International Journal of Lakes and Rivers.
ISSN 0973-4570 Volume 17, Number 1 (2024), pp. 57-73

https://dx.doi.org/10.37622/IJLR/17.1.2024.57-73

RIVER ARPA: THE LIFELINE OF BILASPUR, CHHATTISGARH

Alok Kumar Chandrakar*, Ajay Kumar Singh, Shiv Shankar Dhuria

Department of Forestry, Wildlife & Environmental Sciences,
Guru Ghasidas Vishwavidyalaya, Bilaspur, Chhattisgarh, India.

Abstract

Rivers have always been important to humans, and many of the world's ancient and greatest civilisations were established near rivers. River landscapes have served as areas for settlements, infrastructure, and production for several thousand years. The River Arpa is a major tributary of the river Seonath that meets with river Mahanadi in central India. Arpa River is regarded as the very core of the economic sustenance of Bilaspur district of Chhattisgarh. The economy, culture, tradition, and livelihood are all inextricably linked to the river and surrounding forests. Round the year Arpa river goes on making the agricultural lands of district more fertile, and Bilaspur contributes considerably to the state's total annual crop production. Apart from its economic viability, the Arpa river with its scenic beauty also provides a significant boost to the tourism industry of the district. Arpa river is one of the vital strongholds of district and thus it is indeed a lifeline of Bilaspur.

Keywords: River Arpa, Culture, Livelihood, Bilaspur, Chhattisgarh.

1. INTRODUCTION

The planet Earth owes the onset and existence of life forms to the very fact that water forms the basis of life. Civilizations and settlements were established at the banks of water sources realizing its diversified application, importance, and obligation for life. From Mesopotamia that flourished around the Tigris and Euphrates rivers, to Egypt that thrived along the banks of the river Nile, rivers have always been the lifeline of all civilizations. Particularly in the making of India, ancient Bharat has always been referred to as the land of seven rivers. The great civilization of Harappa and Mohenjo-Daro came up along the Indus, Sutlej and ancient Saraswati. River Ganga (Ganges) is

the life source of northern India and is reckoned to be the most important river in Indian culture. The southern part of civilization developed around the Krishna, Kaveri and Godavari rivers. In India, rivers have been so significant that we worship them as our life-giving god and goddesses (World Economic Forum, 2018).

Rivers benefit communities in ways that are easily recognisable: they are a source of water for domestic, agricultural and industrial purposes and of food and livelihoods; they can be used for transportation; those that are amenable to damming are used to supply energy needs; and they are often used for recreational and religious activities. Rivers also serve less obvious functions that are as important as the obvious ones. They are feeding and spawning areas for fish and other aquatic biota and can purify water as they have the ability to break down or absorb pollutants. A properly maintained river system can act as a drainage area and help in flood management. Because the water table is at or close to the surface in river basins and because sand retains water, rivers perform the important functions of water storage and groundwater replenishment.

The present work is an attempt to explore the river Arpa and its cultural, economic and environmental significance in the region based on the information collected from various primary and secondary sources.

2. OVERVIEW OF ARPA RIVER:

The Arpa river, being about 147 km long, is major river in Bilaspur district of Chhattisgarh. Historically Bilaspur used to be a small settlement on the banks of River Arpa and was under the Kalchuri Dynasty of Ratanpur. The region was inhabited by a few fishermen. The historical records of Imperial Gazetteer of India, Vol 8, 1908 note that the city is said to be named after a fisher-woman named “Bilasa” in the 17th century (Aarambha, 2010; Singh, 2011), and for a long period it consisted only of a few fishermen's huts at the bank of river Arpa. Bilaspur came to become popular around 1741, when the Marathas started ruling this region. After the fall of Maratha Empire Bilaspur passed into the hands of English East India Company and remained part of British Empire till 1947 when India got independence from the British rule. The town of Bilaspur kept growing during British era and by 1901 with total population of 18,937 became the eight-largest town of British India. It became an important center of trade and commerce and emerged as home to the major Tasar silk and cotton clothes in India. Today it stands as one of the prominent city of the state (Bilaspur Nagar Nigam, 2020).

2.1 Origin and Extension:

Arpa river is originated from Khondri village at Pendra tehsil in Bilaspur district where Malaniya nallah (originate from Surhighat village of Pendra tehsil) and Sonkachar nallah (originate from Kamra Pathra forest village, Keochi) merges with each other and gives the birth to Arpa river. The length of Arpa is about 147 km and average water flow is 400 m. The water flows from north-west to south direction.

Arpa river meets in river Sheonath (another major tributary of river Mahanadi) near Matiyari village (Bilha tehsil) of Bilaspur district. The geographical extent of the Arpa river watershed is 3427.66 sq. km and it is located between 81º25'49" to 82º25'55" East longitude and 21º45'48" to 22º45'59" North latitude. The total catchment area of the watershed is about 2022 sq. km (Bhat et al., 2013; Chandrakar et al., 2022).

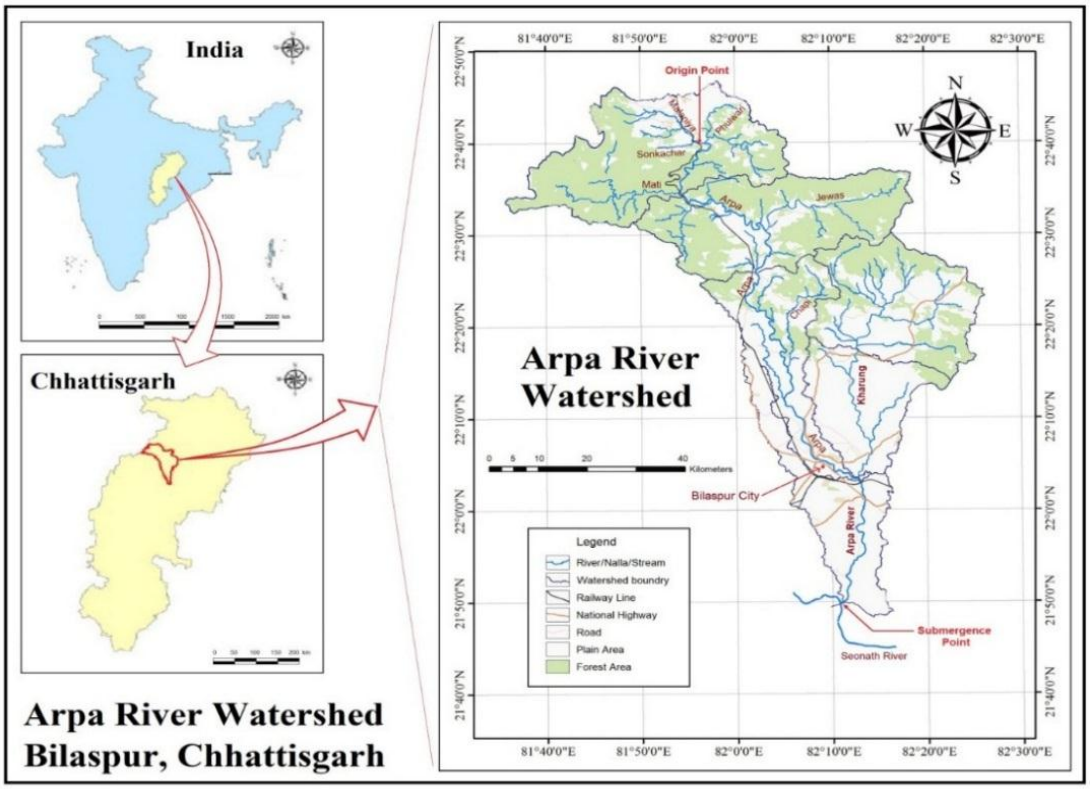

Figure 1. Arpa river watershed and drainage map

2.2 Climate and Rainfall:

The Arpa river watershed falls under the sub-tropical zone, and the climate is mainly influenced by the geographical location, temperature and rainfall. The district experiences a hot and semi-humid climate. The annual temperature varies from 10°C to 45°C. The hottest months are May and June and the minimum temperature is observed in the months of December and January. The region receives rainfall mainly from the southwest monsoon. The average annual rainfall for the district is around 1351 mm (Verma, 2013). The months of July and August are the heaviest rainfall months and nearly 95% of the annual rainfall is received during June to September months. The rainfall is unevenly distributed in different areas and also the amount of rainfall varies from year to year. The climate is ideal for agriculture development, particularly for wheat, rice, sugarcane and cotton crops. Limited rainy season, good and healthy climate is suitable for industrial development also. (Bilaspur Gov., 2019).

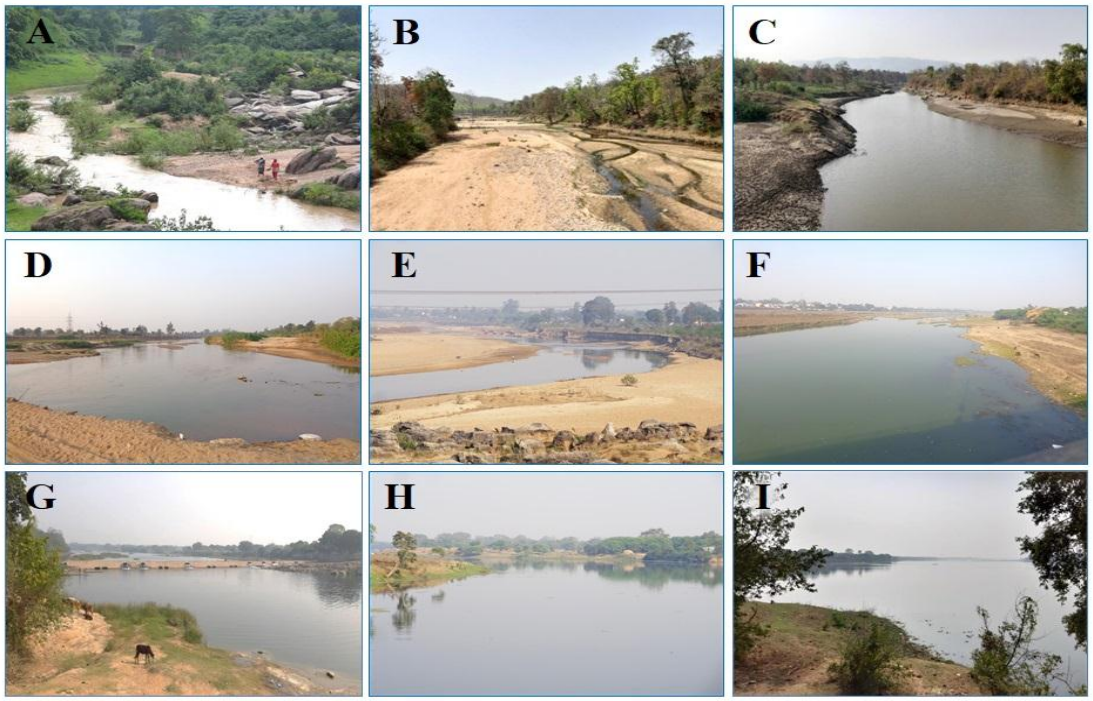

Figure 2. The journey of Arpa River (A – Origin point; B & C - upper stretch; D, E & F – middle stretch, G & H – lower stretch, I - submergence point)

2.3 Geography and Land Use:

Physiographically the Arpa river watershed can be divided into two parts. The first part consist high plateau area covering north and central part of the district separated by the intermittent narrow valleys and steeply sloping plains. The second part is the gently sloping plain land covering southern parts of the district. The topography varies between 1120 m amsl (above mean sea level) in the northern hills and 250 m amsl in the southern plains (Verma, 2013).

Arpa river has its origin from the forest area of Khondri-Khongsara in Maikal hill ranges of district. The forest area represents the tropical deciduous forest and forest cover is mainly occupied by Sal (*Shorea robusta*), Teak (*Tectona grandis*), Bamboo (*Dendrocalamus strictus*), Muhua (*Mudhuca indica*), Shisham (*Dalbergia sissoo*), Semal (*Bombax ceiba*), Tendu (*Diospyros melanoxylon*), Imli (*Emblica officianalis*) and Babul (*Acacia catechu*) etc. tree species. The major area is under Sal (40.56%) and Teak (9.42%) of the total forest area while rest of forest cover (50.02%) showed mixed population of different species (Bhat et al. 2013).

The northern part of the region is mostly hilly with highly undulating topography where the agriculture is restricted to few patches only. The southern part of the region is a plain land with gentle slopes covering an area of 48% of the total geographical area in the district. The land is very fertile and is mostly used for the agriculture purposes with few surface irrigation facilities (Verma, 2013).

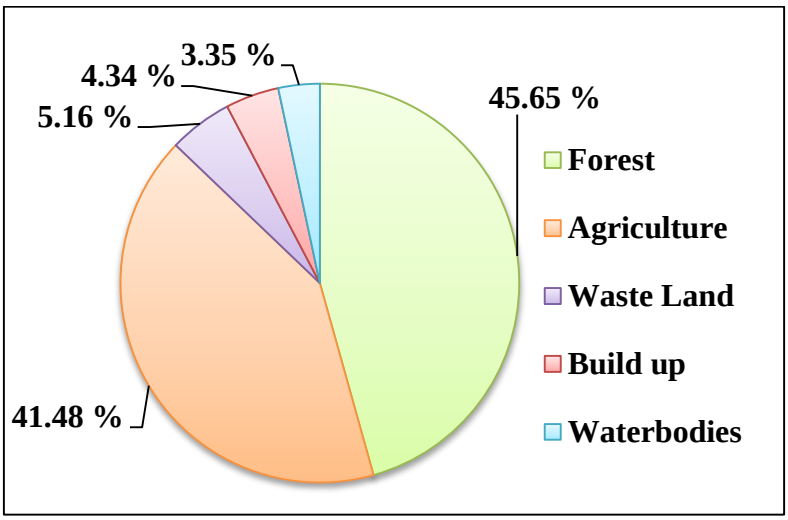

Figure 3. The Percentage land cover under major land use classes (Rajput et al., 2020).

2.4 Tributaries of Arpa River:

The total catchment area of the watershed is about 2022 sq. km. There are about 10-15 tributaries of Arpa river, which vary with respect to their length, catching area and water flow (Figure-1). The important ones are Khutki nallah, Phulwari nallah, Pirhakhar nallah, Mati nallah, Sargor nallah, Jawas nallah, Sakari nallah, Sat nallah, Gahila nallah, Chapi nallah, Lamer nallah, Kharang river, Gokena nallah and Gudguda nallah (Bhat et al., 2012).

2.5 Water Availability:

The Arpa river, which was once a perennial sub-tributary, is seeing rapid changes in the form of barrage and riverfront development and now has only seasonal flows. Streams originating from the Maikal hill range which is located between the Khondari to Khongsara is the source of water of this river which flow throughout the year. Presently, due to the drying of its origin sites, river has been fully dependent on rain water. During rainy season its water level raises 2-3 m up and in summer season it moves 5 m down. The northern portion of Arpa river specially from Belghana to Bilaspur city, the entire region faces water problem except some rainy seasons (Wani et al., 2003). In the southern portion of Bilaspur, water is stored in check dams for irrigation purpose. The water availability and environmental condition in this region is much better than northern part (Kerr et al., 2002; Reddy et al., 2004). Due to the continuous deforestation, increasing population and climatic change, water level of Arpa river has gone down and a situation of drought has been generated which can be easily recognized today.

2.6 Water Resource Development in the Arpa River:

As Bilaspur is situated on the bank of Arpa, people are fully dependent on it since ancient times. In the earlier times flood was the major problem and to overcome this problem Madhya Pradesh government in 1974 built first check dam on this river. But only one dam was not sufficient to stop the flood water so taking this fact under consideration many more check dams were constructed on Arpa river to stop the flood water and its maximum utilization for agricultural purposes (Shrivastava et al., 2003). But due to the drying of its origin sites, its water content is decreasing day by day and these check dams have become danger for the river. The maximum part of the rain water gets stored in these check dams, and consumed for irrigation and other uses and as a result little water reaches to lower starches (Kerr et al., 2004).

3. GOOD & SERVICES FROM ARPA RIVER:

Rivers have been most important part of human life since the ancient times. In the evolution of humans, rivers played an unimaginable role. The various ecosystem services provided by river are given in Table-1.

Table-1 Principal ecosystem services (ES) supplied by rivers

Ecosystem service (ES) type	Individual ES	Description
Supporting	Biogeochemical cycling	Maintenance of natural flux of material and energy between living and nonliving components
	Biotic interactions	Pollination of wild species, seed dispersal, preservation and maintenance of trophic chains
	Habitat	Habitat for transient and resident population
	Plant food/raw material	The proportion of gross primary production that can be extracted as food/raw material
Provisioning	Animal food/raw material	The proportion of secondary production that can be extracted as food/raw material
	Water supply	Filtering, retention, and storage of fresh water for human use
	Climate regulation	Regulation of the chemical composition of the atmosphere, global temperature
	Hydrological dynamics	Regulation of natural hydrological flows, role of land cover in regulating runoff, infiltration
Regulating	Water quality	Retention and removal of xenic compounds, water purification
	Regulation of extreme events	Capacity and integrity of ecosystem response to environmental fluctuations such as floods, storms
	Regulation of soil fertility	Soil maintenance and formation, prevention of erosion, accumulation of organic matter
	Regulation of invasive species, pests	Regulation of invasive species population, pest population
Cultural	Recreation	Provision of opportunities for recreational activities

Source: Millennium Ecosystem Assessment (MEA) (2005)

Since many decades Arpa river has long been providing ecological and social welfare (services), which play important role in sustainment of the future generation. Ecosystem goods provided by the rivers mainly include: water for irrigation; fisheries; non-timber forest products; water supply; and recreation. Major services include: carbon sequestration, flood control, groundwater recharge, nutrient removal, toxics retention and biodiversity maintenance (Turner et al., 2000; Prasad et al., 2002; Chandrakar et al., 2020).

3.1 Water for Irrigation:

The Arpa river watershed is predominantly agricultural with a mix of commercial and subsistence farming systems dominated by rice cultivation. The northern regions of basin are more heavily forested and have smaller-scale rain fed farming systems, and in southern plain region agriculture is supported by irrigation infrastructure, through small and medium projects. Alluvium soil from Arpa river is mainly responsible for making the region productive and fertile. The soil in Bilaspur is very good for cultivation of rice crop and district is known for its aromatic Doobraj rice. The region is one of the top producers of paddy and contributes significantly in referring Chhattisgarh state as "Dhaan Ka Katora" (Rice bowl of India) (Bilaspur Gov., 2019).

Various agricultural crops were cultivated in the agricultural fields of Arpa river basin. Rice is the major crop in the Kharif season. In recent years, the area under pulses has seen an upswing and rest of the area is occupied by vegetables, oilseeds and few other annual crops. The Rabi crop is dominated by pulses, followed by oilseeds, vegetables and cereals. The river bed of Arpa is also utilized by people (especially in dry seasons from October to May) for growing vegetables like cauliflower, cabbage, chilli, brinjal, cucumber, spinach, potato, tomato, onion, pumpkin etc. (Beck at al., 2015).

3.2 Domestic Needs:

Water is more significant for peoples' livelihood since water is used for everyday needs, drinking-related, irrigation and many other things. That's why availability of water is one of the main criteria for better livelihood. Arpa river with various reservoirs and check dams on it, plays an important role in providing domestic water security in both rural and urban areas. One government project to provide drinking water from Kutaghat reservoir to households of Bilaspur city is under progress (Bilaspur Gov. 2019; Chandrakar et al., 2022).

3.3 Fisheries and Recreational Use:

Right from the dawn of civilisation human beings, as hunter-gatherer, took to fishing for a major source of food. With passage of time and acquiring of knowledge and skill fishing crystallised into the livelihood practice of some sections of people, thus giving rise to fishing communities. Arpa river offers livelihoods to many riverine

communities along its bank, and along with agriculture, fishing was an important source of livelihood in the region. As per the information collected from respondent fishermen, fisheries department and other secondary sources more than thirty five fish species were found in the Arpa river. The most common fish species are Rohu (*Labeo rohita*), Catla (*Catla catla*), Kari (*Labeo calbasu*), Kotari (*Puntius chola*), Bami (*Macrognathus puncalus*), Tengna (*Mystus tengara*, *Mystus aor*), Sarangi (*Salmo stomabacaila*), Padhina (*Wallago attu*), Dhesra (*Mystus seenghala*), Telpia (*Oreochromis mossambicus*), Silver carp (*Hypthalmichthys molitrix*), Chital (*Notopterus notopterus*) etc.

The rivers of India are being subjected to excessive stress and consquent adverse effects are manifested in poor fish landing and loss of livelihood of fishing communities. Hundreds of thousands of riverine fishing communities have been migrating to other occupations and areas in search of livelihood (Saha, 2010). The fishing communities, once located throughout the Arpa catchment are now either restricted to a few households spread out in a village or living in locality together in small groups

3.4 Cultural and Religious Activities:

River flows connect people, places, and other forms of life, inspiring and sustaining diverse cultural beliefs, values, and ways of life. The rivers are imbued with purity, sanctity, and divine powers. They are efficient means to bring salvation and also to enable one to go to the imperishable world and to the abodes of gods. Peoples from around the world traditionally gather at the banks of the river for holy festivals and immerse themselves in the water for purification from sins. Arpa river is life-line of Bilaspur since its inception, and centre of many cultural and religious belief of people living in its bank. Despite of being polluted, river Arpa, occasionally becomes the centre of attraction when devotees and believers come to take bath in its waters during festivals, such as Chhatt puja, Navami (ninth day of idol worship) and Ganesh Visarjan (Chandrakar et al., 2022).

3.5 Supporting Biodiversity:

Rivers support a large diversity of biota representing almost all taxonomic groups. The biodiversity of Arpa river comprises periphytons, phytoplanktons and macrophytes which are producers, and zooplanktons, zoobenthos, fishes and higher aquatic vertebrates which are consumers of the food produced. Together, these micro- and macro-organisms, through their interplay with the abiotic environment, represent the ecological status of river.

Riparian ecosystems encompass a diverse suite of ecosystem types, including river banks, floodplains, and wetlands, that are characterized primarily by being ecotones, or transitional zones, between adjacent terrestrial and aquatic realms. The riparian vegetation plays a key role in: regulating microclimates and water quality; preventing riverbank erosion and promoting landform stability; subsidizing aquatic and terrestrial

food webs; and providing habitat for a wide range of aquatic, amphibious, and terrestrial organisms.

Figure 4. The diversity of human relationships with Arpa River

4. GROWING THREATS TO ARPA RIVER:

Rivers play a prominent role in the water cycle as they act as drainage channels for surface water. Due to increasing population, water demand is increasing day by day making already insufficient water scarcer. Since groundwater has its limits, rivers are becoming more and more important. However, most rivers are overexploited and the current minimum flow in rivers is only one-third of what is required. Major threats faced by the rivers:

4.1 Urban Expansion and Population Pressure:

In some decades, Bilaspur city has experienced a huge amount of population pressure and infrastructural development. Population growth is the main problem for this city and increased land scarcity (Census of India, 2011). People have been migrated to this local for better accessibility of transportation and others amenities. This urban growth increases pollution load and causes serious social, environmental and cultural

challenges like urban poverty, land values, climate change impact, vulnerabilities of natural events and various forms of pollution (Halder et al., 2021). The increase in population in surrounding areas coupled with encroachment of the riparian areas for, infrastructure development, crop farming and livestock grazing resulted to loss of riparian forest patches/vegetation and associated biodiversity with negative implications on household livelihoods.

4.2 Waste Water and Municipal Sewage:

Arpa river is undergoing large-scale deterioration in terms of both water availability and quality. The main reasons for the high pollution load in the river are discharge of storm-water loaded with sediments and untreated municipal wastewater. River pollution is caused due to addition of polluted water of the city into the Arpa river (Verma et al., 2007; Khan, 2007; Nanda et al., 2008; Bhat et al., 2013; Tiwari et al., 2013; Majumdar, 2015; Dhruw et al., 2016; Soni et al., 2022). Dumping of waste, untreated sewage caused the biological death of rivers, water turns toxic leading to the harmful effect on fishes and plants.

4.3 Industrial Development and Effluent Discharge:

Bilaspur is second largest city of state and due to better transportation accessibility and others amenities, huge industrial development occurred in Bilaspur city. More than 450 registered factories and industries like paper mills, brick industries, bakeries, cement industries, ceramics, fertiliser plant, agro-tech industries, coal washery and thermal power plant (NTPC) etc. were established in Bilaspur. Besides, there are industrial cluster at Tifra and Sirgitti. The above industrial units release industrial pollutants into the river and cause pollutions (Bhat et al. 2013; Vaishnav et al., 2014). The atmospheric pollutants from industries dissolved in rainwater and causing acidification of water bodies (Aggarwal et al., 2001; Tiwari et al., 2013).

4.4 Dumping of Municipal Solid Waste (MSW):

Improper management and disposal of MSW has become one of the major problems in urban and semi-urban areas. Tonnes of domestic waste and garbage dumped into the Arpa river daily (Tewari, 2014), which causes all types of pollution: air, soil, and water. Indiscriminate dumping of wastes contaminates surface and ground water supplies. Health and safety issues also arise from open dumping. The solid waste clogs drains, creating stagnant water for insect breeding and water logging during rainy seasons. Insect and rodent vectors are attracted to the waste and can spread diseases such as cholera and dengue fever. Using water polluted by MSW for bathing, food irrigation and drinking water can also expose individuals to disease organisms and other contaminants.

4.5 Agricultural Activities and Runoff:

The Arpa river watershed is predominantly agricultural with a mix of commercial and subsistence farming systems dominated by rice cultivation. The river bed farming is also a common practice by people (especially in dry seasons from October to May) for growing vegetables like cauliflower, cabbage, chilli, brinjal, cucumber, spinach, potato, tomato, onion, pumpkin etc. (Beck et al., 2015; Tegar et al., 2016). Farmers put fertilizers and pesticides on their crops so that they grow better. But these fertilizers and pesticides can be washed through the soil by rain, to end up in rivers. If large amounts of fertilizers or farm waste drain into a river the concentration of nitrate and phosphate in the water increases considerably. Algae use these substances to grow and multiply rapidly turning the water green. This massive growth of algae, called eutrophication, leads to pollution. When the algae die they are broken down by the action of the bacteria which quickly multiply, using up all the oxygen in the water which leads to the death of aquatic life (Sao, 2015).

4.6 Cultural and religious activities:

Arpa river is associated with the culture and religious. Thousands devotees take bath in Arpa river during Chhath Puja. Numerous rituals like mundane sanskar (haircut) and antim sanskar (ceremonial) activities took place at the river bank. Dispersal of worship material, flowers, ashes, dead bodies etc. pollutes the river water. The floating materials released through idol in the river and lake after decomposition result in eutrophication, increase in acidity and heavy metal concentration. Heavy metal pollution caused by idol immersion can damage the ecosystem as it kills fishes, damages plants, blocks the natural flow of the water, causing stagnation (Aggarwal et al., 2001).

4.7 Environmental alterations:

Due to increasing population and associated developmental activities, deforestation is increasing day by day and forest areas in Arpa river catchment are being replaced by alternative land uses. Forests are known to perform several hydrological functions including flood attenuation, sustaining dry season flows and maintaining rainfall patterns (Venkatesh et al., 2014). Forest provides tiny particles like pollen and spores which act as a condensation platform for raindrops, thus air over forest absorbs moisture from trees and creates rain, the loss of trees means less rain and less water on the ground. Fewer trees, means less condensation, reducing the amount of water in rivers due to less rainfall.

River sand mining (the extraction of sand (and gravel) from the drainage network of a river) adversely effects the physical, biological, chemical and anthropogenic environment of river (Rentier et al., 2022). The severity, however, depends on the rate, type and execution of the extraction. Excessive sand mining in Arpa river, is major cause of environmental degradation of river ecosystem and it destroy river channel causing water to run off. River sand mining also severely affects the

livelihood of people depending on or living near the river and that it can do great social and economic harm.

4.8 Stopping Environmental Flow:

The Environmental flow is described as the quantity, quality and timing of water flow required to sustain freshwater, the riverine ecosystem and human livelihoods that depend on these ecosystems (Brisbane Declaration, 2007). Diversion and obstruction of river flow, for example, excessive dams prevent minimum flow which is essential for the sustainability of river. Since there are large numbers of barrage and check dams are being constructed on the Arpa River, which can possibly change the natural flow of the river, it is obvious that such alterations have impacted the riverine ecosystems and the livelihoods of the people depending on this ecosystem. Arpa river has become a seasonal rivers and become dry in many starches. Due to drying of river, the underground water level of Bilaspur is also going down day by day, which is appearing as major problem to the growing population (Bajpai, 2012; Dhruw et al., 2020).

4.9 Climate Change:

Changes in climatic conditions will affect demand, supply and water quality. The potential changes in precipitation pattern (amount and seasonality) will affect soil moisture, groundwater reserves and the frequency of floods or droughts. Any shortfall in water supply will enhance competition for water use for a wide range of economic, social and environmental applications. The growing population will heighten demand for irrigation and perhaps industrialization at the expense of drinking water. Disputes over water resources may well be a significant social consequence in an environment degraded by pollution and stressed by climate change (Veerabhadrannavar et al., 2022).

Figure 5. Arpa River water pollution

5. CONCLUSION

It is evident that, all kinds of human activity such as agriculture, land use change, urban growth, etc. have an impact on the environmental integrity of the rivers. Due to water pollution, control of water-level fluctuations and transformation of floodplains, human everyday life and cultural activities have become decoupled from riverine phenomena, river-borne resources (other than water) have lost their values, the flood cycle has lost its function as cultural pulse generator. Affections to rivers, acknowledgment of their positive effects on human spiritual and physical wellbeing are increasingly lost. The 'western', mechanistic view of nature and the position of man as "Master and owner of nature", has largely eliminated the option to respect nature for values that go beyond their quantifiable services. Rivers are today seen as a sum of megawatts of hydraulic energy, cubic meters of water for cooling, irrigation or drinking supply, and some kilograms of fish (Wantzen et al., 2016).

Now it's requires to rethink, appreciate and harmonize the relationships between humans and rivers. A crucial step will be for researchers and water managers to reflexively acknowledge the diversity of ways of knowing, relating, and utilizing rivers, to move towards more locally or contextually situated assessments and negotiations of environmental flows. This will lead to better recognition of the mutual interdependencies between humans and rivers, and support the development of effective approaches to foster more mutually beneficial modes of relating to rivers in situations where water extraction and river regulation threaten to undermine the health of rivers and their dependent human communities. It is our hope that this paper and the following discussions may bring back the reference of rivers to the cultural heritage of societies and to provide the scientific background for promoting the culture of sustainable use of riverine resources and the conservation of their biological and cultural diversities.

REFERENCES

[1] Aarambha (2010). Blog on Bilasa Devi. https://aarambha.blogspot.com/2010/03/blog-post_09.html?m=0

[2] Aggarwal, S.G., Chandrawanshi, C.K., Patel, R.M., Agarwal, S., Kamavisdar, A., Mundhara, G.L. (2001). Acidification of surface water in central India. Water, Air and Soil Pollution, 130: 855-862.

[3] Bajpai, R. (2012). Comparative Analysis of Physicochemical Parameters of Hasdeo River Barrage & Arpa River Water Samples of Bilaspur Region. International Journal of Scientific and Research Publications, 2 (9): 1-5.

[4] Beck, S., Khan, M. A., Narbaria, S. and Gupta, N. K. (2015). Adoption pattern of vegetable cultivation practices in river bed areas. Plant Archives, 15 (2): 827-832.

[5] Bhat, S. J. A., Geelani, S. M. (2013). Studies on Natural Resources and their Significance Around Arpa River Basin in Chhattisgarh. Nature Environment and Pollution Technology, 12 (2): 309-313.

[6] Bhat, S. J. A., Geelani, S. M. (2013). Studies on the Impact of Arpa River Check Dams on the Microenvironment of District Bilaspur, Chhattisgarh. Nature Environment and Pollution Technology, 12 (1): 135-138.

[7] Bhat, S. J. A., Geelani, S. M., Haq, S., Geelani, S. H. (2013). Studies on the Forest types available around Arpa River Watershed in Chhattisgarh. Journal of Plant Science Research, 29 (1)

[8] Bhat, S. J. A., Singh, S. S., Geelani, S. M. (2012). Studies on the Origin and Contribution of Important Tributaries to Arpa River Watershed in India. International Journal of Environment and Bioenergy, 4(1): 15-21.

[9] Bilaspur Gov. (2019). Bilaspur district, Chhattisgarh government website. https://bilaspur.gov.in/en/

[10] Bilaspur Nagar Nigam (2020). History of Bilaspur city: Origin and development. https://bilaspurnagarnigam.com/history.php

[11] Brisbane Declaration (2007). The Brisbane Declaration. https://riverfoundation.org.au/wp-content/uploads/ 2017/02/THE-BRISBANE-DECLARATION.pdf

[12] Census of India (2011). Census o India 2011 Data. https://censusindia.gov.in/

[13] Chandrakar, A. K., Dhuria, S. S. (2020). Sustainable Wetland Management in India: Charting a course for a Sustainable Future. Life Sciences International Research Journal, 7(1): 46-52.

[14] Chandrakar, A. K., Dhuria, S. S. (2022). Cultural, Economic and Environmental Significance of River Arpa, Bilaspur, Chhattisgarh. Researchgate, Proceedings of National Seminar on Sustainable Water Resources Management: Challenges, Strategies and Future Prospects, pp-4.

[15] Dhruw G., Tripathi V. K. and Dhankar B. (2020). Trend detection Analysis of Seasonal Groundwater Levels in Arpa River Basin, Bilaspur District, Chhattisgarh, India. Int. J. Curr. Microbiol. App. Sci, 9(6): 1425-1436.

[16] Halder B., Bandyopadhyay J. (2021). Evaluating the impact of climate change on urban environment using geospatial technologies in the planning area of Bilaspur, India, Environmental Challenges, 5: 100286. https://doi.org/10.1080/15715124.2021.2016780

[17] Kerr, J. (2002). Watershed development, environmental services and poverty alleviation in India. World Development, 30(8): 1387-1400.

[18] Khan, S. A. (2007). Water quality criteria and Arpa river water of Bilaspur city (India). Current World Environment, 2(1), 61–66.

[19] Majumdar, A. S. (2015). Underground Water Quantity and Quality Assessment in Next Decade in Bilaspur District, Chhattisgarh. The International Journal of Engineering and Science, 4(5): 24-30.

[20] Millennium Ecosystem Assessment (MEA) (2005). Ecosystems and human well-being: a frame-work for assessment. Wetlands and water. World Resources Institute, Washington, DC, 68.

[21] Nanda, M., Shivhare, U., Kshetrapal, M. (2008). Effect of industrial waste disposal on the water quality of river Arpa in Bilaspur district, Chhattisgarh. Ecology, Environment and Conservation, 14(4): 535–541.

[22] Prasad, S.N., Ramchandra, T.V., Ahalya, N., Sengupta, T., Kumar, A., Tiwari, A.K., Vijayan, V.S., Vijayan, L. (2002). Conservation of wetlands in India – a review. Trop. Ecol., 43 (1): 173-186.

[23] Rajput, P., Sinha, M. K. (2020). Geospatial evaluation of drought resilience in sub-basins of Mahanadi river in India. Water Supply, 20 (7): 2826-2844.

[24] Reddy, V., Ratna, Gopinath, R.M., Galab, S., Soussan, John and Springate-Baginski, Oliver (2004). Participatory watershed development in India: Can it sustain rural livelihoods? Development and Change 35(2): 297-326.

[25] Rentier, E. S., Cammeraat, L.H. (2022). The environmental impacts of river sand mining. Science of the Total Environment, 838,155877, pp.1-7.

[26] Saha, D. (2010). Fishery Sub Sector Study of Chhattisgarh State of India.- a revised Technical Report. State Institute of Rural Development, Chhattisgarh.

[27] Sao, S. (2015). Physiochemical properties of Dist. Bilaspur (C.G.) with special reference to Planktons. Journal of Global Biosciences, 4(6): 2525-2431.

[28] Singh R. K. (2011). Sihavalokan: Blog on Bilasa. http://akaltara.blogspot.com/2011/01/blog-post_31.html

[29] Soni P., Singh P. R. (2022). A water quality assessment of Arpa River under Bilaspur-Arpa basin area, of Chhattisgarh state. Intl. J. River Basin Management.

[30] Srivastava, R.C., Kannan, K, Mohanty, S., Sahoo, N., Mohanty, R.K, Nanda, P., Das, M. and Verma, H.N. (2003). Micro-level Water Resource Development Through Rainwater Management for Drought Mitigation in Sub-humid Plateau Areas of Eastern India. WTCER Publication No. 15. WTCER, Bhubaneswar, India.

[31] Tegar, A., Banafar, K. N. S., Gauraha, A. K., Chandrakar, M. R. (2016). An analysis of growth in area, production and productivity of major vegetables in Bilaspur district of Chhattisgarh state, India. Plant Archives, 16(2): 797-800.

[32] Tewari, U., Bahadur, A. N., Soni, P., Pandey, S. (2014). Physicochemical characterization of city sewage discharged into river Arpa at Bilaspur, India. Indian Journal of Life Sciences, 4(1): 31+.

[33] Tiwari, V. K., Guria, N. (2013). Dynamics of population and planning for waste water management: a case study of Bilaspur city. International Journal of Current Research. 5(11): 3524-3528.

[34] Turner, R.K., van der Bergh, J.C.J.M., Soderqvist, T., Barendregt A., van der Straaten, J., Maltby, E., van Ireland, E.C. (2000). Ecological-economic analysis of wetlands: scientific integration for management and policy. Ecol. Econ., 35(1): 7-23.

[35] Vaishnav, M. M., Hait, M., Priydarsani, P. (2014). Impact of Kanoi Paper Mills effluent in GW and SW of Bilaspur district (C.G.). International Journal of Chemistry and Pharmaceutical Sciences, 2(5): 825-829.

[36] Veerabhadrannavar S.A., Venkatesh B. (2022) Assessment of Impacts of Climate Change on Varied River-Flow Regimes of Peninsular India. Indian Journal of Science and Technology 15(29):1458-1465. https://doi.org/10.17485/IJST/v15i29.825

[37] Venkatesh, B., Lakshman, N., Puruandara, B. K. (2014). Hydroloical impacts of afforestation- A review of research in India. Journal of Forestry Research, 25(1): 37-42.

[38] Verma, S. K. (2013). Ground water brochure of Bilaspur district, Chhattisgarh, 2012-2013. Government of India, Ministry of Water Resources, Central Ground Water Board.

[39] Verma, S., Khan, S. A. (2007). Water quality criteria and Arpa river water of Bilaspur city (India). Current World Environment, 2(1): 61-66.

[40] Verma, S., Khan, S. A. (2007). Water quality criteria and Arpa river water of Bilaspur city (India). Current World Environment, 2(2): 199-204.

[41] Wani, S.P., Pathak, P., Sreedevi, T.K. and Singh, H.P. (2003). Efficient management of rainwater for increased crop productivity and groundwater recharge in Asia. In: W. Kijne, Barker, R. and Molden, D. (Eds.) Water Productivity in Agriculture: Limits and Opportunities for Improvement, CAB International, Wallingford, U.K., pp. 199-215.

[42] Wantzen K.M., Ballouche A., Longuet I., Bao I., Bocoum H., Cisse´ L., Chauhan M., Girard P., Gopal B., Kane A., Marchese M.R., Nautiyal P., Teixeiram P., Zalewski M. (2016). River Culture: an eco-social approach to mitigate the biological and cultural diversity crisis in riverscapes. Ecohydrology & Hydrobiology, 16: 7–18.

[43] World Economic Forum (2018). Saving India's lifelines: what we must do to rescue our rivers. World Economic Forum. https://www.weforum.org/agenda/2018/02/saving-india-s-lifelines-what-we-must-do-to-rescue-our-rivers/