class of 0-21 degree area can be considered as most suitable for aquaculture(Table 5).Slope class 21-40 degree area

Table 2: Land use land cover categorization of West Kameng district

Sr. No	Land use category	(Area in ha)
1	Agricultural land	14.81
2	Built up	18.12
3	Forest	3377.43
4	Grassland & Grazing land	3.42
5	Wastelands	927.55
6	Water bodies	41.79
7	Shifting Cultivation	255.28
8	Snow / Glacier area	109.80

under moderately suitable for aquaculture and slope class above 40 degree area under least suitable for aquaculture of the West Kameng district.

Potential aquaculture suitability sites

The success of any aquaculture project or fish farming depends to a large extent on the proper selection of the site to be developed into a fish farm or fish hatchery. The utilization of remote sensing and geographic information systems is considered to be the most favorable option by employing different input feature classes. The outcomes of the feature classes taken as input criteria to designate the probable potential areas for fish farming in West Kameng district were the water resources, drainage network, road network, slope and elevation class of the region and Land Use Land Cover pattern. Table 5 showed almost equal possibilities for cultivating

trout, mid hill carps and carps due to variation in the altitudinal regimeof the district.

CONCLUSION

The identification and management of habitats of these cultivable fishes can be much effective with spatial assessment of the aquatic resources and understanding the range of land use pattern affecting their distribution. Advancements in spatial technologies such as global positioning systems, geographic information systems, remote sensing, satellite imagery and toposheets blended with non-spatial information revolutionized the ability to spatially represent resources relevant to the decision context by integrating hardware, software and data for capturing, managing, analyzing, and displaying geographically referenced information. The integration of GIS with site suitability criteria
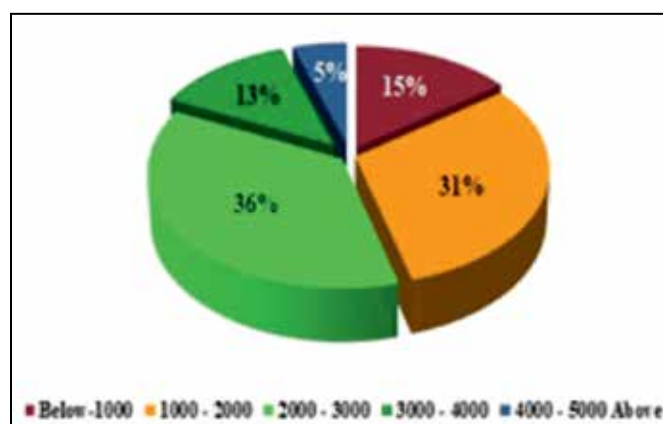

Fig. 6: Percentage share of different elevation gradients of West Kameng District
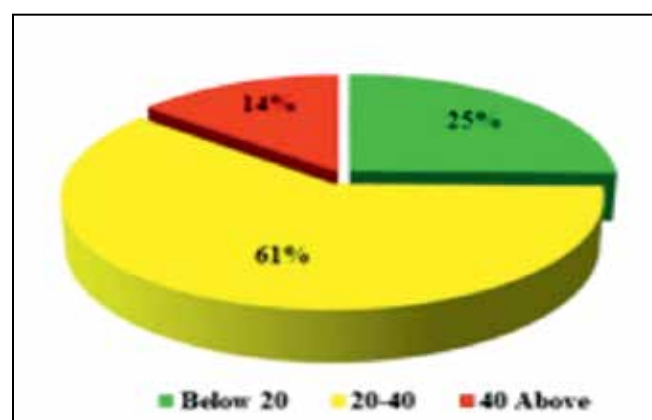

Fig. 7: Percentage share of different slope degree classes of West Kameng District

J Krishi Vigyan 2020 (Special Issue) : 131-136

Table 3: Elevation class of West Kameng district.

Sr. No	Height (meters)	Area (Sq.km)
1.	Below-1000	686.82
2.	1000 - 2000	1426.75
3.	2000 - 3000	1677.3
4.	3000 - 4000	594.51
5.	4000 - Above	232.41
	Slope in Degree	
6.	Below 20	1185.06
7.	20-40	2842.20
8.	Above 40	653.50

Table 4: Fisheries potential zones in West Kameng district.

Probable fisheries zones	Classification	Potential area (Sq. km)
Trout potential zone	High Potential	224.52
	Moderate Potential	482.15
	Least Potential	140.5
Mid hill carp potential zone	High Potential	556.141
	Moderate Potential	1602.1
	Least Potential	347.32
Carp potential zone	High Potential	398.43
	Moderate Potential	731.97
	Least Potential	159.41

depicted in this communication is expected as supportive database in framing strategies and developing action plans for fisheries improvement in remote hill locked state of Arunachal Pradesh.

ACKNOWLEDGMENT

REFERENCES

Bagra K(2009).Ichthyological survey and review of the checklist of fish fauna of Arunachal Pradesh, India. *Check List* **5**(2): 330–350.

Baruah D and Singh N D (2018). Rice-fish cultivation of Apatanis: a high altitude farming system in Arunachal Pradesh. *J Krishi Vigyan* **7**(1): 187 - 191.

Census Handbook (2011).West Kameng District, Office of the Registrar General & Census Commissioner, India.

Das M K and Bordoloi S (2013). Fish diversity of streams in two watersheds of West Kameng district, Arunachal Pradesh, Recent trends in bio resource management and biodiversity conservation.Abstract Book.

National Wetland Atlas (2009). Space Applications Centre (ISRO), Ahmedabad.

National Wetland Atlas (2012). High Altitude Lakes of India. Space Applications Centre (ISRO), Ahmedabad.

Nayak A K, Kumar P, Pant D and Mohanty R K (2018). Land suitability modelling for enhancing fishery resource development in Central Himalayas (India) using GIS and multi-criteria evaluation approach. *Aquacultural Eng* **83**: 120–129.