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The impact of human activities on mugger crocodile and their habitat in central Gujarat, India

Raju Vyas*

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Author Affiliation:
Shashwat Flats, BPC-Haveli Road, Alkapuri, Vadodara 390 007, Gujarat, India,
ORCID ID: 0000-0003-2467-5494,
Email: razoovyas@hotmail.com

***Corresponding author:**
Raju Vyas,
Shashwat Flats, BPC-Haveli Road, Alkapuri, Vadodara 390 007, Gujarat, India,
ORCID ID: 0000-0003-2467-5494,
Email: razoovyas@hotmail.com

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ABSTRACT

From 2019 to 2025, various authorities in central Gujarat, India, restored 11 water bodies for beautification, tourism, and rejuvenation, excluding two sites that were Typha swamps set on fire by farmers. The note outlines a detailed account of habitat destruction and alteration for these 11 water bodies, including nine lentic and two lotic river habitats across four districts. These water bodies are home to a few 'Schedule I' reptile species under IWPA-1972, such as Mugger crocodiles. Four sites permanently lost their mugger populations, while seven sites lost them only temporarily. The largest affected area, in terms of size, is in Vadodara district, followed by Narmada and Anand, with the smallest in Kheda. Additionally, the note provides a current scenario, estimate, and discussion of the mugger population in the state.

Keywords: Anthropogenic, Aquatic-habitat, Marsh Crocodiles, Rejuvenation, Threats, Tourism, Wetlands

1. INTRODUCTION

The Mugger Crocodile (Crocodylus palustris) is one of the most versatile crocodilian species in South Asia, occupying a remarkably wide ecological and geographic range that stretches from Iran across the Indian subcontinent to Bangladesh, Nepal, Pakistan, and Sri Lanka (Bors et al., 2024). The species remains legally protected across its native countries, and in India it receives the highest level of protection. Under the Wildlife Protection Act, 1972 (amendment 2023), the mugger is listed in Schedule I. Conservation assessments by the IUCN/SSC Red List categorize the species as 'vulnerable', (Choudhury and De Silva, 2013).

The national legal status of the species and its vulnerabilities on the IUCN/SSC Red List indicate that the species faces numerous threats, especially habitat loss, destruction, disturbance, and entanglement in gillnets, which remain the primary threats across its range (Choudhury and de Silva, 2013). Several mortality incidents have been reported in Gujarat due to entanglements or ingestion of discarded rubbish, as well as collisions with vehicles on roads and railways (Vyas, 2014; Vyas and Vasava, 2019; Vyas et al., 2020a, 2020b, 2023). Recently found alarming numbers of mysteriously dead muggers from the Vishwamitri River add further information about threats to the species (Vyas, 2023a). Here, I present changes in the waterbodies

and habitat destruction in the native habitats of muggers, noting the different levels of disturbances observed in central Gujarat, India, over the past few years.

2. MATERIALS AND METHODS

Over the past thirty years, I have studied and monitored mugger crocodiles in Gujarat, India, and actively engaged with them in Vadodara and the Charotar region to raise awareness and address human-crocodile conflicts (HCC), especially in central Gujarat. I have found evidence that some wetland habitats, particularly those of mugger crocodiles, are now at risk. From 2019 to 2025, various state authorities have been developing water bodies for tourism and flood control, while some farmers in central Gujarat have been burning swamp reeds. Similar anthropogenic activities have caused alterations and destruction of wetland ecosystems and habitats, either temporarily or permanently, under the guise of beautification and tourism development. I have personally visited each incident site, documented each case, and attempted to assess the damage and impact on the affected wildlife.

3. RESULTS

Here, I present notable examples of mugger threats associated with altered or temporarily degraded habitats in Gujarat (Table 1, Figure 1). Alarming levels of habitat change and destruction have been observed across 11 locations, including nine lentic and two lotic river habitats in four districts of central Gujarat. Four sites permanently lost their mugger populations, while seven sites lost them only temporarily; each of four sites in Vadodara and Anand districts, followed by two in Narmada, and one in Kheda. The largest affected area in terms of size is Vadodara district, followed by Narmada and Anand, and the smallest is Kheda. The specific sites and their details are listed below.

1. Goya Talav Bakrol, Anand is a small waterbody on the outskirts of the urban areas of Anand and Bakrol village, which supports a small breeding population of mugger crocodiles and several hundred turtles, including the Ganges softshell turtle (*Nilssonia gangetica*) and the Indian flapshell turtle (*Lissemys punctata*). In 2019, the local urban authorities decided to beautify and develop the waterbody. As part of the project, they planned to drain the water and dry the area for construction around it. In September, volunteers from a local NGO began capturing these reptiles under the guise of rescue efforts (Figure 2), with assistance from the local forest department staff, and relocated them near their habitat without proper guidelines or arrangements. A total of 57 turtles were removed from the waterbody, including large Ganges softshell turtles, in four days of the rescue operation. Additionally, muggers and several turtles are migrating near the waterbody. However, the natural waterbody is transformed into a large, empty concrete-and-cement tank, and all aquatic animals have invaded both the natural habitat and the waterbody.

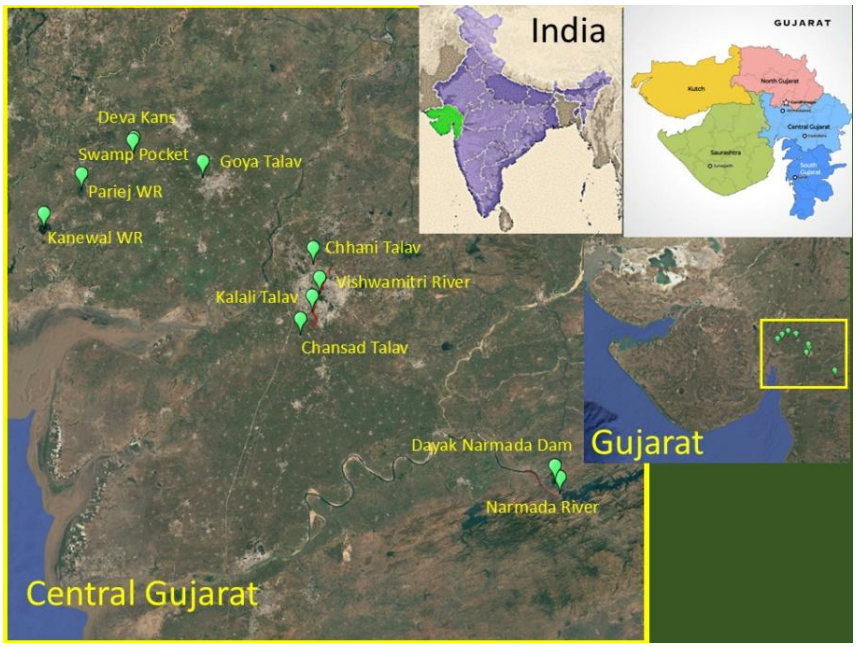

Figure 1: Map of Gujarat (A) showing waterbody locations in Central Gujarat that are altered or temporarily degraded in the habitat of mugger crocodiles (B), the site numbers correspond with Table 1. (Courtesy of Google Earth)

Figure 2: A team of volunteers from local NGOs rescue a turtle (A); rescued Ganges soft-shelled turtles *Nilssonia gangetica* (B); aerial views comapring before (C) and after (D) development of Goya Talav Bakrol, Anand, Central Gujarat. (Photo Credit: Google Earth)

Table 1: The summary list of anthropogenic activities and their impact on the mugger crocodiles' habitat, Central Gujarat, India

No	Location Habitat	Area (Approx)	Activity	Year of Development	Major Impact	No. of Animals noted	Source
1	Goya Talav Bakrol, Ananad (22° 34.066'N; 72° 54.643'E)	1 sq km	Wetland Beautification	2019	Population permanently eliminated	subadult rescues	Vasava et al., 2015
2	Chhani Gam Talav, Vadodara (22° 21.945'N; 73° 10.208'E)	1.6 sq km	Wetland Beautification	2021	Population permanently eliminated	Often subadult rescues	Vyas, 2010
3	Kalali village pond, Kalali, Vadodara. (22°15'30.11"N; 73° 9'47.67"E)	0.4 sq km	Wetland Beautification	2021	Population temporarily eliminated, Habitat Loss	8	Vyas, 2010
4	Narmada Dykes, Narmada Dam, Narmada (21° 51.623'N; 73° 43.737'E)	15 sq km	Tourism Development	2019-21	Permanently population eliminated	75	Vyas and Basu, 2008
5	Narmada River, Narmada Dam Down Stream, Narmada (21° 49.877'N; 73° 43.825'E)	7 km long	Tourism Development	2019-21	Permanently population eliminated	12	Vyas and Basu, 2008
6	Chansad Gam Talav, Vadodara (22° 12.505'N; 73° 7.962'E)	1.6 sq km	Wetland Beautification	2020	Habitat Loss	6	Vyas et al., 2020a
7	Pariej Water Reservoir, Sojitra, Anand (22° 32.959'N; 72° 36.984'E)	9 sq km	Wetland Development	2024	Population temporarily eliminated, Habitat Loss	6	Vyas, 2013, Vasava et al., 2015
8	Swamp Pocket of Mahi	0.7 sq km	Agricultural	2024	Population	9	Vyas et al.,

	canals, Nr. Deva, Anand (22° 37.694'N; 72° 44.744'E)		Benefits		temporarily eliminated, Habitat Loss		2024
9	City River Stretch, Vishwamitri, Vadodara (22° 17.638'N; 73° 10.846'E)	25 km long	Flood Mitigation	2025	Population temporarily eliminated, Habitat Loss	442	Sahu et al. ,2025
10	Deva Kans, Nr. Deva, Vaso, Kheda (22° 37.348 ' N; 72° 43.954'E)	1.5 sq km	Agricultural Benefits	2025	Temporary Habitat Loss	14	Vyas et al., 2025
11	Kanewal Water Reservoir, Khambhat, Anand (22° 27.956 ' N; 72° 31.469'E)	18 sq km	Tourism Development	2025	Population temporarily eliminated, Habitat Loss	2	Vyas, 2013

*prior to the project

2. Chhani Gam Talav, Vadodara, is a small village pond similar to the previous one, which was subjected to a drastic makeover by the urban planning authorities under the guise of beautification and neighborhood development. The reason for development was that some areas were used for commercial activities, which led to the construction of a peripheral boundary wall (cement and brick), creating a jogging track and dedicated shops, ultimately resulting in reducing the total area of the waterbody. Previously, the pond was home to a few mugger crocodiles (Vyas, 2010), many turtles from two turtle species—the Ganges softshell turtle and the Indian flapshell turtle (Vyas, 2015)—excluding an invasive species, the Red-eared Slider, *Trachemys scripta elegans* (Vyas, 2019), and supported 22 species of local and migratory birds (Soni and Bhatt, 2008). Now, such a natural, scenic view of the wasteland is lost after the development, in turn replaced by large cement tanks with polluted water, leading to the disappearance of all aquatic reptiles from the waterbody (Figure 3).

3. Kalali village pond, Kalali, Vadodara, is a small village pond near Vadodara city facing similar anthropogenic threats due to the urban authority proposals aiming to beautify and develop. The primary reason for supposedly 'redeveloping' the pond was to accommodate recreational garden spaces along with some commercial activities, resulting in an overall reduction in the volume of the waterbody (Figure 4). The beautification proposal resulted in a brick and concrete embankment built around the waterbody, creating non-submerged areas for a garden, a jogging track, and some shops. Kalali pond is situated close to the Vishwamitri River, within a 300-meter distance, and was once a safe breeding area for mugger crocodiles, with over a dozen adults and subadults inhabiting it. However, today, it only supports the seasonal migration of a few subadult animals between the river and the waterbody.

4. Narmada Dyke, Narmada Dam, Narmada: Dyke 3 of Narmada Dam was among the largest and best habitats of muggers in Gujarat State. In 2019, the state authorities proposed tourism development at the dam site and its surroundings, which included the construction of world's tallest statue, known as the Statue of Unity (SoU), in memory of Sardar Vallabhbhai Patel (*Ironman of India*), along with other tourism facilities (e.g., floating hotel, seaplane). The dam authority took advantage of this ambitious mega-tourist project and decided to eliminate all muggers from the area for the safety of tourists. Therefore, the local forest authority and Sardar Sarovar Narmada Nigam Ltd (SSNNL) trapped 194 muggers of various sizes from Panchmuli Lake (Dyke 3, Narmada Dam), Sardar Sarovar Dam (Narmada Dam), and surrounding areas, and began translocating them to two captive facilities: Indroda Nature Park in Gandhinagar (GEER Foundation) and Pavagadh Rescue Center in Panchmahal (Figure 5). The authorities released the remaining muggers into the backwaters of the dam site and the upper Narmada River. However, the non-scientific approach of the relevant authorities jeopardized the entire translocation operation involving a large number of crocodiles from a specific area (Vyas, 2024a, 2024b).

5. Narmada River, Narmada Dam Downstream, Narmada: The state authorities and SSNNL developed a seven-kilometer stretch of the Narmada River, downstream of the Narmada Dam site, including the Statue of Unity (SoU) complex and national tourist facilities, with involvement from local forest staff. This river stretch was once considered a secret grove and a sacred site for many Narmada devotees and local tribal communities. There was a spot called Laxman Kund, a backwater pool of the river, viewed as an ideal habitat for over two dozen Muggers. Local people believed that Muggers were sacred animals that never attacked devotees because they were

the vehicle of Goddess Narmada (*Maa Namamidevi Narmada*). However, following the development of the SoU complex, the administration removed all the Muggers and transformed the natural habitat along the entire riverbank into tourist facilities.

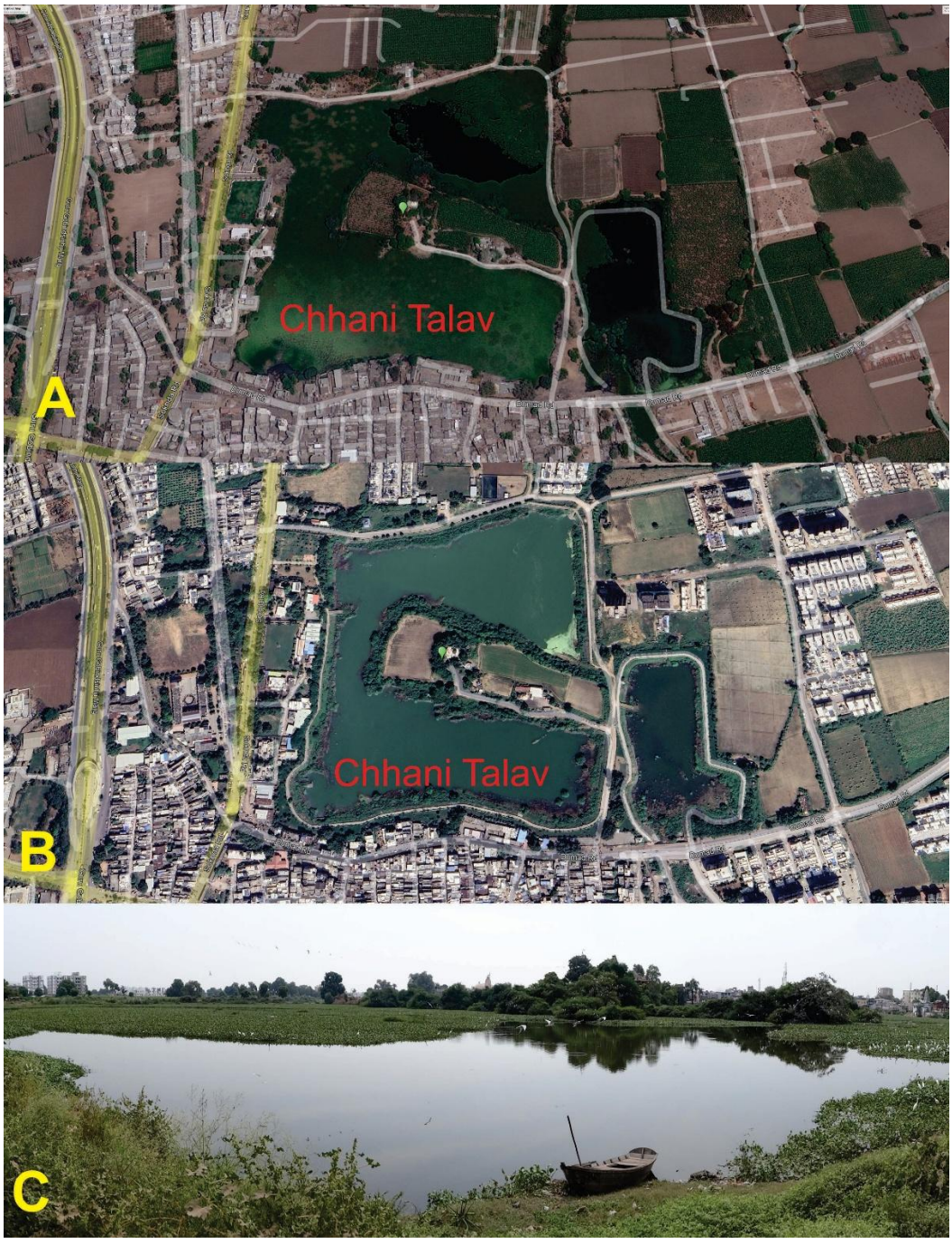

Figure 3: The image depicts the development in Chhani Talav aerial view 2010 (A); the reduction of the total area of the waterbody by the construction of a boundary wall made of cement and brick built around the area to create a garden, a jogging track, and shops (B); natural scenic view prior to development (C).

6. Chansad Gam Talav, Vadodara, is a wetland on the small river streams of the Vishwamitri River near Chansad village. The local temple authority and the village council (*gram panchayat*) developed the site as part of a beautification agenda. The authorities excavated the waterbody to a depth of 10 meters for soil collection and converted the surrounding 0.6 km banks into stepped Ghats (embankment) and fountain gardens for temple tourists. However, this waterbody is one of the best habitats for two native trionychid turtle species and mugger crocodiles, with few females breeding regularly (Vyas et al., 2020a). Presently, the village authority has

developed only 33% area of the wetland (Figure 6), but there is a definite possibility that the remaining area will also be transformed for artificial beautification, eventually losing a majority of its natural habitat. As of now, the waterbody still supports a small breeding population of muggers in the remaining part of the wetland.

Figure 4: Picture of Kalali pond in the early 2000s (A) and after the beautification in 2025 (B). (Photo Credit: Raju Vyas)

Figure 5: The translocated Muggers of Narmada, as kept at Pavagadh rescue center, Halol, Panchmahal, Gujarat. (Photo Credit: Raju Vyas)

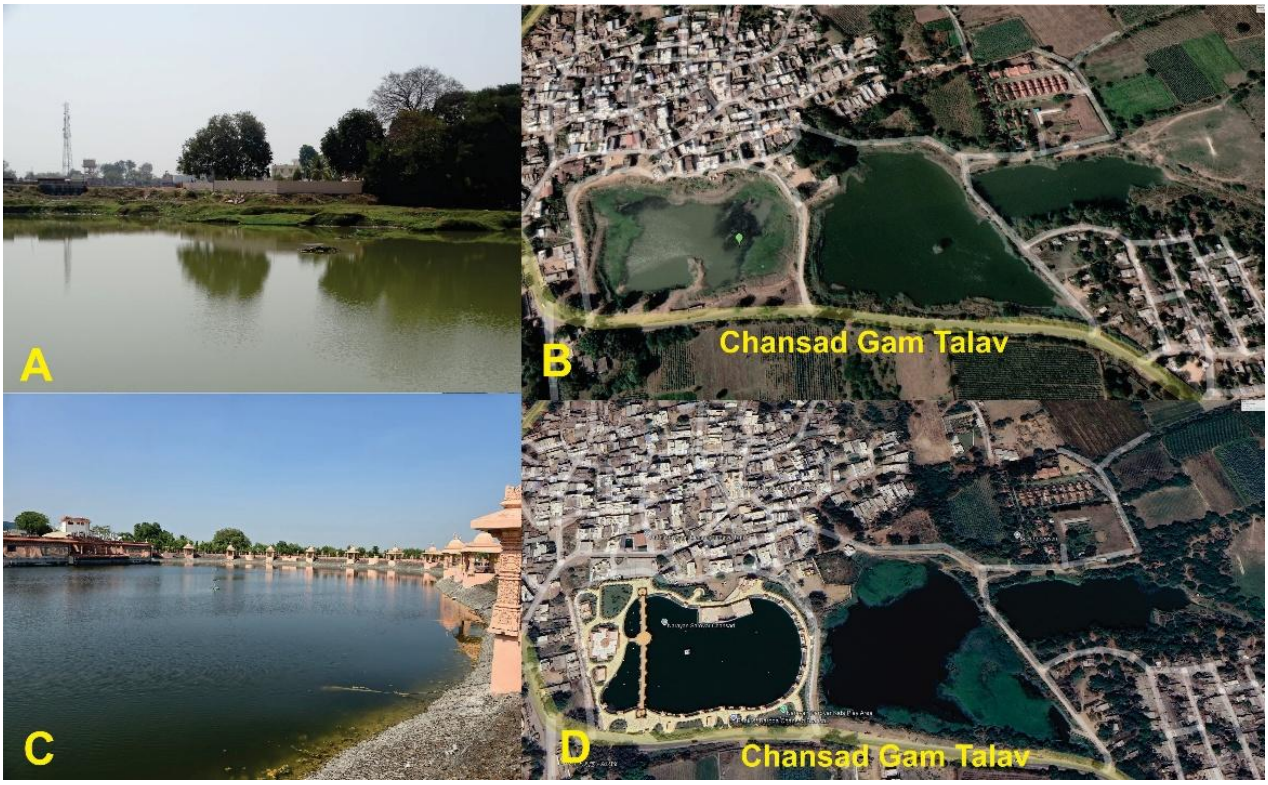

Figure 6: The photographs showing the condition of Chansad Gam Talav prior to development in the year 2020 (A, B), and after development by the construction of a garden and entertainment zone within some part of the waterbody in 2025 (C, D). (Photo Credit: Raju Vyas)

Figure 7: Pariej wetland's surface covered by various hydrophytes providing proper habitat to many wildlife (A), and developed banks with gabion walls (B). (Photo Credit: Raju Vyas)

7. Pariej Wetland, Sojitra, Anand, located in the Matar, Kheda district, is one of the largest constructed water bodies in the region, covering an area of 445 hectares (4.45 sq. km) with a maximum depth of 1.8 meters. The construction of a five-meter-tall earthen embankment transformed the low-lying saline region of Matar tehsil into a reservoir. A sub-minor canal of the Mahi Irrigation Canal System connects to Pariej. The water serves both irrigation and drinking needs. Saline land surrounds the wetland on the east and south, while the other sides border agricultural fields. The wetland teems with aquatic vegetation, with *Typha angustata* forming the

dominant hydrophytes along the edges. The surface of the water body is nearly entirely covered by various hydrophytes (Figure 7), including *Nymphaea* sp., *Nelumbo nucifera*, *Ichthyophthirius cressi*, and *Ipomoea aquatica*. An overgrowth of submerged plants supports multiple wildlife, including 80 species of wintering and migratory waterfowl and birds (Joshi et al., 2018), along with a few aquatic reptiles such as over two dozen mugger crocodiles and three species of freshwater turtles: Ganges softshell turtle, India flapshell turtle, and Indian tent terrapin *Panshura tecta*.

The Water and Irrigation Department of Gujarat began developing the Pariej Wetland in January 2024, claiming the project aimed at redevelopment, beautification, and rejuvenation. They started work without consulting other state forest and environmental agencies or any expert groups. The department deepened the entire wetland's shallow waters through the excavation of earth from reservoirs. Excavators, machines, and bulldozers transformed the wetland's ecology into extensive, dry, empty grounds surrounded by tall Typha vegetation (Tatu, 2024). Most living organisms either disappeared due to loss of habitat or migrated to nearby water bodies, including wetland-dependent local birds. Adding to the severity of habitat loss, the development contractor also cleared the dry tall Typha grass without realizing that these activities directly threatened the local wildlife and ecology. Several animal species were burned alive, including muggers (Figure 8). The full story came to light when observers found several severely burned large marsh crocodiles emerging from the fires (Vyas et al., 2024).

Figure 8: The fire-damaged Typha grass site (A), a half-burnt adult mugger was rescued by volunteers of local NGOs from the fire at the Pariej wetland (B), the victim mugger under treatment (C). (Photo Credit: VNC, Vidyanagar)

8. Swamp Pocket of Mahi Canals, N. Deva, Anand: The Charotar region has an extensive irrigation network, and due to water seepage from the canals, many different-sized swamps have formed in the area. These swamps and Typha reed beds are ideal habitats for many water birds and freshwater reptiles. However, on June 25, 2024, a local farmer set fire to the dried Typha reed beds to destroy the Purple Swamphen (*Porphyrio porphyrio*) habitat and to protect paddy (*Oryza sativa*) crops from bird damage. This swamp and Typha reed habitat was home to over two dozen mugger crocodiles and is a well-known site for breeding and for sightings of three bitterns: Cinnamon Bittern (*Botaurus cinnamomeus*), Yellow Bittern (*Ixobrychus sinensis*), and Black Bittern (*Dupetor flavicollis*). Although no wildlife casualties occurred, and this is a temporary damage to the swamp, the Typha reed has regrown well, and all inhabitants, including mugger crocodiles, have returned. However, I predict that this fire definitely affected the nests of the inhabiting turtles and muggers, because the month of June is the pre-monsoon and nesting season for these reptiles.

9. Vishwamitri River, within Vadodara City: This non-perennial river originates from the Pavagadh hills, flowing east to west between the two large perennial rivers, Mahi and Narmada. River Vishwamitri is known for supporting the Mugger crocodile population and is synonymous with Vadodara city (Vyas, 2024c). In 2024, during the monsoon (Figure 9), Vadodara experienced three

floods within a two-month period (Vyas, 2024d). In response to these floods, the local urban authority, with assistance from the Gujarat government, formed a High-Level Committee (HLC). The HLC recommended both long-term and short-term flood mitigation measures in its report (HLC, 2024). As part of these measures, the urban authorities initiated a project to widen and deepen a 25 km stretch of the Vishwamitri River to prevent future flooding. The State Environmental Impact Assessment Authority approved the project with an exemption from environmental clearance, specifically an exemption for 'Vishwamitri River Flood Mitigation & River Rejuvenation with associated activities from the state forest permission,' incorporating necessary precautions for wildlife as specified by SEAC (SEIAA/GUJ/EC/55/2025 – Jan 21, 2025). The local authority proceeded with the project, and between March 5 and May 30, 2025, 50 bulldozers and 1,000 laborers excavated the entire 25 km of riverbanks on both sides, removed the topsoil to widen the river, and cleared the natural riverine forest habitat (Figure 10).

Figure 9: Vishwamitri flows over a dangerous mark at the Kamnath temple, Vadodara (A), local volunteer rescues a large mugger from the bogging waters of Vishwamitri (B). (Photo Credit: Hemant Vadhvana)

Figure 10: A scenic view of Vishwamitri River with high-rise buildings of Vadodara city (A), several bulldozers, tractors, and trucks collecting soil from the banks (B), work on the Vishwamitri River Project in Vadodara (C), and habitat and burrows of muggers (D).

Figure 11: Images of damage to the mugger nest and eggs at Bhimnath (A), excavated nest of mugger with exposed eggs (B), and a large, badly injured Ganges softshell turtle victimized by bulldozer buckets (C), during the Vishwamitri River Project, at Vadodara.

During the Vishwamitri River flood mitigation and rejuvenation project, the construction activities injured several animals and destroyed about six nests of muggers and turtles (Figure 11). As a result, authorities transferred 88 mugger eggs and 284 turtle eggs to a local zoo for artificial incubation. However, only sixteen mugger eggs (18%) and twenty turtle eggs (7%) hatched successfully, according to zoo officials. Meanwhile, the state forest department sought permission for the temporary translocation of Schedule I (inhabiting animals) to the Union Government. The Union Government approved the temporary translocation of 50 muggers and 100 softshell turtles with necessary precautions and care (F.No.WL-1/13/2025-WL [E 255069] 7 February 2025). Additionally, the state forest department, with help from the GEER Foundation, Gandhinagar, and local volunteers, conducted a two-day survey in February 2025 utilizing citizen science to assess the status of muggers and other wildlife. The survey results released in April 2025, show a total of 442 muggers of all sizes in the river and about a dozen muggers in other waterbodies within the city (Sahu et al., 2025).

10. Deva Kans, Nr. Deva, Vaso, Anand, located near the swamp pocket of Mahi Canals (No.8), is also one of mugger's favorite habitats. A similar fire hazard disturbed the habitat, as farmers lit fires to eliminate the Purple Swamphen habitat and to protect their paddy crops from birds. While the fires caused a temporary disturbance to the swamp's habitat and wildlife, and species eventually returned, the practice raises inevitable concerns. If local farmers continue this practice, it could cause long-term effects in the area.

11. Kanewal Water Reservoir, Khambhat, Anand, is the largest artificial freshwater body in the region, covering 18 sq. km and containing three islands. High earthen banks surround this earthen depression, and excess water from the Mahi irrigation canals fills it. This water body shelters a diverse array of wildlife species, including 77 local and migratory birds (Joshi et al., 2018), as well as some reptiles, such as the Indian rock python (*Python molurus*), three turtle species: the Ganges softshell turtle, the Indian flapshell turtle, the Indian tent terrapin (Vyas, 2023b, 2022), and the mugger. The local district administrator decided to develop this waterbody into a tourism destination which will require rejuvenation and the addition of tourist facilities. In 2024, the project began with draining the waterbody, following which the workers were to reinforce the surrounding earthen banks with gabion walls for stability (Figure 12). The plan outlined how the local authority and the state water irrigation department will focus on wildlife conservation and, with the support of the forest department and local volunteers from an NGO, will also rescue important species, inspired by the episode of Pariej. However, the project resulted in a tragic displacement of several wildlife species, including some rock pythons, numerous turtles, and a half-dozen muggers. The project has caused severe habitat loss, specifically the destruction of nesting banks during certain breeding seasons.

Figure 12: The rejuvenation and development work at Kanewal Water Reservoir, Khambhat, Gujarat, India (Photo Credit: Raju Vyas)

4. DISCUSSION

The recorded habitat disturbance affecting the mugger, along with the documented harm to five reptiles from four families (Table 2), represents only a fraction of the overall problem. The true extent of habitat damage and the actual number of impacted wildlife are likely underestimated, as local authorities, sometimes in coordination with government agencies, have attempted to suppress full disclosure of the situation. Most incidents occurred outside protected areas and near human settlements, except for cases involving Narmada Dykes and the downstream Narmada River near Narmada Dam, which also involved participation by higher authorities.

Table 2: The list of reptile victims and their habitat in Gujarat, India

No	Co. English Name (Scientific name)	Status in IWPA-1972	IUCN Redlist Status (Criteria)	Site Location No.
	Family Crocodylidae			
1	Mugger Crocodile (*Crocodylus palustris*)	Schedule I	Vulnerable (VU A2cd)	All
	Family Geoemydidae			
2	Indian ten terrapin (*Pangshura tecta*)	Schedule I	Vulnerable (VU A4d)	7, 10, 11
	Family Trionychidae			
3	Co. flpshell turtle (*Lissemys punctata*)	Schedule I	Vulnerable (VU A2cd+4cd)	All
4	Ganges softshell turtle (*Nilssonia gangetica*)	Schedule I	Endangered (EN A2d+4d)	All
	Family Pythonidae			
5	Indian rock python (*Python molurus*)	Schedule I	Near Threatened (NT A2d)	7, 11

Vyas et al. (2024a, 2024b) thoroughly discussed the case of the Narmada Dykes and the downstream stream area at the Narmada Dam, but recent news from neighboring Madhya Pradesh reveals a very different approach towards the species. The Chief Minister of Madhya Pradesh released half a dozen sub-adult muggers at Narmada Nagar, Khandwa, MP, and stated that the state government is moving forward with its plan to resettle the crocodiles, who are considered symbols of the sacred river Goddess '*Maa Narmada*', back into their native waters (The Print, 2025). It is noteworthy that within the 300 km long upstream stretch of the Narmada, the situation has favorably changed for the species, in turn also changing the political views towards the species.

The remaining waterbodies at Goya Talav Bakrol, Anand, and the three village water bodies in Vadodara district, including Chhani Gam Talav, Kalali village Pond, and Chansad Gam Talav, are astonishing examples of wetland beautification which clearly resulted in a total loss of biodiversity and aesthetic value, directly caused by urban developers and designers. The construction of vertical or stiff-slope cement and brick walls around water bodies has been carried out without preserving the habitat of aquatic life and its needs, destroying natural bank slopes that served as breeding grounds for invertebrates and vertebrates, such as fish, crustaceans, mollusks, amphibians, and reptiles. Such construction not only harms the biodiversity and ecology of the water bodies but also diminishes ground water absorption, further depleting natural water tables.

The most significant wetlands in Anand District, Pariej Wetland and Kanewal Water Reservoir, are known as the 'Heaven of Birds' in Gujarat because both areas support large populations of migratory waterfowl and local bird species (Parasharya and Jani, 2006). As a result, they are designated as Important Bird Areas (IBAs) in India (Rahmani et al., 2016; KBAP, 2024). These water bodies have been developed and restored primarily without regard for wetland ecology or the wildlife that inhabits them, even though they are designated as IBAs for the nation. The apathetic tendencies of local authorities and some farmers, highlights the neglect and inefficiency of the state's irrigation and forest departments in fulfilling their responsibilities.

The city of Vadodara faced three consecutive floods in 2024, where multiple drivers played a role in exacerbating the flooding events. Soon after, the local urban authority carried out the Vishwamitri River Project between March and May 2025 by widening and deepening a section of the river to meet the flood-mitigation recommendations of the HLC. Somehow, the events raise a direct question: why did the consulting authorities choose to prioritize this specific intervention above the others? The chronological details of actions related to the project are listed here (Table 3). Therefore, unresolved questions remain regarding the specified requirements for the river's width and depth, along with the sequence of events. Nevertheless, the project significantly damaged the river's ecology and habitat, including the habitats of several 'Schedule I' protected reptile species.

Table 3: The chronological details of activities related to Vishwamitri River Project, Vadodara city, Gujarat.

Date	Action / Steps Taken /News	Comments
24 Jul. 2024	Vishwamitri flows over from 7.93 m danger mark	Low-lying areas are flooded in Vadodara city
26 Aug. 2024	Vishwamitri flows over 11.3 meters; it is over 3.4 meters from the danger mark	31.30 cm of rain flows within 16 hours. Low-lying areas of the city were submerged for two days
13 Sep. 2024	Government of Gujarat forms a High-Level Committee (HLC) of Experts for mitigation of floods (UDUHD/ MTN/e-file/18/2024/3155/L-1 Branch-PF1 13.9.24)	Committee members are appointed, including bureaucrats and engineers. Surprisingly, no wildlife or ecology experts, or even forest officers, are appointed to this committee.
25 Sep. 2024	Vishwamitri flows again above the high flood level.	Third flood within 60 days
7 Dec 2024	Vadodara Municipal Commissioner's office applies (VMC/WL /Vishwamitri/396/2024-25, Dt. 07.12.2024 for WLS clearance to Deputy Conservator of Forest/ Chief Wildlife Warden, FD, Gujarat	Urban authority is seeking clearance from the state forest department, even before the HCL report was released, with no knowledge of the current status of muggers in the affected areas.
26 Dec 2024	HCL committee submitted a detailed report and flood mitigation measures suggestions to the government	HCL committee finalized the task within 100 days
21 Jan 2025	Urban authority gets clearance of Vishwamitri River Flood Mitigation & River Rejuvenation with associated activities from MoEF & CC, Government of India (SEAC (SEIAA/GUJ/EC/55/2025 - 21 Jan 2025).	The Ministry of Environment, Forest and Climate Change, Government of India, approved this clearance with some necessary actions and provisions. Authorities surprisingly proceeded without conducting a status report of the inhabiting wildlife.
5th & 6th Feb. 2025	Two days of mugger count event at the river - with help of Forest Department, GEER Foundation, & volunteers	5th & 6th Day + 5th Night mugger counts conducted by citizen science
11 Feb. 2025	PCCF issues the permission for the shifting 50 muggers and 100 turtles (vps/32/b/6987-88/2024-25), if required during the work	Forest department promptly issued the shifting permission for muggers, turtles, and other inhabiting wildlife despite the authority lacking both translocation protocols and appropriate facilities.
5 Mar. 2025	The urban authority starts excavation of river banks in the entire 25 km long river stretch of Vishwamitri	The urban authority launched the river project, promising local crocodile rescuers that the work would not damage any mugger dens and burrows.
16 Mar 2025	Identified 150 mugger burrows on the river banks with the help of local volunteers of NGOs, to save the habitats.	Rescuers marked all burrows with red flag poles on the riverbanks and informed the urban authority and local forest officers not to disturb those demarcated areas.
24 Mar 2025	First, news reports revealed damage to turtle nests and destruction of the identified mugger habitats.	Local volunteers rescue several snakes, turtles, and shift turtle eggs.
22 Apr. 2025	Local pressure group of experts & prominent citizens - Call a 'Round Table Expert Meeting' for saving river habitat and ecology	Brought attention to the damages and suggested measures to the local urban authority and forest department for protecting the river habitat.
26 Apr 2025	Local tabloid published news about destroyed mugger nest and two dozen eggs	No action from forest department - see the permission letter dated
30 Apr 2025	Local tabloid published news about a large Ganges softshell turtle injured by bulldozer drivers at Mangal Pandey Bridge, Vadodara	No action from forest department - see the permission letter dated
Apr. 2025	GEER Foundation releases the mugger count report	442 various sizes of muggers in the city stretch of the river, excluding 11 in different water tanks and

		pounds
15 May 2025	All mugger burrows identified by wildlife enthusiasts destroyed by the urban authority	No action taken by forest department, despite an absolute violation of wildlife protection laws resulting in deliberate habitat destruction of Schedule I species
19 May 2025	Local tabloid published news about 21 mugger eggs found during river bank excavation	Eggs are shifted to the city zoo for artificial incubation.
30 May 2025	The excavation and desilting alongside Vishwamitri ended by the authority.	The project mostly excavated topsoil, plants, trees, in the name of cleaning garbage and sludge
15 Jun 2025	Local tabloid publishes news about 200 old branched palm trees and roots damaged due to the soil excavation	Pointed out by a local botany expert from M.S. University
12 July 2025	At a cost of five million rupees, the Urban Authority began covering both banks with artificial vetiver grass (Chrysopogon sp.) and coir (coconut fiber) mats to prevent soil erosion	On July 29, members of the Human Rights Committee point out to the local urban authority: suggesting a high possibility of soil erosion on the river banks due to 23 lakh sq. feet of soil excavated and 1.70 lakh trees & plant vegetation removed
15 July 2025	The Urban Authority starts tree plantations on both banks to prevent soil erosion	In monsoon, both river banks were largely affected by soil erosion.

Altogether, the project's implications, timing, and approach are highly questionable. A thorough examination of the timeline, including each step taken by the authorities to widen and deepen the 25 km urban stretch of the river (said to prevent future flooding) reveals some gaps. There are still unresolved concerns regarding the rest of the river, particularly in the downstream stretches. The HLC report advised clearing forest cover, trees, and other vegetation from the riverbanks because dense growth can obstruct water flow during flood events (HLC, 2024: page 28). In the same document, the authors also recommended establishing tree strips along selected riverbank sections and requested budget estimates from forest officers for plantation (HLC, 2024: page 153). These recommendations remain highly contentious. In doing so, urban planners and authorities continue to overlook encroachments on waterbodies and riverbanks, and also fail to incorporate lessons learnt from previous flood events (Kumar, 2023). Both the current HLC report (2024) and earlier assessments (Sharma et al., 2004) document extensive encroachment on waterbodies and natural drainage networks (see Sarwate and Raval, 2025). As a result, Vadodara has already lost more than 40 percent of its wetlands (Vyas, 2015).

One of the HCL team members clearly states that, to prevent re-sectioning during upcoming periods, especially during the nesting seasons of crocodiles and turtles, river re-sectioning should be carried out only with the approval of the State Wildlife Board (HCL, 2024: 102 Page). This statement by the team members, along with the measures taken under the Vishwamitri River Project reveals some illogicalities. Here, I emphasize on the fact that the Union Government granted an interim temporary permission for translocation (F.No.WL-1/13/2025-WL [E 255069], February 7, 2025) and specified that the authority may revoke this approval at any time. Despite the conditional permission, the urban authority confidently proceeded with large scale excavation on both riverbanks, a process that caused substantial damage to the riverine ecosystem. The absence of any response from the state forest department underscores a striking and troubling silence.

An older case study, 'Role of ponds & lakes in water crisis management for Vadodara city' (Mujumdar and Nihali, 2006), clearly states that the city has about 23 lakes scattered across various locations. The current condition of these lakes shows that people are not fully utilizing them. The main issue with all the lakes is the absence of constructed embankments. Slum encroachments exist, and in many cases, slum residents dump garbage. Although the water is not suitable for drinking, the residents around these lakes use it for household activities. Many of these lakes pose a greater environmental risk than serving as water sources.

Historically, a well-developed network of storm drains connected most water bodies, collecting and diverting rainwater to the lakes (Sharma et al., 2004). These lakes were once interconnected, eventually channeling water to the River Vishwamitri, which flows through the city. Today, however, haphazard infrastructure development has narrowed or obstructed most natural waterways due to the solid waste dumping, reckless attitude towards nature, and poorly managed wastewater drains. Finally, these problems keep arising because urban planners and authorities grant building permits without regard for nature and the environment.

There is no doubt that the mugger population has risen in the state, and its habitat has further expanded due to the development of irrigation canal networks. The recent estimate of mugger numbers (based on a combination of a habitat viability study and recent survey results) indicated there are over three thousand adult muggers in the state (Table 4), with 40-30% occurring in the protected areas, namely Jambughoda (30-40 individuals), Barda (100-150), Girnar (100-150), and Gir Wildlife Sanctuary and National Park (800-1200 animals). Large numbers of muggers continue to reside near human settlements; frequent conflicts with this aquatic carnivore in central Gujarat also necessitate the implementation of conflict mitigation measures. However, addressing these issues requires a scientific approach and careful planning. Finally, these cases reveal a continuous discrepancy.

Table 4: Year 2025, estimated numbers of Muggers *C. palustris* in each region of Gujarat State, India

Regions	Area	Recorded	Reported
South Gujarat	Tapi + Purna + Water Bodies	75	100-125
Central Gujarat	Narmada+ Vishwamitri + Mahi + Water Bodies	1000	1200-1500
North Gujarat	Sabarmati + Dantiwada Dam + Water Bodies	75	100-125
Saurashtra	Hiran +Singoda + Shentrunji Dam+ Water Bodies	1400	1500-1800
Kutch	Water bodies + Dams	450	600-800
Total	Entire Gujarat State	3000	3500-4350

5. CONCLUSION

Fundamentally, the persistent problem is that the infrastructural and real estate developments, proposed and built by the local urban authorities, always remain anthropocentric and not based on scientific methods. The same applies to various efforts by the state government agencies, especially since mugger crocodiles and other reptiles are highly protected under the India Wildlife Protection Act by the Union government of India. It also shows that responsible higher-level government officials accept the agenda of local politicians and cave in to political dominance without any fairness, strategies, or constitutional obligation. At all times, development must advance in harmony with ecological preservation, not at nature's expense. These cases expose systematic, multi-pronged failures in protecting and managing Schedule I reptile species through unscientific interventions by state authorities and agencies; occurring paradoxically while the nation celebrates fifty years of crocodilian conservation. As a crocodilian biologist and state researcher, I assert that such deviations from scientific protocol and legal protections demand immediate accountability and institutional reform to prevent irreversible damage to India's critically protected herpetofauna.

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Authors contribution

RV: Data collection, literature survey, draft, and finalized the manuscript.

Informed consent

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Conflicts of interests

The authors declare that they have no conflicts of interests, competing financial interests or personal relationships that could have

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Ethical approval & declaration

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Data and materials availability

All data associated with this study are presented in the paper.

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