



*Socio-Ecological
Profile of*

**GARRA
RIVER**

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preface

India, as a megadiverse country, is home to a diverse range of landscapes and ecosystems, including freshwater ecosystems that comprise rivers and associated wetlands. Among them, the Ganga River basin is an important life-support system that has sustained human civilizations. The Ganga River, which flows across the five states is a vital source of life for more than 40 per cent of India's billion-plus population. The Ganga River is fed by several tributaries, which contribute to the river's resourcefulness by providing adequate nutrients, drift, and favourable ecological conditions for the species it houses. On the contrary, such tributaries also bring with them numerous pollutants and toxic waste resulting in the increase of the pollution load on the Ganga River.


The Wildlife Institute of India through the Biodiversity Conservation and Ganga Rejuvenation Project funded by the Ministry of Jal Shakti "National Mission for Clean Ganga" under its flagship programme 'Namami Gange' has been working towards the conservation of the Ganga River, to strengthen concerted efforts for restoration of its biodiversity value. During the project's first phase, which focused on the detailed biodiversity profiling of the Ganga River, the importance of conservation of its tributaries in supporting the biodiversity of Ganga River was realized. As a result, phase II of the project "Planning and Management for Aquatic Species Conservation and Maintenance of Ecosystem Services in the Ganga River Basin for a Clean Ganga" was designed to develop a comprehensive restoration and long-term plan for the Ganga River's tributaries.

In view of this the project undertook study of major tributaries of Ganga River and studied smaller tributaries in the Ganga basin. Garra is one of the left bank tributary of Ganga. It originates from the Kumaon Hills, in the Nandhaur range near Haldwani, Uttarakhand. Based on the secondary literature review, the report attempts to compile the socio-ecological profile of the Garra River and will enable the reader to better understand the variety of the flora and fauna of the Garra River, change in forest cover and land use land cover patterns, and the threats faced by the River. This report aims to highlight the need for more focused scientific studies of the Garra River, conservation efforts, to develop a knowledge base for the species of Garra River, aid in biological restoration, and assist policy planners and managers to judiciously use water from the Garra River, given the needs of the species therein.

Ruchi Badola
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INTRODUCTION

The Garra River is a small left-bank tributary of the Ganga River, which flows through two Indian states, Uttarakhand and Uttar Pradesh (Figure 1). It covers a length of about 433 km, of which 357 km flows through Uttar Pradesh and 76 km through Uttarakhand. The Garra River basin covers an area of about 6795 km², of which 80.5% falls in Uttar Pradesh and 19.5% in Uttarakhand. The river is highly sinuous and slightly migratory in nature (Roy and Sinha, 2005). In Uttarakhand, Garra is also known as Nandhaur and Deoha. Nanakmatta, a town named after the famous Sikh shrine Gurudwara Sri Nanak Matta Sahib, is located on the bank of the Garra River.

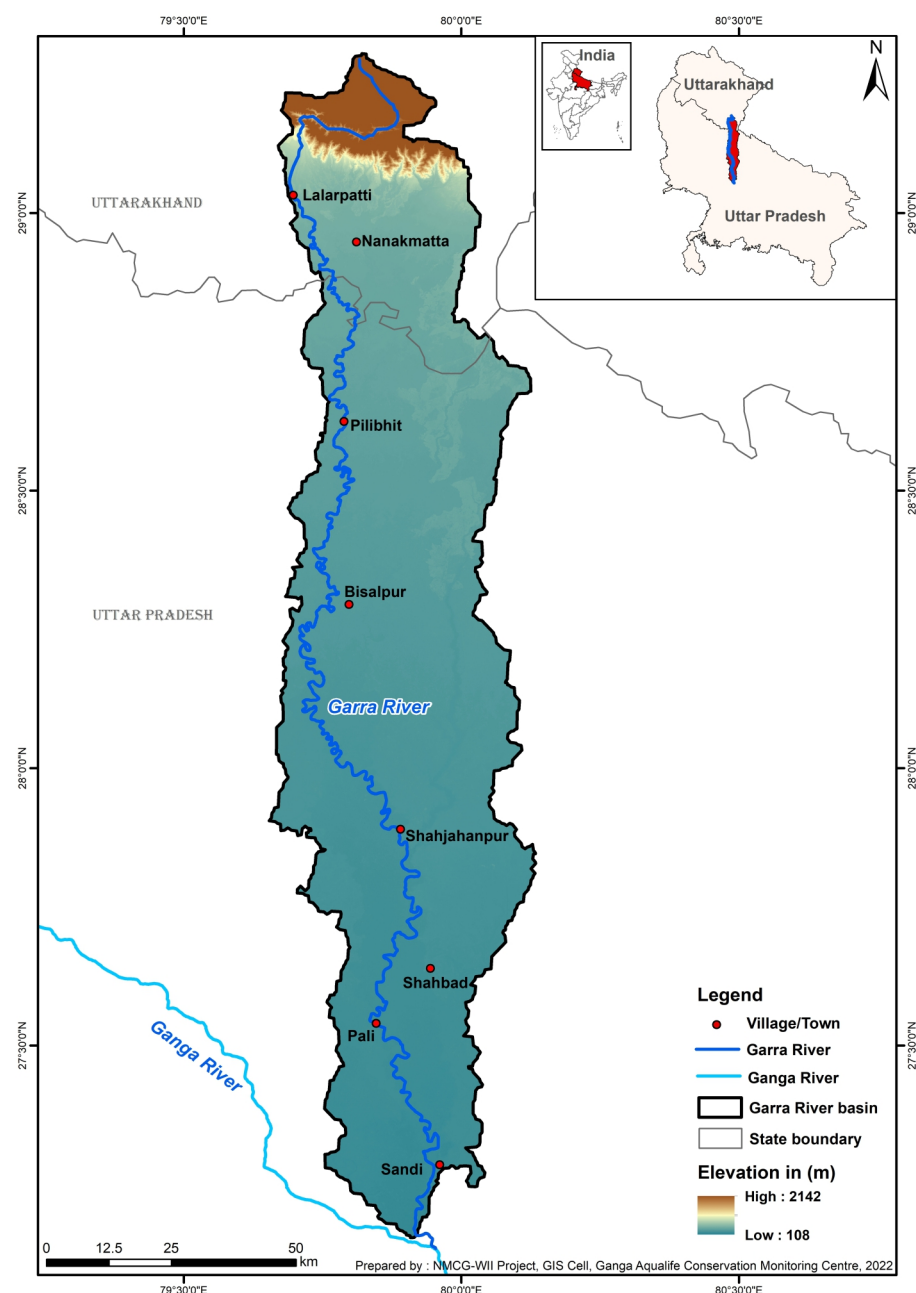


Figure 1. Map of Garra River

COURSE OF THE RIVER

Garra River originates from the Kumaon hills in the Nandhaur range near Haldwani in Uttarakhand and flows through Nandhaur Wildlife Sanctuary, where it is known as the Nandhaur. After entering the Bhabar plains in Chorgallia in Nainital District, it is known as the Deoha. Flowing in a southward direction through Lalarpatti, Sitarganj, and Khatima, it enters Uttar Pradesh in Pilibhit and traverses through Bisalpur, Shahjahanpur, Shahbad, Pali, and Sandi. The river changes its course in a southeast direction just before joining the Ganga River 10 km downstream of the Ramganga-Ganga confluence. Devha, Khakhra, Jhabaria, Sakaria, Barah, and Rapatua are the tributaries of Garra (Roy and Sinha, 2007) (Figure 2).

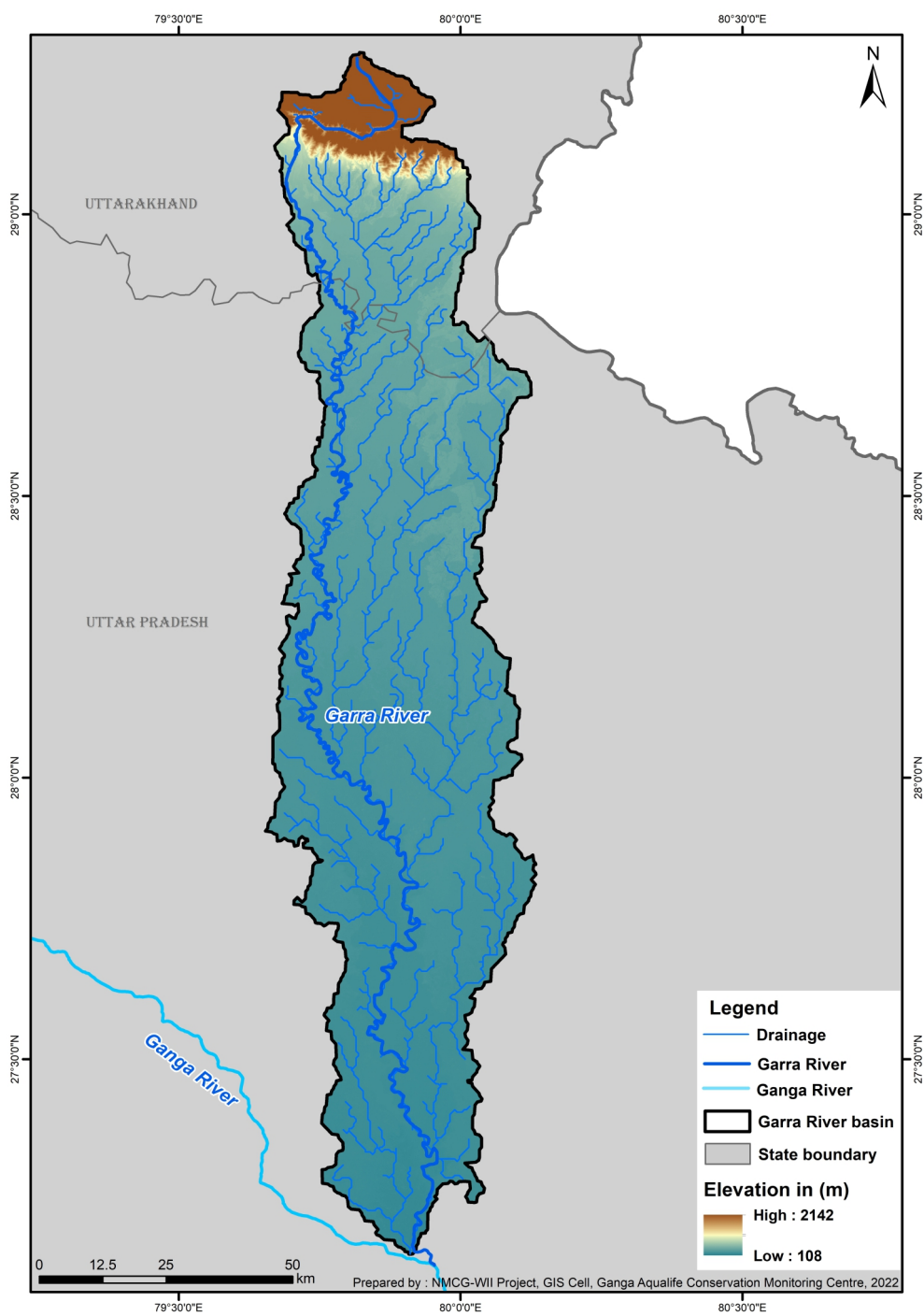


Figure 2. Drainage map of Garra River

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GEOLOGY AND GEOMORPHOLOGY

Garra, a plains-fed river system, is represented by the Indo-Gangetic alluvial plain of the Quarternary age (CGWB, 2021). Garra River basin has two distinct morphoclimatic regimes, the upper mountainous region, which is a part of the Himalayan foothills, and the lower alluvial plains, which is a part of the upper Indo-Gangetic plains (Roy and Sinha, 2007; Swarnkar et al., 2018). Garra River is characterised by threads of abandoned channels, high meanders, presence of multiple ox-bow lakes and ponds. On the basis of varied geomorphic elements, the Garra River basin can be categorised into five geomorphic units, namely, major active channel belt, active flood plains of major channels, active minor channels and flood plains, inactive minor channels and floodplains, and slightly dissected surface (Roy and Sinha, 2005).



Garra River in Shahjahanpur district, Uttar Pradesh

SOIL TYPE

The Garra River system is represented by alluvial soil, which can be broadly categorised into Khadar (new alluvium) and Bhangar (old alluvium) (Ali and Husain, 2015). Khadar is regularly deposited near the riverside due to regular floods. It is represented by sandy to sandy loam soil and characterised by low nitrogen and phosphate content and a high potash-lime. Bhangar is deposited above the riverine floodplain, represented by enriched light to moderate loam that varies from heavy clay to light sandy soil (Ali and Husain, 2015; CGWB, 2016; CGWB, 2021). According to FAO-UNESCO (1977), the catchment of the Garra River is represented by 89.45% of Cambisols soil and 10.55% of Regosols soil. Cambisols soil occurs in the northern, eastern, western and southern parts of the catchment and Regosols in the central northern parts of the catchment. The soil found in the Garra River basin is prone to soil erosion because of its undulating topography, steep slope, and high rainfall (Swarnkar et al., 2018).

CLIMATE

The climate of the area is sub-tropical and subhumid, which is characterised by three seasons, summers, monsoons and winters. Summers from March to May are hot, while November to February is cold. The minimum and maximum temperatures range between 8.5 °C and 40.5 °C (CGWB, 2016; CGWB, 2021). During monsoon, about 85 to 90% of the annual rainfall occurs from June to September, with a high average annual precipitation of 1500 mm in the upper mountainous region and lower average annual precipitation of 1050 mm in the lower alluvial plains (CGWB, 2016; Swarnkar et al., 2018, CGWB, 2021).

BIOGEOGRAPHY, FLORA, AND FAUNA

The Garra River flows through two biogeographic zones, the Himalaya and the Gangetic Plains and two biotic provinces, Western Himalaya (2B) and Upper Gangetic Plains (7A). According to Champion and Seth (1968), the Garra River basin is represented by four major forest types, moist Siwalik sal forest (3C/C2a), moist bhabar sal forest (3C/C2b), moist tarai sal forest (3C/C2c), and west Gangetic moist mixed deciduous forest (3C/C3a). The vegetation of these forests is dominated by *Shorea robusta* (Sal), *Anogeissus latifolia* (Bakli), *Terminalia tomentosa* (Indian Laurel), *Adina cordifolia* (Haldu), *Pinus roxburghii* (Chir pine), *Lannea coromandelica* (Indian ash tree), *Garuga pinnata* (Kakad), *Terminalia bellirica* (Baheda), *Diospyros tomentosa* (Persimmons).

The reconnaissance survey of the Garra River basin revealed that in terms of fauna, it supports populations of key indicator species such as smooth-coated otters and muggers. It also supports five turtle species, Indian roofed turtle (*Pangshura tecta*), Indian tent turtle (*Pangshura tentoria*), brown roofed turtle (*Pangshura smithii*), Indian softshell turtle (*Nilssonia gangetica*) and Indian flapshell turtle (*Lissemys punctata*). Painted stork, sarus crane, partridge peafowl, snipe, cuckoo and geese are commonly occurring birds in the area (Ali, 2005). A total of 34 fish species belonging to 26 genera and 15 families have been reported from the Garra river in Pilibhit District of Uttar Pradesh (Saxena and Saxena, 2014).

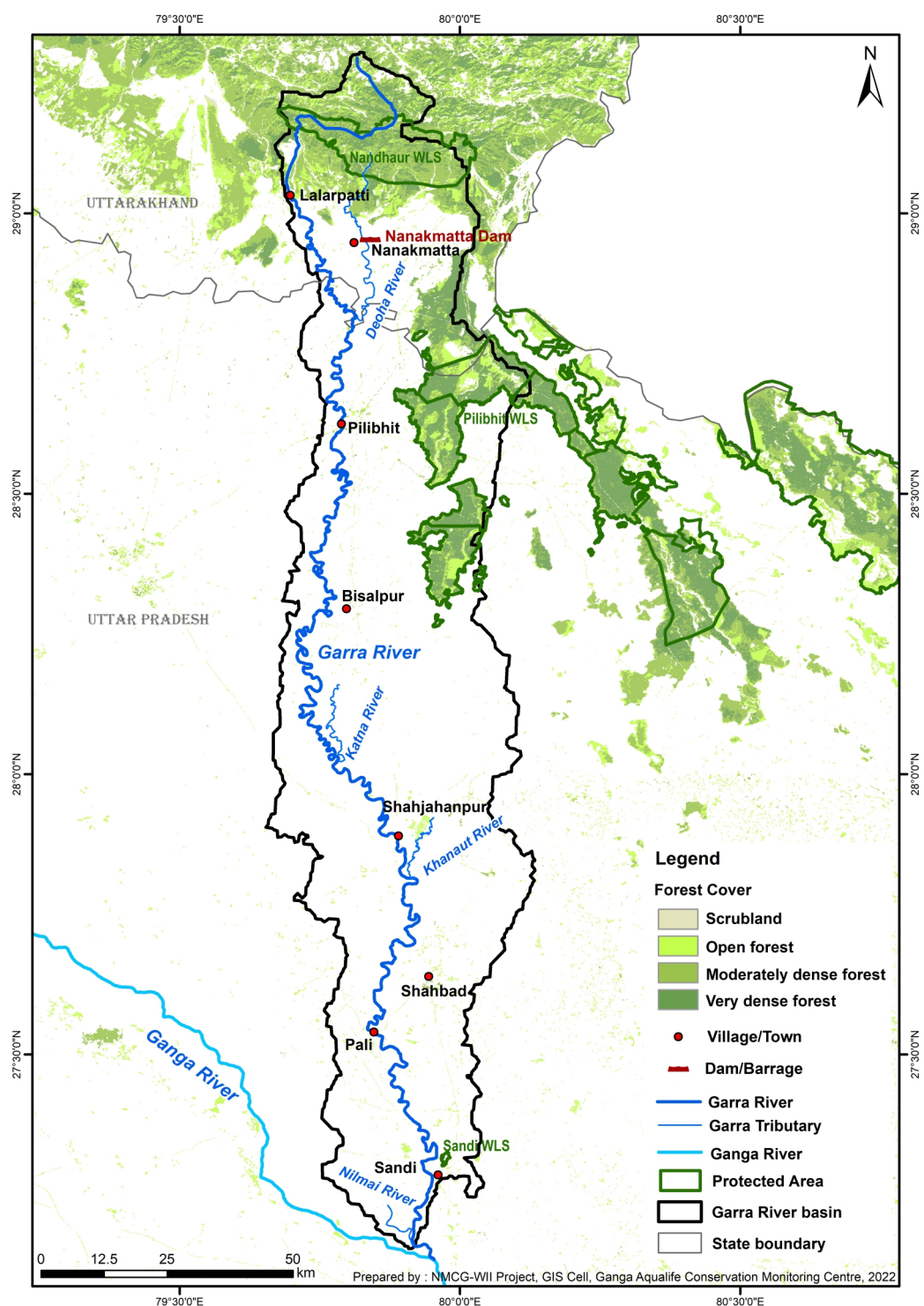
CONSERVATION STATUS

Nandhaur Wildlife Sanctuary (Uttarakhand), Pilibhit Wildlife Sanctuary (Uttar Pradesh), and Sandi Wildlife Sanctuary (Uttar Pradesh) are the three Protected Areas that fall in the Garra River basin. Around a 23 km stretch of Garra River flows through Nandhaur Wildlife Sanctuary and has been protected since 2012 under Section 36 A of the Wild Life (Protection) Act, 1972. Nandhaur Wildlife Sanctuary supports 25 mammalian species, 250 bird species, 15 reptilian species and 20 fish species (Verma, 2011). Tiger, leopard, elephant, sloth bear, mahseer, Indian skimmer and Great pied hornbill are some of the charismatic species of Nandhaur Wildlife Sanctuary. Pilibhit Wildlife Sanctuary in the Garra River basin supports the population of muggers and provides the breeding ground for Critically Endangered Bengal Floricans. Besides this, it supports about 450 resident and migratory bird species and provides a home to tiger, leopard, sloth bear, sambar, swamp deer, spotted deer, hog deer and barking deer (WII, 2021). The water from the Garra river is crucial for the wildlife of Sandi Wildlife Sanctuary. It supports 12 mammalian species, 15 reptilian species, 157 bird species, three amphibian species and 11 fish species (Kumar et al., 2015). Among the Sandi Wildlife Sanctuary fauna, reptiles such as *Chitra indica* and *Lissemys punctata*, birds such as *Neophron percnopterus*, *Grus Antigone*, *Ploceus philippinus* and *Anhinga melanogaster* and fishes such as *Cirrhinus cirrhosis* and *Hypophthalmichthys molitrix* represents the species listed in IUCN Red List.

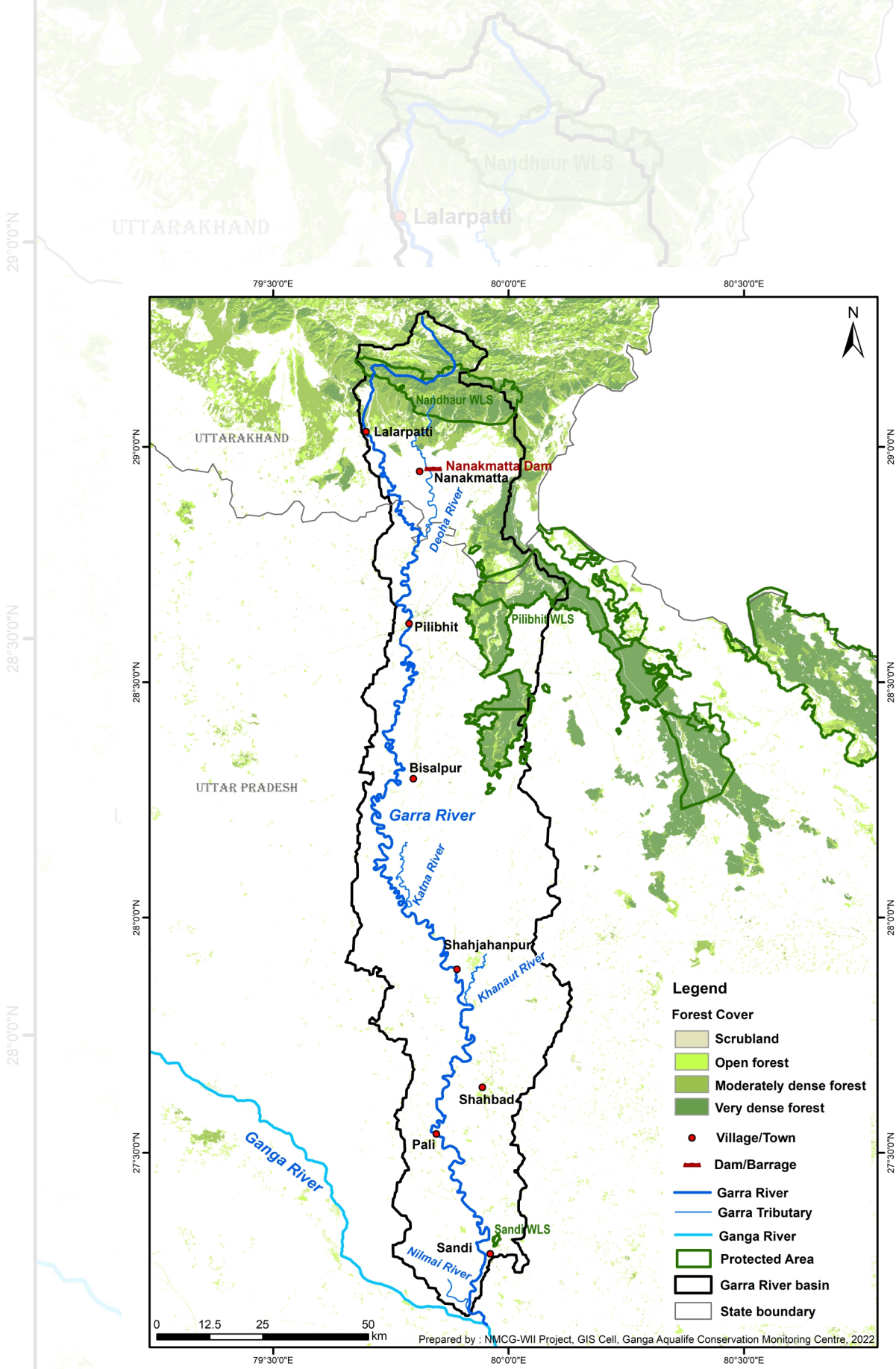
FOREST COVER

According to the Forest Survey of India (2015 & 19), the catchment of the Garra River is dominated by non-forest area, followed by moderately dense forest, very dense forest, open forest, and scrubland. From 2015 to 2019, an increase of 1.15%, 0.84% and 0.03% was recorded for the very dense forest, non-forest and scrubland, respectively. However, a decrease of 1.02% and 1% was recorded for moderately dense and open forests, respectively (Figure 3a & 3b and Table 1).

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Figure 3. Forest Cover of Garra River basin in a) 2015 and b) 2019

Table 1. Summary statistics of the forest cover of the Garra River basin from 2015 to 2019.

S.No.	Forest Cover Classes	2015		2019		Change (2015 to 2019)	
		Area (km ²)	Area (%)	Area (km ²)	Area (%)	Area (km ²)	Area (%)
1	Scrubland	0.27	0.01	2.57	0.04	2.3	0.03
2	Open Forest	258.78	3.81	190.93	2.81	-67.85	-1
3	Moderately Dense Forest	466.98	6.87	397.37	5.85	-69.61	-1.02
4	Very Dense Forest	440.41	6.48	518.67	7.63	78.26	1.15
5	Non-forest	5628.61	82.83	5685.51	83.67	56.9	0.84
Total Area		6795.05	100	6795.05	100		

Source: FSI (2015 & 2019)

DEMOGRAPHY

Garra River basin supports a human population of 34.42 lakh people, of which 28.35 lakh are in Uttar Pradesh and 6.07 lakh in Uttarakhand (GOI, 2011). There are five districts in the Garra River basin, of which Nainital and Udham Singh Nagar fall in Uttarakhand and HarDOI, Pilibhit and Shahjahanpur in Uttar Pradesh. HarDOI and Pilibhit districts hold more than 55% of the human population. Bhawal Khera, Amariya, Bawan and Haldwani represent the most populated blocks in the Garra River basin (Figure 4 and Table 2).

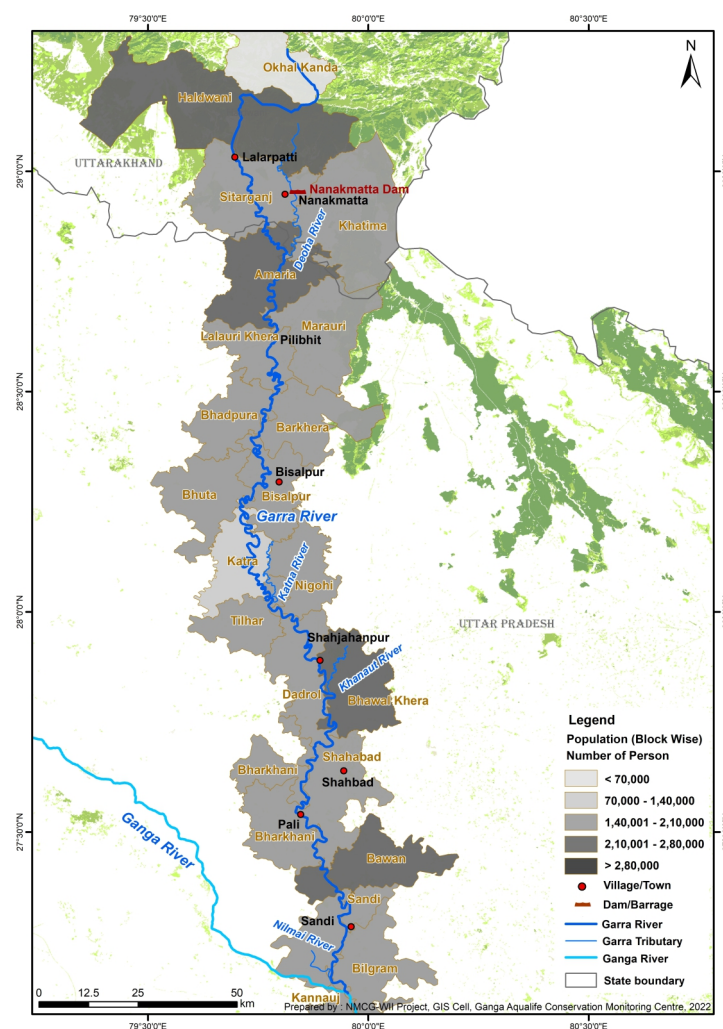
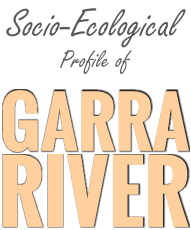


Figure 4. Human population status of Garra River basin (2011)

Table 2. Block-wise human population statistics of the Garria River basin for 2011

State	District	Block	Population	Population (%)
Uttarakhand	Nainital Udham Singh Nagar	Haldwani	227329	6.60
		Sitarganj	176446	5.13
		Khatima	203220	5.90
Uttar Pradesh	Shahjahanpur	Katra (Khudaganj)	138438	4.02
		Nigohi	170582	4.96
		Tilhar	140166	4.07
		Dadrol	168586	4.90
		Bhawal Khera	250424	7.28
	Pilibhit	Amariya	246186	7.15
		Marori	209926	6.10
		Lalaurikhera	168474	4.89
		Barkhera	177875	5.17
		Bisalpur	167453	4.86
	Hardoi	Shahabad	184795	5.37
		Bharkhani	204786	5.95
		Bawan	233954	6.80
		Sandi	165273	4.80
		Bilgram	208150	6.05
Total			3442063	100

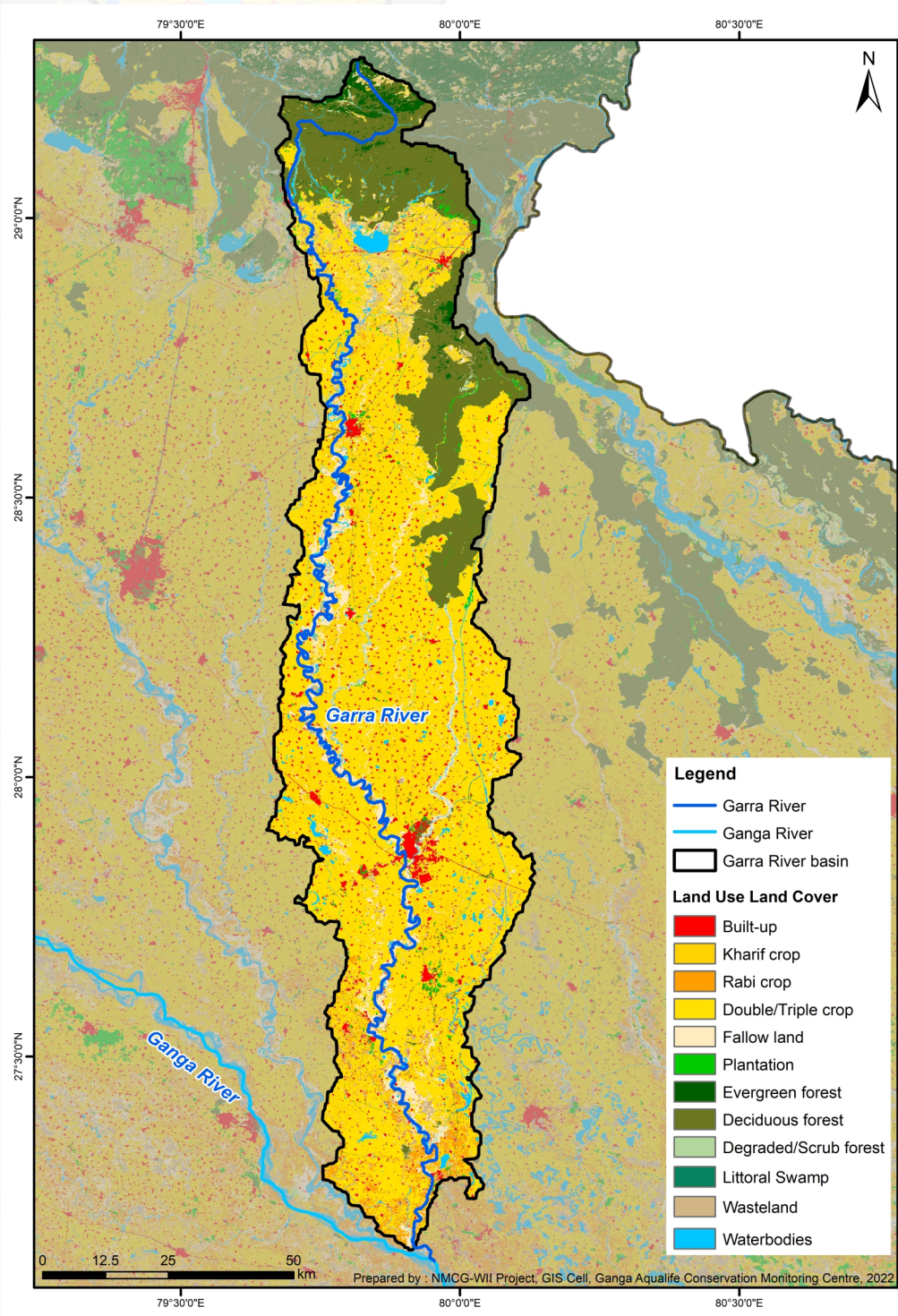
Source: Government of India, 2011



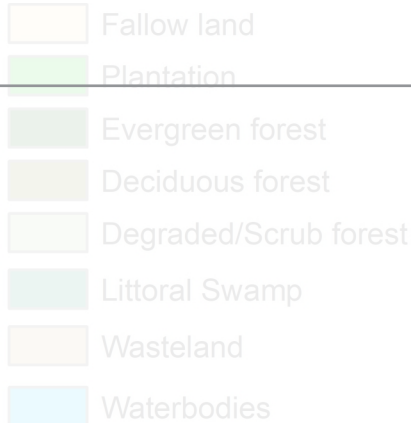
LAND USE AND LAND COVER

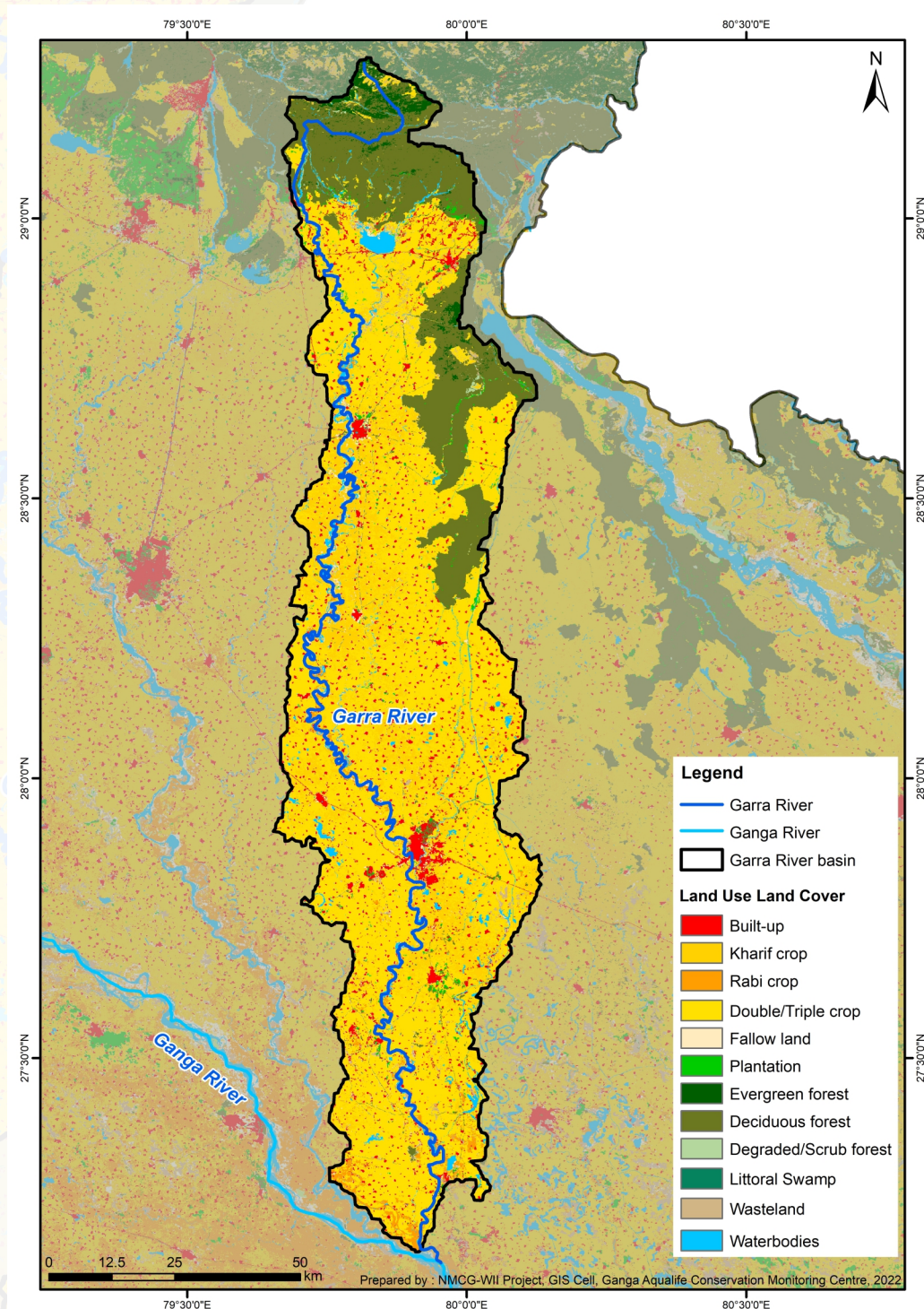
Based on NRSC data (2008-09 and 2018-19), two Land Use and Land Cover (LULC) maps of the Garra River basin were prepared. For the Garra River basin, LULC can be categorised into 12 categories: built-up, Kharif crop, rabi crop, double/triple crop, fallow land, plantation, evergreen forest, deciduous forest, degraded/ scrub forest, littoral swamp, wasteland and waterbodies. From 2008-09, the Garra River basin was dominated by 52.29% double/triple crop, followed by 15.66% of deciduous forest, 8.66% of Kharif crop, 7.58% of fallow land, 3.81% of built-up area, 3.66% of wasteland, 3.18% of waterbodies, 2.8% of rabi crop, 1.37% of evergreen forest, 0.7% of plantation, and 0.29% of degraded/scrub forest. From 2018-19 the basin was dominated by 54.46% of double/triple crop, followed by 15.7% of deciduous forest, 13.66% of Kharif crop, 4.82% of built-up area, 3.26% of waterbodies, 2.28% of fallow land, 2.27% of rabi crop, 1.4% of evergreen Forest, 1.17% of wasteland, 0.69% of plantation and 0.29% of degraded/scrub forest. LULC maps revealed that over a period of ten years, there was an increase of 5%, 2.17% and 1.01% in the Kharif crop, double/triple crop and built-up area, respectively. And a decrease of 5.3%, 2.49% and 0.53% in the fallow land, wasteland and rabi crop area, respectively (Figure 5a & 5b and Table 3).

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Figure 5. LULC map of Garra River basin a) 2008-09 and b) 2018-19



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Table 3. LULC statistics of the Garra River basin for 2008-09, 2018-19 and 2008 to 2019.

S. No.	LULC Classes	2008-09		2018-19		Change (2008-19)	
		Area (km ²)	Area (%)	Area (km ²)	Area (%)	Area (km ²)	Area (%)
1	Built-up	259.17	3.81	327.83	4.82	68.66	1.01
2	Kharif crop	588.51	8.66	928.04	13.66	339.53	5
3	Rabi crop	190.09	2.8	153.93	2.27	-36.16	-0.53
4	Double/Triple crop	3553.04	52.29	3700.73	54.46	147.69	2.17
5	Fallow land	515.22	7.58	154.72	2.28	-360.5	-5.3
6	Plantation	47.67	0.7	47.17	0.69	-0.5	-0.01
7	Evergreen forest	92.9	1.37	95.47	1.4	2.57	0.03
8	Deciduous forest	1063.91	15.66	1066.54	15.7	2.63	0.04
9	Degraded/ Scrub forest	19.45	0.29	19.5	0.29	0.05	0
10	Littoral Swamp	0.04	0	0.03	0	-0.01	0
11	Wasteland	248.64	3.66	79.54	1.17	-169.1	-2.49
12	Waterbodies	216.41	3.18	221.55	3.26	5.14	0.08
Total Area		6795.05	100	6795.05	100		

Source: NRSC (2009 and 2019)

DAMS AND BARRAGES

Nanak Sagar dam is the only dam located in the Garra River basin. The dam was built in 1962 on the Deoha River in the Udham Singh Nagar district of Uttarakhand. This earthen dam was built to create the Nanak Sagar reservoir to supply water for irrigation and domestic purpose in Uttarakhand and parts of Uttar Pradesh (WWF, 2012). With a 19.7 km length and $3833 \times 10^3 \text{ m}^3$ volume, the dam has an irrigation potential of 39200 hectares (ICAR, 2014; Chandra and Sharma, 2018). The dam supplies water to the Nanakmatta canal system, which has a 13.66 km length and 1232 ha of culturable command area.

THREATS TO THE BIODIVERSITY OF GARRA RIVER

Discharge of untreated effluent from the industries such as sugar mills, paper & pulp and thermal power plants into the river deteriorates the water quality and makes it unsuitable for aquatic fauna (Saxena and Saxena, 2014; Khan et al., 2016). Agricultural runoff is one of the major sources of pollution in the Garra River. The discharge of untreated sewage into the river due to changing land use patterns and rapid urbanisation has been affecting the quality of the water and the riverine habitat of aquatic fauna (Saxena and Saxena, 2014). Khan et al., 2016, conducted a study on physio-chemical aspects of the Garra River in the Shahjahanpur district and revealed that agricultural and industrial runoff as the major source of pollution.

CONSERVATION IMPLICATIONS

The tributaries are known to increase in channel and habitat complexities, depth, and change in substrate composition, which increases the mainstem diversity downstream of the tributaries (Benda et al., 2004; Fernandez et al., 2004). Apart from contributing to the flow and aquatic diversity of the mainstem the tributaries also contribute to the pollution load to the mainstem. Any conservation actions for the mainstem, thus should also be directed at the tributaries. Thus the smaller tributaries of the Ganga River were taken up for study. Garra River, despite being a

small tributary of the Ganga River hasn't received the attention of the research institutions. The secondary literature review of the Garra River highlights that the information available on the Garra River basin is fragmented and limited. Therefore, there is a need for robust and continued scientific studies focusing on detailed information on biodiversity both in terms of flora and fauna, ecotoxicology and physicochemical parameters of river water and identification of threats to understand the ecological status of the Garra River.



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Garra River in Shahjahanpur district, Uttar Pradesh



REFERENCES

- Ali, M., & Husain, S. M. (2015). Geographical Analysis of Micro Natural and Cultural Unit Shahjahanpur District, Uttar Pradesh, India. *International Journal of Advanced and Innovative Research*, 4(6), 111-115.
- Ali, M. (2005). Role of periodic markets in transaction of agricultural commodities in Shahjahanpur District. MSc thesis submitted to Department of Geography Aligarh Muslim University Aligarh (India).
- Benda, L. E. E., Andras, K., Miller, D., & Bigelow, P. (2004). Confluence effects in rivers: interactions of basin scale, network geometry, and disturbance regimes. *Water Resources Research*, 40(5).
- CGWB (2016). Aquifer Mapping and Ground Water Management Plan, Udham Singh Nagar District, Uttarakhand. Central Ground Water Board (CGWB), Ministry of Water Resources, River Development and Ganga Rejuvenation, Government of India.
- CGWB (2021). Aquifer Mapping and Management of Ground Water Resources Shahjahanpur District Uttar Pradesh. Central Ground Water Board (CGWB), Department of Water Resources, River Development and Ganga Rejuvenation, Ministry of Jal Shakti Government of India.
- Champion, H. G., & Seth, S. K. (1968). *A revised survey of the forest types of India*. Manager of publications. Government of India.
- Chandra, H., & Sharma, H. C. (2018). Performance Evaluation of Water Delivery System in Nanakmatta Canal Command Area. *Journal of Research in Engineering and Applied Sciences*. 3(1), 6-11.
- FAO-UNESCO (1977). *Soil map of the world, 1: 50,00,000: South Asia (Volume VII)*. Food and Agriculture Organization of the United Nations.
- Fernandes, C. C., Podos, J., & Lundberg, J. G. (2004). Amazonian ecology: tributaries enhance the diversity of electric fishes. *Science*, 305(5692), 1960-1962.
- FSI (2015). *Indian State of Forest Report*. Ministry of Environment, Forests & Climate change, Government of India.
- FSI (2019). *Indian State of Forest Report 2019*. Ministry of Environment, Forests & Climate change, Government of India.
- GOI (2011). Census of India. Available online at <https://censusindia.gov.in/census.website/data/census-tables>.
- ICAR (2014). All India Coordinated Research Project on Groundwater Utilization Annual Report 2013-2014. Directorate of Water Management (ICAR), Bhubaneswar, Odisha.



Kaushal, N., Babu, S., Mishra, A., & O'Keeffe, J. (2018). Environmental Flows for a healthy Ramganga. *WWF-India Report*, (pp. 4).

Khan, M. Y. A., Khan, B., & Chakrapani, G. J. (2016). Assessment of spatial variations in water quality of Garra River at Shahjahanpur, Ganga Basin, India. *Arabian Journal of Geosciences*, 9(8), 1-10.

Kumar, A., Kanaujia, A., Kushwaha, S., & Kumar, A. (2015). A Biodiversity Hub: Sandi Bird Sanctuary, Hardoi, Uttar Pradesh, India. *International Journal of Applied Biology and Pharmaceutical Technology*, 6(2), 273-288.

NRSC (2009). Land Use Land Cover (2008-2009). National Remote Sensing Centre (NRSC), ISRO, Government of India, Hyderabad, India.

NRSC (2019). Land Use Land Cover (2018-2019). National Remote Sensing Centre (NRSC), ISRO, Government of India, Hyderabad, India.

Ramsar Sites Information Service (2022). Annotated List of Wetlands of International Importance: India. https://rsis.ramsar.org/sites/default/files/rsiswp_search/exports/ris-report-annotated_summary-20220914-074354-7b246bdf23546da2c01b786984768d37.pdf. Accessed on 19th September 2022.

Roy, N. G., & Sinha, R. (2005). Alluvial geomorphology and confluence dynamics in the Gangetic plains, Farrukhabad-Kannauj area, Uttar Pradesh, India. *Current Science*, 2000-2006.

Roy, N., and Sinha, R. (2007). Understanding confluence dynamics in the alluvial Ganga-Ramganga valley, India: An integrated approach using geomorphology and hydrology. *Geomorphology*, 92(3-4), 182-197.

Saxena, P., & Saxena, K. K. (2014). Fish-diversity in relation to physico-chemical characteristics of river Devaha, District Pilibhit (UP), India. *G-Journal of Environmental Science and Technology*, 1(6), 134-138.

Swarnkar, S., Malini, A., Tripathi, S., & Sinha, R. (2018). Assessment of uncertainties in soil erosion and sediment yield estimates at ungauged basins: An application to the Garra River basin, India. *Hydrology and Earth System Sciences*, 22(4), 2471-2485.

Verma, A. (2011). Proposal for Nandhaur Wildlife Sanctuary. Uttarakhand Forest Department.

WII (2021). Mitigation measures to permit permeability for wildlife across the Indo-Nepal Border Road, Uttar Pradesh. Wildlife Institute of India (WII), Dehradun. TR/WI/2021/11, Pp. 70.

WWF (2012). *Wetlands of Uttarakhand: A Documentation*. Report jointly published by the Uttarakhand Forest Department and WWF India.

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ANNEXURE I

Mammalian species of the Garra River Basin

Family	Common Name/s	Scientific Name	IUCN status	IWPA status	Previous studies
Bovidae	Nilgai	<i>Boselaphus tragocamelus</i> (Pallas, 1766)	LC	Schedule III	a , b
Canidae	Bengal Fox	<i>Vulpes bengalensis</i> (Shaw, 1800)	LC	Schedule II	a
	Golden Jackal	<i>Canis aureus</i> (Linnaeus, 1758)	LC	Schedule II	a , b
Cercopithecidae	Northern Plains Gray Langur	<i>Semnopithecus entellus</i> (Dufresne, 1797)	LC	Schedule II	a
	Rhesus Monkey	<i>Macaca mulatta</i> (Zimmermann, 1780)	LC	Schedule II	a , b
Cervidae	Barking Deer	<i>Muntiacus muntjak</i> (Zimmermann, 1780)	LC	Schedule III	a
	Indian Spotted Deer/Chital	<i>Axis axis</i> (Erxleben, 1777)	LC	Schedule III	a
	Sambar	<i>Rusa unicolor</i> (Kerr, 1792)	VU	Schedule III	a
Elephantidae	Asian Elephant	<i>Elephas maximus</i> (Linnaeus, 1758)	EN	Schedule I	a
Felidae	Jungle Cat	<i>Felis chaus</i> (Schreber, 1777)	LC	Schedule II	a
	Leopard	<i>Panthera pardus</i> (Linnaeus, 1758)	VU	Schedule I	a
	Tiger	<i>Panthera tigris</i> (Linnaeus, 1758)	EN	Schedule I	a
Herpestidae	Indian Grey Mongoose	<i>Herpestes edwardsii</i> (É. Geoffroy Saint-Hilaire, 1818)	LC	Schedule II	a , b
	Small Indian Mongoose	<i>Herpestes auropunctatus</i> (Hodgson, 1836)	LC	Schedule II	a
Hystriidae	Indian Crested Porcupine	<i>Hystrix indica</i> (Kerr, 1792)	LC	Schedule IV	a , b
Leporidae	Indian Hare	<i>Lepus nigricollis</i> (F. Cuvier, 1823)	LC	Schedule IV	a , b
Manidae	Indian Pangolin	<i>Manis crassicaudata</i> (É. Geoffroy, 1803)	EN	Schedule I	a
Muridae	Common Indian Field Mouse	<i>Mus booduga</i> (Gray, 1837)	LC	Schedule V	b
	Greater Bandicoot Rat	<i>Bandicota indica</i> (Bechstein, 1800)	LC	Schedule V	b
	House Rat	<i>Rattus rattus</i> (Linnaeus, 1758)	LC	Schedule V	b
Pteropodidae	Indian Flying Fox	<i>Pteropus giganteus</i> (Brünnich, 1782)	LC	NL	a
	Leschenault's Rousette	<i>Rousettus leschenaultii</i> (Desmarest, 1820)	NT	Schedule V	a
Sciuridae	Northern Palm Squirrel	<i>Funambulus pennantii</i> (Wroughton, 1905)	LC	Schedule IV	a , b
Scoricidae	Asian House Shrew	<i>Suncus murinus</i> (Linnaeus, 1766)	LC	NL	a
Suidae	Wild Boar	<i>Sus scrofa</i> (Linnaeus, 1758)	LC	Schedule III	a

Family	Common Name/s	Scientific Name	IUCN status	IWPA status	Previous studies
Ursidae	Sloth Bear	<i>Melursus ursinus</i> (Shaw, 1791)	VU	Schedule I	a
Viverridae	Common Palm Civet	<i>Paradoxurus hermaphroditus</i> (Pallas, 1777)	LC	Schedule II	b
	Small Indian Civet	<i>Viverricula indica</i> (É. Geoffroy Saint-Hilaire, 1803)	LC	Schedule II	a , b

^aVerma (2011); ^bKumar et al. (2015)

REFERENCES

Kumar, A., Kanaujia, A., Kushwaha, S., & Kumar, A. (2015). A Biodiversity Hub: Sandi Bird Sanctuary, Hardoi, Uttar Pradesh, India. *International Journal of Applied Biology and Pharmaceutical Technology*, 6(2), 273-288.

Verma, A. (2011). Proposal for Nandhaur Wildlife Sanctuary. *Uttarakhand Forest Department*.

ANNEXURE II

Bird species of the Garra River Basin

Family	Common Name/s	Scientific Name	IUCN status	IWPA status	Previous studies
Accipitridae	Black Eagle	<i>Ictinaetus malaiensis</i> (Temminck, 1822)	LC	NL	a
	Black Kite	<i>Milvus migrans</i> (Boddaert, 1783)	LC	NL	a , b
	Black-shouldered Kite	<i>Elanus axillaris</i> (Latham, 1802)	LC	NL	b
	Black-winged Kite	<i>Elanus caeruleus</i> (Desfontaines, 1789)	LC	NL	a
	Changeable Hawk-Eagle	<i>Nisaetus cirrhatus</i> (Gmelin, 1788)	LC	NL	a
	Crested Goshawk	<i>Accipiter trivirgatus</i> (Temminck, 1824)	LC	NL	a
	Crested Serpent Eagle	<i>Spilornis cheela</i> (Latham, 1790)	LC	NL	a , b
	Egyptian Vulture	<i>Neophron percnopterus</i> (Linnaeus, 1758)	EN	Schedule IV	a , b
	Eurasian Buzzard	<i>Buteo buteo</i> (Linnaeus, 1758)	LC	NL	a , b
	Eurasian Sparrowhawk	<i>Accipiter nisus</i> (Linnaeus, 1758)	LC	Schedule I	a
	Grey-headed Fish Eagle	<i>Ichthyophaga ichthyaetus</i> (Horsfield, 1821)	NT	NL	a
	Indian Vulture	<i>Gyps indicus</i> (Scopoli, 1786)	CR	Schedule I	a
	Lesser Spotted Eagle	<i>Clanga pomarina</i> (Brehm, 1831)	LC	NL	a
	Pallid Harrier	<i>Circus macrourus</i> (Gmelin, 1770)	NT	NL	a
	Shikra	<i>Accipiter badius</i> (Gmelin, 1788)	LC	NL	a , b
	Western Marsh-harrier	<i>Circus aeruginosus</i> (Linnaeus, 1758)	LC	NL	a
	White-rumped Vulture	<i>Gyps bengalensis</i> (Gmelin, 1788)	CR	Schedule I	a
Acrocephalidae	Paddyfield Warbler	<i>Acrocephalus agricola</i> (Jerdon, 1845)	LC	NL	a , b
Aegithinidae	Common Iora	<i>Aegithina tiphia</i> (Linnaeus, 1758)	LC	Schedule IV	b
Alcedinidae	Common Kingfisher	<i>Alcedo atthis</i> (Linnaeus, 1758)	LC	Schedule IV	a , b
	Pied Kingfisher	<i>Ceryle rudis</i> (Linnaeus, 1758)	LC	Schedule IV	a , b
	White-breasted Kingfisher	<i>Halcyon smyrnensis</i> (Linnaeus, 1758)	LC	Schedule IV	a , b
Anatidae	African Comb Duck	<i>Sarkidiornis melanotos</i> (Pennant, 1769)	LC	Schedule IV	a , b
	Bar-headed Goose	<i>Anser indicus</i> (Latham, 1790)	LC	Schedule IV	a , b
	Common Pochard	<i>Aythya ferina</i> (Linnaeus, 1758)	VU	Schedule IV	a , b

Family	Common Name/s	Scientific Name	IUCN status	IWPA status	Previous studies
	Common Teal	<i>Anas crecca</i> (Linnaeus, 1758)	LC	Schedule IV	a , b
	Cotton Pygmy-goose	<i>Nettapus coromandelianus</i> (Gmelin, 1789)	LC	Schedule IV	b
	Eurasian Wigeon	<i>Mareca Penelope</i> (Linnaeus, 1758)	LC	Schedule IV	b
	Ferruginous Pochard	<i>Aythya nyroca</i> (Güldenstädt, 1770)	NT	Schedule IV	b
	Gadwall	<i>Anas strepera</i> (Linnaeus, 1758)	LC	Schedule IV	a , b
	Garganey	<i>Spatula querquedula</i> (Linnaeus, 1758)	LC	NL	a , b
	Goosander	<i>Mergus merganser</i> (Linnaeus, 1758)	LC	NL	a
	Greater Scaup	<i>Aythya marila</i> (Linnaeus, 1761)	LC	NL	a
	Greyleg Goose	<i>Anser anser</i> (Linnaeus, 1758)	LC	Schedule IV	a , b
	Indian Spot-billed Duck	<i>Anas poecilorhyncha</i> (Forster, 1781)	LC	Schedule IV	b
	Lesser Whistling-Duck	<i>Dendrocygna javanica</i> (Horsfield, 1821)	LC	Schedule IV	a , b
	Mallard	<i>Anas platyrhynchos</i> (Linnaeus, 1758)	LC	Schedule IV	a , b
	Northern Shoveler	<i>Spatula clypeata</i> (Linnaeus, 1758)	LC	Schedule IV	a , b
	Northern Pintail	<i>Anas acuta</i> (Linnaeus, 1758)	LC	Schedule IV	a , b
	Red-crested Pochard	<i>Netta rufina</i> (Pallas, 1773)	LC	Schedule IV	a , b
	Ruddy Shelduck	<i>Tadorna ferruginea</i> (Pallas, 1764)	LC	Schedule IV	a , b
	Tufted Duck	<i>Aythya fuligula</i> (Linnaeus, 1758)	LC	Schedule IV	a , b
Anhingidae	African Darter	<i>Anhinga rufa</i> (Daudin, 1802)	LC	Schedule IV	a
	Oriental Darter	<i>Anhinga melanogaster</i> (Pennant, 1769)	NT	Schedule IV	b
Ardeidae	Black Bittern	<i>Ixobrychus flavicollis</i> (Latham, 1790)	LC	Schedule IV	b
	Black-crowned Night-heron	<i>Nycticorax nycticorax</i> (Linnaeus, 1758)	LC	Schedule IV	a , b
	Cattle Egret	<i>Bubulcus ibis</i> (Linnaeus, 1758)	LC	Schedule IV	a , b
	Cinnamon Bittern	<i>Ixobrychus cinnamomeus</i> (Gmelin, 1789)	LC	Schedule IV	a , b
	Great White Egret	<i>Ardea alba</i> (Linnaeus, 1758)	LC	Schedule IV	a , b
	Green-backed Heron	<i>Butorides striata</i> (Linnaeus, 1758)	LC	Schedule IV	b

Family	Common Name/s	Scientific Name	IUCN status	IWPA status	Previous studies
	Grey Heron	<i>Ardea cinerea</i> (Linnaeus, 1758)	LC	Schedule IV	a , b
	Indian Pond-Heron	<i>Ardeola grayii</i> (Sykes, 1832)	LC	Schedule IV	a , b
	Intermediate Egret	<i>Ardea intermedia</i> (Wagler, 1829)	LC	Schedule IV	b
	Little Egret	<i>Egretta garzetta</i> (Linnaeus, 1766)	LC	Schedule IV	a , b
	Purple Heron	<i>Ardea purpurea</i> Linnaeus, 1766)	LC	Schedule IV	a , b
	Yellow Bittern	<i>Ixobrychus sinensis</i> (Gmelin, 1789)	LC	Schedule IV	b
Bucerotidae	Great Indian Hornbill	<i>Buceros bicornis</i> (Linnaeus, 1758)	VU	Schedule I	a
	Indian Grey Hornbill	<i>Ocyrceros birostris</i> (Scopoli, 1786)	LC	NL	a , b
	Malabar Pied Hornbill	<i>Anthraceroceros coronatus</i> (Boddaert, 1783)	NT	Schedule I	a
Burhinidae	Eurasian Thick-knee	<i>Burhinus oedicnemus</i> (Linnaeus, 1758)	LC	Schedule IV	a
Campephagidae	Indian Cuckooshrike	<i>Coracina macei</i> (Lesson, 1831)	LC	NL	b
	Small Minivet	<i>Pericrocotus cinnamomeus</i> (Linnaeus, 1766)	LC	Schedule IV	a
Caprimulgidae	Indian Nightjar	<i>Caprimulgus asiaticus</i> (Latham, 1790)	LC	Schedule IV	a , b
	Jungle Nightjar	<i>Caprimulgus indicus</i> (Latham, 1790)	LC	Schedule IV	a
Charadriidae	Common Ringed Plover	<i>Charadrius hiaticula</i> (Linnaeus, 1758)	LC	Schedule IV	b
	Little Ringed Plover	<i>Charadrius dubius</i> (Scopoli, 1786)	LC	Schedule IV	b
	Red-wattled Lapwing	<i>Vanellus indicus</i> (Boddaert, 1783)	LC	NL	a , b
	Yellow-wattled Lapwing	<i>Vanellus malabaricus</i> (Boddaert, 1783)	LC	NL	a , b
Ciconiidae	Asian Openbill	<i>Anastomus oscitans</i> (Boddaert, 1783)	LC	Schedule IV	a , b
	Asian Woolly-necked Stork	<i>Ciconia episcopus</i> (Boddaert, 1783)	NT	Schedule IV	a , b
	Black Stork	<i>Ciconia nigra</i> (Linnaeus, 1758)	LC	Schedule IV	b
	Black-necked Stork	<i>Ephippiorhynchus asiaticus</i> (Latham, 1790)	NT	Schedule IV	a , b
	Painted Stork	<i>Mycteria leucocephala</i> (Pennant, 1769)	NT	Schedule IV	a , b
	White Stork	<i>Ciconia ciconia</i> (Linnaeus, 1758)	LC	Schedule I	a
Cistocolidae	Ashy Prinia	<i>Prinia socialis</i> (Sykes, 1832)	LC	NL	a , b
	Common Tailorbird	<i>Orthotomus sutorius</i> (Pennant, 1769)	LC	NL	a , b
	Graceful Prinia	<i>Prinia gracilis</i> (Lichtenstein, 1823)	LC	NL	a

Family	Common Name/s	Scientific Name	IUCN status	IWPA status	Previous studies
	Jungle Prinia	<i>Prinia sylvatica</i> (Jerdon, 1840)	LC	NL	b
	Plain Prinia	<i>Prinia inornata</i> (Sykes, 1832)	LC	NL	b
Columbidae	Eurasian Collared Dove	<i>Streptopelia decaocto</i> (Frisvaldszky, 1838)	LC	Schedule IV	a , b
	Grey-capped Emerald Dove	<i>Chalcophaps indica</i> (Linnaeus, 1758)	LC	Schedule IV	a
	Laughing Dove	<i>Spilopelia senegalensis</i> (Linnaeus, 1766)	LC	Schedule IV	a , b
	Red Collared-Dove	<i>Streptopelia tranquebarica</i> (Hermann, 1804)	LC	Schedule IV	a , b
	Rock Dove	<i>Columba livia</i> (Gmelin, 1789)	LC	Schedule IV	a
	Spotted Dove	<i>Spilopelia chinensis</i> (Scopoli, 1786)	LC	Schedule IV	a , b
	Yellow-footed Green-pigeon	<i>Treron phoenicopterus</i> (Latham, 1790)	LC	Schedule IV	a
Coraciidae	Indian Roller	<i>Coracias benghalensis</i> (Linnaeus, 1758)	LC	Schedule IV	a , b
Corvidae	House Crow	<i>Corvus splendens</i> (Vieillot, 1817)	LC	NL	a , b
	Large-billed Crow	<i>Corvus macrorhynchos</i> (Wagler, 1827)	LC	NL	a , b
	Rufous Treepie	<i>Dendrocitta vagabunda</i> (Latham, 1790)	LC	Schedule IV	a , b
Cuculidae	Common Cuckoo	<i>Cuculus canorus</i> (Linnaeus, 1758)	LC	Schedule IV	a , b
	Common Hawk-cuckoo	<i>Hierococyx varius</i> (Vahl, 1797)	LC	Schedule IV	a , b
	Greater Coucal	<i>Centropus sinensis</i> (Stephens, 1815)	LC	Schedule IV	a , b
	Indian Cuckoo	<i>Cuculus micropterus</i> (Gould, 1838)	LC	Schedule IV	a , b
	Pied Cuckoo	<i>Clamator jacobinus</i> (Boddaert, 1783)	LC	Schedule IV	a
	Madagascar Coucal	<i>Centropus toulou</i> (Müller, 1776)	LC	Schedule IV	a
	Sirkeer Malkoha	<i>Taccocua leschenaultii</i> (Lesson, 1830)	LC	Schedule IV	b
	Western Koel	<i>Eudynamys scolopacea</i> (Linnaeus, 1758)	LC	Schedule IV	a , b
Dicruridae	Black Drongo	<i>Dicrurus macrocercus</i> (Vieillot, 1817)	LC	Schedule IV	a , b
	Crow-billed Drongo	<i>Dicrurus annectens</i> (Hodgson, 1836)	LC	Schedule IV	a
	Greater Racquet-tailed Drongo	<i>Dicrurus paradiseus</i> (Linnaeus, 1766)	LC	Schedule IV	a , b
	Hair-crested Drongo	<i>Dicrurus hottentottus</i> (Linnaeus, 1766)	LC	Schedule IV	a
Emberizidae	Black-headed Bunting	<i>Emberiza melanocephala</i> (Scopoli, 1769)	LC	Schedule IV	a
Estrildidae	Black-headed Munia	<i>Lonchura malacca</i> (Linnaeus, 1766)	LC	Schedule IV	a

Family	Common Name/s	Scientific Name	IUCN status	IWPA status	Previous studies
	Indian Silverbill	<i>Euodice malabarica</i> (Linnaeus, 1758)	LC	Schedule IV	a , b
	Scaly-breasted Munia	<i>Lonchura punctulata</i> (Linnaeus, 1758)	LC	Schedule IV	b
Falconidae	Common Kestrel	<i>Falco tinnunculus</i> (Linnaeus, 1758)	LC	Schedule IV	a
	Eurasian Hobby	<i>Falco subbuteo</i> (Linnaeus, 1758)	LC	Schedule IV	a
	Peregrine Falcon	<i>Falco peregrinus</i> (Tunstall, 1771)	LC	Schedule I	a
Fringillidae	Common Rosefinch	<i>Carpodacus erythrinus</i> (Pallas, 1770)	LC	Schedule IV	a
Gruidae	Sarus Crane	<i>Grus antigone</i> (Linnaeus, 1758)	VU	Schedule IV	b
Hirundinidae	Barn Swallow	<i>Hirundo rustica</i> (Linnaeus, 1758)	LC	NL	a , b
	Plain Martin	<i>Riparia paludicola</i> (Vieillot, 1817)	LC	NL	b
	Wire-tailed Swallow	<i>Hirundo smithii</i> (Leach, 1818)	LC	NL	a , b
Jacanidae	Bronze-winged Jacana	<i>Metopidius indicus</i> (Latham, 1790)	LC	Schedule IV	b
	Pheasant-tailed Jacana	<i>Hydrophasianus chirurgus</i> (Scopoli, 1786)	LC	Schedule IV	b
Laniidae	Bay-backed Shrike	<i>Lanius vittatus</i> (Valenciennes, 1826)	LC	NL	a
	Great Grey Shrike	<i>Lanius excubitor</i> (Linnaeus, 1758)	LC	NL	a
	Long Tailed Shrike	<i>Lanius schach</i> (Linnaeus, 1758)	LC	NL	a , b
Laridae	Common Tern	<i>Sterna hirundo</i> (Linnaeus, 1758)	LC	NL	a
	Indian Skimmer	<i>Rynchops albicollis</i> (Swainson, 1838)	EN	NL	a
	Indian Whiskered Tern	<i>Chlidonias hybrida</i> (Pallas, 1811)	LC	NL	a
	River Tern	<i>Sterna aurantia</i> (Gray, 1831)	VU	NL	a , b
Leiotrichidae	Common Babbler	<i>Argya caudata</i> (Dumont, 1823)	LC	Schedule IV	a , b
	Jungle Babbler	<i>Argya striata</i> (Dumont, 1823)	LC	Schedule IV	a , b
	Large Grey Babbler	<i>Argya malcolmi</i> (Sykes, 1832)	LC	Schedule IV	a
	Striated Babbler	<i>Argya earlei</i> (Blyth, 1844)	LC	Schedule IV	a
Locustellidae	Striated Grassbird	<i>Megalurus palustris</i> (Horsfield, 1821)	LC	NL	a
Megalaimidae	Blue-throated Barbet	<i>Psilopogon asiaticus</i> (Latham, 1790)	LC	Schedule IV	a
	Brown-headed Barbet	<i>Psilopogon zeylanicus</i> (Gmelin, 1788)	LC	Schedule IV	b

Family	Common Name/s	Scientific Name	IUCN status	IWPA status	Previous studies
	Lineated Barbet	<i>Psilopogon lineatus</i> (Vieillot, 1816)	LC	Schedule IV	a
Meropidae	Asian Green Bee-eater	<i>Merops orientalis</i> (Latham, 1802)	LC	NL	a , b
	Blue-tailed Bee-eater	<i>Merops philippinus</i> (Linnaeus, 1766)	LC	NL	a , b
	Chestnut-headed Bee-eater	<i>Merops leschenaulti</i> (Vieillot, 1817)	LC	NL	a
Monarchidae	Asian Paradise Flycatcher	<i>Terpsiphone paradisi</i> (Linnaeus, 1758)	LC	NL	a , b
	Black-naped Monarch	<i>Hypothymis azurea</i> (Boddaert, 1783)	LC	NL	a
Motacillidae	Forest Wagtail	<i>Dendronanthus indicus</i> (Gmelin, 1789)	LC	NL	b
	Grey Wagtail	<i>Motacilla cinerea</i> (Tunstall, 1771)	LC	NL	a , b
	Paddyfield Pipit	<i>Anthus rufulus</i> (Vieillot, 1818)	LC	Schedule IV	b
	Tree Pipit	<i>Anthus trivialis</i> (Linnaeus, 1758)	LC	Schedule IV	b
	Western Yellow Wagtail	<i>Motacilla flava</i> (Linnaeus, 1758)	LC	NL	b
	White-browed Wagtail	<i>Motacilla maderaspatensis</i> (Gmelin, 1789)	LC	NL	a , b
	White Wagtail	<i>Motacilla alba</i> (Linnaeus, 1758)	LC	NL	a , b
Muscicapidae	Asian Brown Flycatcher	<i>Muscicapa dauurica</i> (Pallas, 1811)	LC	Schedule IV	a
	Black Redstart	<i>Phoenicurus ochruros</i> (Gmelin, 1774)	LC	Schedule IV	a , b
	Blue Rock Thrush	<i>Monticola solitarius</i> (Linnaeus, 1758)	LC	Schedule IV	a , b
	Brown Rockchat	<i>Oenanthe fusca</i> (Blyth, 1851)	LC	NL	a , b
	Common Stonechat	<i>Saxicola torquatus</i> (Linnaeus, 1766)	LC	Schedule IV	b
	Indian Blue Robin	<i>Larvivora brunnea</i> (Hodgson, 1837)	LC	Schedule IV	a
	Indian Robin	<i>Saxicoloides fulicatus</i> (Linnaeus, 1766)	LC	Schedule IV	b
	Oriental Magpie Robin	<i>Copsychus saularis</i> (Linnaeus, 1758)	LC	Schedule IV	a , b
	Pied Bushchat	<i>Saxicola caprata</i> (Linnaeus, 1766)	LC	Schedule IV	a , b
	Tickell's Blue Flycatcher	<i>Cyornis tickelliae</i> (Blyth, 1843)	LC	Schedule IV	b
	Verditer Flycatcher	<i>Eumyias thalassinus</i> (Swainson, 1838)	LC	Schedule IV	a
	White-rumped Shama	<i>Kittacincla malabarica</i> (Scopoli, 1788)	LC	NL	a
Nectariniidae	Crimson Sunbird	<i>Aethopyga siparaja</i> (Raffles, 1822)	LC	Schedule IV	a
	Purple Sunbird	<i>Cinnyris asiaticus</i> (Latham, 1790)	LC	Schedule IV	a , b

Family	Common Name/s	Scientific Name	IUCN status	IWPA status	Previous studies
Oriolidae	Black-hooded Oriole	<i>Oriolus xanthornus</i> (Linnaeus, 1758)	LC	Schedule IV	a , b
	Eurasian Golden-Oriole	<i>Oriolus oriolus</i> (Linnaeus, 1758)	LC	Schedule IV	a , b
Pandionidae	Osprey	<i>Pandion haliaetus</i> (Linnaeus, 1758)	LC	Schedule I	a
Paradoxornithidae	Yellow-eyed Babbler	<i>Chrysomma sinense</i> (Gmelin, 1789)	LC	Schedule IV	b
Paridae	Eurasian Great Tit	<i>Parus major</i> (Linnaeus, 1758)	LC	Schedule IV	b
Passeridae	House Sparrow	<i>Passer domesticus</i> (Linnaeus, 1758)	LC	NL	a , b
Pelecanidae	Great White Pelican	<i>Pelecanus onocrotalus</i> (Linnaeus, 1758)	LC	Schedule IV	a
Phalacrocoracidae	Great Cormorant	<i>Phalacrocorax carbo</i> (Linnaeus, 1758)	LC	Schedule IV	b
	Indian Cormorant	<i>Phalacrocorax fuscicollis</i> (Stephens, 1826)	LC	Schedule IV	b
	Little Cormorant	<i>Microcarbo niger</i> (Vieillot, 1817)	LC	Schedule IV	a , b
Phasianidae	Black Francolin	<i>Francolinus francolinus</i> (Linnaeus, 1766)	LC	Schedule IV	a
	Common Quail	<i>Coturnix coturnix</i> (Linnaeus, 1758)	LC	Schedule IV	a
	Grey Francolin	<i>Francolinus pondicerianus</i> (Gmelin, 1789)	LC	Schedule IV	a
	Grey Junglefowl	<i>Gallus sonneratii</i> (Temminck, 1813)	LC	Schedule II	a
	Indian Peafowl	<i>Pavo cristatus</i> (Linnaeus, 1758)	LC	Schedule I	a , b
	Jungle Bush-Quail	<i>Perdica asiatica</i> (Latham, 1790)	LC	Schedule IV	a
	Red Junglefowl	<i>Gallus gallus</i> (Linnaeus, 1758)	LC	Schedule IV	a , b
Phylloscoidae	Greenish Warbler	<i>Phylloscopus trochiloides</i> (Sundevall, 1837)	LC	NL	a
Picidae	Black-rumped Flameback	<i>Dinopium benghalense</i> (Linnaeus, 1758)	LC	NL	a , b
	Brown-capped Pygmy Woodpecker	<i>Picoides nanus</i> (Vigors, 1832)	LC	Schedule IV	b
	Streak-throated Woodpecker	<i>Picus xanthopygaeus</i> (Gray & Gray, 1846)	LC	Schedule IV	a
	Yellow-crowned Woodpecker	<i>Leiopicus mahrattensis</i> (Latham, 1801)	LC	Schedule IV	b
Ploceidae	Baya Weaver	<i>Ploceus philippinus</i> (Linnaeus, 1766)	LC	Schedule IV	b
	Finn's Weaver	<i>Ploceus megarhynchus</i> (Hume, 1869)	EN	Schedule IV	a
Podicipedidae	Little Grebe	<i>Tachybaptus ruficollis</i> (Pallas, 1764)	LC	Schedule IV	a , b
Psittacidae	Alexandrine Parakeet	<i>Psittacula eupatria</i> (Linnaeus, 1766)	NT	Schedule IV	a , b
	Blossom-headed Parakeet	<i>Himalayapsitta roseata</i> (Biswas, 1951)	NT	Schedule IV	a

Family	Common Name/s	Scientific Name	IUCN status	IWPA status	Previous studies
	Rose-ringed Parakeet	<i>Alexandrinus krameri</i> (Scopoli, 1769)	LC	Schedule IV	a , b
	Slaty-headed Parakeet	<i>Himalayapsitta himalayana</i> (Lesson, 1832)	LC	Schedule IV	a
Pycnonotidae	Red-vented Bulbul	<i>Pycnonotus cafer</i> (Linnaeus, 1766)	LC	Schedule IV	b
	Red-whiskered Bulbul	<i>Pycnonotus jocosus</i> (Linnaeus, 1758)	LC	Schedule IV	a , b
Rallidae	Common Coot	<i>Fulica atra</i> (Linnaeus, 1758)	LC	Schedule IV	b
	Common Moorhen	<i>Gallinula chloropus</i> (Linnaeus, 1758)	LC	Schedule IV	b
	Purple Swampphen	<i>Porphyrio porphyrio</i> (Linnaeus, 1758)	LC	Schedule IV	b
	White-breasted Waterhen	<i>Amaurornis phoenicurus</i> (Pennant, 1769)	LC	Schedule IV	b
Recurvirostridae	Black-winged Stilt	<i>Himantopus himantopus</i> (Linnaeus, 1758)	LC	Schedule IV	a , b
Scolopacidae	Common Greenshank	<i>Tringa nebularia</i> (Gunnerus, 1767)	LC	Schedule IV	b
	Common Redshank	<i>Tringa totanus</i> (Linnaeus, 1758)	LC	Schedule IV	a , b
	Common Sandpiper	<i>Actitis hypoleucos</i> (Linnaeus, 1758)	LC	Schedule IV	a , b
	Green Sandpiper	<i>Tringa ochropus</i> (Linnaeus, 1758)	LC	Schedule IV	b
	Wood Sandpiper	<i>Tringa glareola</i> (Linnaeus, 1758)	LC	Schedule IV	a , b
Sittidae	Chestnut-bellied Nuthatch	<i>Sitta cinnamoventris</i> (Blyth, 1842)	LC	NL	a
Stenostiridae	Grey-headed Canary Flycatcher	<i>Culicicapa ceylonensis</i> (Swainson, 1820)	LC	Schedule IV	a
Strigidae	Asian Barred Owlet	<i>Glaucidium cuculoides</i> (Vigors, 1831)	LC	Schedule IV	a , b
	Brown Boobook	<i>Ninox scutulata</i> (Raffles, 1822)	LC	Schedule IV	b
	Brown Fish-owl	<i>Ketupa zeylonensis</i> (Gmelin, 1788)	LC	Schedule IV	a
	Eurasian Eagle-owl	<i>Bubo bubo</i> (Linnaeus, 1758)	LC	Schedule IV	a , b
	Jungle Owlet	<i>Glaucidium radiatum</i> (Tickell, 1833)	LC	Schedule IV	a , b
	Spotted Owlet	<i>Athene brama</i> (Temminck, 1821)	LC	Schedule IV	a , b
Sturnidae	Asian Pied Starling	<i>Gracupica contra</i> (Linnaeus, 1758)	LC	Schedule IV	a , b
	Bank Myna	<i>Acridotheres ginginianus</i> (Latham, 1790)	LC	Schedule IV	a
	Brahminy Starling	<i>Sturnia pagodarum</i> (Gmelin, 1789)	LC	Schedule IV	a , b
	Chestnut-tailed Starling	<i>Sturnia malabarica</i> (Gmelin, 1789)	LC	Schedule IV	b
	Common Myna	<i>Acridotheres tristis</i> (Linnaeus, 1766)	LC	Schedule IV	a , b

Family	Common Name/s	Scientific Name	IUCN status	IWPA status	Previous studies
	Jungle Myna	<i>Acridotheres fuscus</i> (Wagler, 1827)	LC	Schedule IV	a , b
	Rosy Starling	<i>Pastor roseus</i> (Linnaeus, 1758)	LC	Schedule IV	b
Threskiornithidae	African Sacred Ibis	<i>Threskiornis aethiopicus</i> (Latham, 1790)	LC	Schedule IV	a
	Black-headed Ibis	<i>Threskiornis melanocephalus</i> (Latham, 1790)	NT	Schedule IV	b
	Eurasian Spoonbill	<i>Platalea leucorodia</i> (Linnaeus, 1758)	LC	Schedule I	a
	Glossy Ibis	<i>Plegadis falcinellus</i> (Linnaeus, 1766)	LC	Schedule IV	b
	Red-naped Ibis	<i>Pseudibis papillosa</i> (Temminck, 1824)	LC	Schedule IV	b
Timaliidae	Pin-striped Tit-babbler	<i>Mixornis gularis</i> (Horsfield, 1822)	LC	Schedule IV	a
Turdidae	Eurasian Blackbird	<i>Turdus merula</i> (Linnaeus, 1758)	LC	NL	a
Tytonidae	African Grass-owl	<i>Tyto capensis</i> (Smith, 1834)	LC	Schedule IV	a
	Common Barn-owl	<i>Tyto alba</i> (Scopoli, 1769)	LC	Schedule IV	b
Upupidae	Common Hoopoe	<i>Upupa epops</i> (Linnaeus, 1758)	LC	NL	a , b
Vangidae	Common Woodshrike	<i>Tephrodornis pondicerianus</i> (Gmelin, 1789)	LC	NL	b
Zosteropidae	Indian White-eye	<i>Zosterops palpebrosus</i> (Temminck, 1824)	LC	Schedule IV	a , b

^aVerma (2011); ^bKumar et al. (2015)

REFERENCES

Kumar, A., Kanaujia, A., Kushwaha, S., & Kumar, A. (2015). A Biodiversity Hub: Sandi Bird Sanctuary, Hardoi, Uttar Pradesh, India. *International Journal of Applied Biology and Pharmaceutical Technology*, 6(2), 273-288.

Verma, A. (2011). Proposal for Nandhaur Wildlife Sanctuary. *Uttarakhand Forest Department*.

ANNEXURE III Reptilian species of the Garra River Basin

Family	Common Name/s	Scientific Name	IUCN status	IWPA status	Previous studies
Agamidae	Oriental Garden Lizard	<i>Calotes versicolor</i> (Daudin, 1802)	LC	NL	a, b
Boidae	Common Sand Boa	<i>Eryx conicus</i> (Schneider, 1801)	NT	Schedule IV	b
	Red Sand Boa	<i>Eryx johnii</i> (Russell, 1801)	NT	Schedule IV	a, b
Colubridae	Green Whip Snake	<i>Hierophis viridiflavus</i> (Lacépède, 1789)	LC	Schedule IV	a
	Oriental Rat Snake	<i>Ptyas mucosa</i> (Linnaeus, 1758)	LC	Schedule II	a
Elapidae	Banded Krait	<i>Bungarus fasciatus</i> (Schneider, 1801)	LC	Schedule IV	a
	Common Krait	<i>Bungarus caeruleus</i> (Schneider, 1801)	LC	Schedule IV	a, b
	Indian Cobra	<i>Naja naja</i> (Linnaeus, 1758)	LC	Schedule II	a, b
	King Cobra	<i>Ophiophagus Hannah</i> (Cantor, 1836)	VU	Schedule II	a
Gekkonidae	Yellow-bellied House Gecko	<i>Hemidactylus flaviviridis</i> (Ruppell, 1835)	LC	NL	a, b
Geoemydidae	Indian Tent Turtle	<i>Pangshura tentoria</i> (Gray, 1834)	LC	Schedule I	a, b
Homalopsidae	Rainbow Mud Snake	<i>Enhydrys enhydrys</i> (Schneider, 1799)	LC	NL	b
Pythonidae	Indian Rock Python	<i>Python molurus</i> (Linnaeus, 1758)	NT	Schedule I	a
	Reticulated Python	<i>Malayopython reticulatus</i> (Schneider, 1801)	LC	Schedule I	b
Scincidae	Common Dotted Garden Skink	<i>Lygosoma punctata</i> (Gmelin, 1799)	LC	NL	b
	Keeled Indian Mabuya	<i>Eutropis carinata</i> (Schneider, 1801)	LC	NL	b
Testudinidae	Elongated Tortoise	<i>Indotestudo elongata</i> (Blyth, 1853)	CR	Schedule IV	a
Trionychidae	Indian Soft-shell Turtle	<i>Nilssonina gangetica</i> (Cuvier, 1825)	EN	Schedule I	a
	Indian Flapshell Turtle	<i>Lissemys punctata</i> (Lacépède, 1788)	VU	Schedule I	b
	Indian Narrow-headed Softshell Turtle	<i>Chitra indica</i> (Gray, 1830)	EN	Schedule IV	b
Varanidae	Bengal Monitor Lizard	<i>Varanus bengalensis</i> (Daudin, 1802)	NT	Schedule I	a, b
Viperidae	Eastern Russell's Viper	<i>Daboia siamensis</i> (Smith, 1917)	LC	Schedule II	a, b
	Himalayan Pit-viper	<i>Gloydius himalayanus</i> (Günther, 1864)	LC	Schedule IV	a

^aVerma (2011); ^bKumar et al. (2015)

REFERENCES

- Kumar, A., Kanaujia, A., Kushwaha, S., & Kumar, A. (2015). A Biodiversity Hub: Sandi Bird Sanctuary, Hardoi, Uttar Pradesh, India. *International Journal of Applied Biology and Pharmaceutical Technology*, 6(2), 273-288.
- Verma, A. (2011). Proposal for Nandhaur Wildlife Sanctuary. *Uttarakhand Forest Department*.

ANNEXURE IV

Amphibian species of the Garra River Basin

Family	Common Name/s	Scientific Name	IUCN status	IWPA status	Previous studies
Bufonidae	Common Indian Toad	<i>Duttaphrynus melanostictus</i> (Schneider, 1799)	LC	NL	a
Dicroglossidae	Indian Bullfrog	<i>Hoplobatrachus tigerinus</i> (Daudin, 1802)	LC	Schedule IV	a
	Skipper Frog	<i>Euphlyctis cyanophlyctis</i> (Schneider, 1799)	LC	Schedule IV	a

^aKumar et al. (2015)

REFERENCES

Kumar, A., Kanaujia, A., Kushwaha, S., & Kumar, A. (2015). A Biodiversity Hub: Sandi Bird Sanctuary, Hardoi, Uttar Pradesh, India. *International Journal of Applied Biology and Pharmaceutical Technology*, 6(2), 273-288.

ANNEXURE V

Fish species of the Garra River Basin

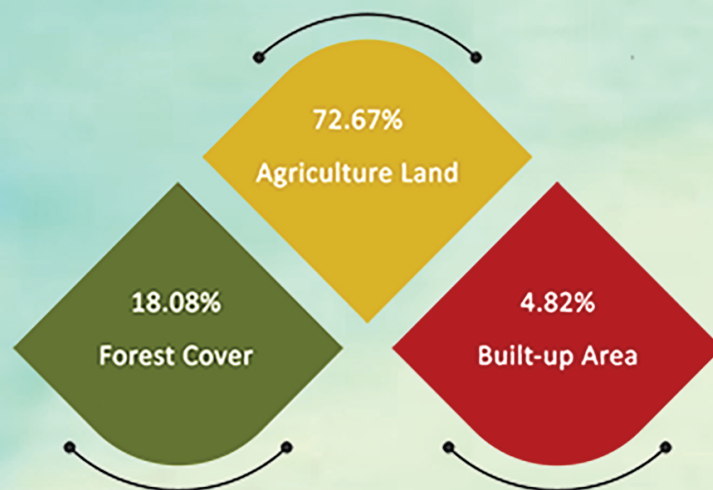
Family	Common Name/s	Scientific Name	IUCN status	Previous studies
Bagridae	Giant River Catfish	<i>Sperata seenghala</i> (Sykes, 1839)	LC	a
Chandidae	Spotted Snakehead	<i>Channa punctatus</i> (Bloch, 1793)	LC	a
	Striped Snakehead	<i>Channa striata</i> (Bloch, 1793)	LC	a
Clariidae	Philippine Catfish	<i>Clarias batrachus</i> (Linnaeus, 1758)	LC	a
Cyprinidae	Catla	<i>Labeo catla</i> (Hamilton, 1822)	LC	a
	Karnataka Labeo	<i>Labeo calbasu</i> (Hamilton, 1822)	LC	a
	Mrigal Carp	<i>Cirrhinus cirrhosus</i> (Bloch, 1795)	VU	a
	Mrigal	<i>Cirrhinus mrigala</i> (Hamilton, 1822)	LC	a
	Rohu	<i>Labeo rohita</i> (Hamilton, 1822)	LC	a
Heteropneustidae	Stinging Catfish	<i>Heteropneustes fossilis</i> (Bloch, 1794)	LC	a
Xenocyprinidae	Silver Carp	<i>Hypophthalmichthys molitrix</i> (Valenciennes, 1844)	NT	a

^aKumar et al. (2015)

REFERENCES

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Land Use Land Cover Statistics

Source: Land Use, Land Cover, NRSC, ISRO (2018-19)









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