



Research paper

Wetland Management Quality as a Determinant of Human-Wildlife Conflict Intensity

Evidence from Rajasthan's Wetland Ecosystems

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ARTICLE INFO

Keywords

human-wildlife conflict
wetland management
crop damage
conservation economics
wildlife management

ABSTRACT

Human-wildlife conflict is a major problem for conservation in semi-arid places, especially if wetlands are damaged and animals have to move into farming areas. This research investigates the correlation between the quality of wetland management and the level of human-wildlife conflict in 46 wetlands located in Rajasthan, India. We looked at incidences of crop damage, economic losses, and conflict patterns between species in connection to five management categories, from good to no active management. The results show that wetlands that were well-managed had 96% fewer crop damage events (28 vs. 623 per year) and 96% lower economic losses (₹12.4 vs. ₹289.7 lakhs/year) than wetlands that weren't maintained. Species-specific analysis demonstrated a consistent decrease in conflicts ranging from 79% to 87% across seven significant animal species when the quality of wetland habitats was preserved. An economic analysis showed that investments in integrated wetland management had an 8.3:1 benefit-cost ratio because they reduced conflicts. This saved ₹393.5 lakhs a year compared to an investment of ₹47.5 lakhs. Community opinion surveys indicated that 87% of inhabitants in protected areas supported conservation, despite encountering some conflict. Additionally, targeted interventions in high-conflict interface zones (2-5 km from wetlands) were crucial for sustaining social tolerance. These results show that protecting wetlands is a good way to reduce conflict that is also good for the economy and the community. It also helps conserve biodiversity and rural livelihoods.



DOI

[10.5281/ib-2270326](https://doi.org/10.5281/ib-2270326)

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1. Introduction

Human-wildlife conflict has become a significant concern in modern conservation biology, jeopardising biodiversity and rural livelihoods in underdeveloped countries (Dickman, 2010; Nyhus, 2016). In semi-arid places, where natural resources are few, rivalry between people and animals is high, and conflict frequently becomes so bad that it hurts conservation efforts and makes life harder for farmers (Madhusudan, 2003; Ogra & Badola, 2008). The Indian subcontinent, characterised by high human

population densities and diverse wildlife assemblages, faces significant human-wildlife conflict, resulting in annual economic losses estimated in billions of rupees and periodic human fatalities that foster considerable opposition to wildlife conservation (Karanth et al., 2013; Nyhus et al., 2005).

Rajasthan, the biggest state in India, is a good example of these problems since it has a unique mix of water shortage, agricultural dependency, and high animal populations (Johnsingh et al., 2004). The state's wetlands make up less than 1% of the total

land area, but they are very important for resident and migratory animal populations, including big herbivores, predators, and globally important waterbird groups (Vijayan, 1991; Kumar et al., 2005). But these wetlands are under more stress than ever before because of farming growth, water extraction, invasive species colonisation, and climate change (Prasad et al., 2002; Kingsford & Basset, 2012). As wetland ecosystems degrade, animal populations progressively encroach into agricultural landscapes in pursuit of water, fodder, and shelter, resulting in conflict with farming communities reliant on crop production for sustenance and livelihoods (Sukumar, 1991; Woodroffe et al., 2005).

Prior studies have shown significant relationships between habitat degradation and the severity of human-wildlife conflict across many ecosystems (Treves & Karanth, 2003; Sitati et al., 2003). Research in Africa indicates that elephant crop-raiding escalates significantly when the quality of natural habitats deteriorates (Hoare, 1999; Sitati & Walpole, 2006). Similarly, studies in Asia reveal analogous trends across several species, including primates and ungulates (Hill, 2000; Linkie et al., 2007). Nonetheless, the majority of current research is on forest ecosystems, whereas the interplay between wetlands and conflict has garnered relatively little attention, despite wetlands' critical significance for animal populations in arid locations (Junk et al., 2006; Davidson, 2014).

Moreover, whereas many research record patterns of conflict, only a limited number investigate the impact of active management interventions on conflict dynamics or evaluate the economic feasibility of management-oriented conflict mitigation techniques (Barua et al., 2013; van Eeden et al., 2018). This lack of information makes it harder for conservationists to use strong economic arguments that decision-makers would understand to push for wetland preservation (Naidoo et al., 2006; Sutherland et al., 2004).

This research investigates the correlations between wetland management quality and human-wildlife conflict throughout the varied wetland ecosystems of Rajasthan, therefore addressing existing deficiencies. We examine three principal hypotheses: (1) the quality of wetland management is inversely related to the intensity of human-wildlife conflict, (2) species-specific conflict patterns consistently respond to habitat management across taxonomic groups, and (3) investments in wetland management yield positive economic returns by mitigating conflict. We also look at how people in the community feel and how tolerant they are to find social elements that affect conservation success. Our results provide essential evidence for wetland conservation programs and illustrate scalable conflict

reduction measures relevant to semi-arid locations worldwide.

2. Methodology

2.1 Study Area

This study was carried out in 46 wetlands located in Rajasthan, India (23°3' to 30°12' N and 69°30' to 78°17' E), covering almost 342,000 km² of mostly semi-arid terrain. Rajasthan has very harsh weather. The western desert gets 100 mm of rain per year, while the southeastern portions get 650 mm. In the winter, the temperature drops below 0°C, while in the summer, it rises beyond 50°C (Maji et al., 2010). The selected wetlands represent diverse management contexts, from formally protected sites under active conservation programs to completely unmanaged systems, with total wetland area surveyed exceeding 33,800 hectares adjacent to approximately 33,800 hectares of agricultural land.

Stratified random sampling was used to choose the study wetlands so that there would be a good mix of management categories, geographic locations, size classes, and wetland forms, such as natural depressions, seasonal water bodies, manmade reservoirs, and riverine wetlands (Cowardin et al., 1979). The selection criteria called for wetlands to be at least 50 hectares in size, have agricultural land within 5 km, and have at least three years of conflict data from forest department records or community surveys.

2.2 Management Quality Classification

A composite scoring method that included several ecological and administrative factors was used to rate the quality of wetland management. Each wetland was given scores (0–100) on ten different things: the amount and quality of water, the amount and variety of plants, the amount of prey (for carnivore habitat), the control of invasive species, the marking and enforcement of boundaries, habitat restoration activities, the regulation of human disturbance, the implementation of a monitoring program, community engagement initiatives, and the allocation of financial resources (Finlayson & van der Valk, 1995; Mitsch & Gosselink, 2015).

Based on composite scores, wetlands were categorized into five management classes: Excellent Management (≥ 80 points, $n=4$), Good Management (60–79 points, $n=9$), Moderate Management (40–59 points, $n=14$), Poor Management (20–39 points, $n=11$), and No Active Management (< 20 points, $n=8$). Classification was validated through independent expert assessment by wildlife biologists and wetland ecologists familiar with study sites (Cronbach's $\alpha = 0.89$).

2.3 Conflict Data Collection

Data on human-wildlife conflict were gathered from several different places to make sure they were complete and accurate. The main sources of data were: (1) official records from the forest department showing claims for crop damage, livestock predation, property damage, and human injury or death from 2019 to 2023; (2) structured surveys of 1,247 farming households near the study wetlands; (3) participatory rural appraisal sessions with 89 village communities; and (4) key informant interviews with 156 local leaders, farmers, and forest guards (Chambers, 1994; White & Runge, 1995).

We put conflict events into groups based on the kind of conflict, the species involved, the time of day, the location, and the economic consequence. Crop damage assessment adhered to standardised standards that estimated the impacted area, crop type, damage severity, and the market worth of the losses (Mackenzie & Ahabyona, 2012). Examination of carcasses, identification of pugmarks, and witness statements corroborated occurrences of livestock predation. Economic values included the costs of replacing animals, the costs of repairing property, and the costs of medical care and funerals for those who died, all of which were adjusted for local market circumstances (Thirgood et al., 2005).

2.4 Wildlife Population Assessment

Wildlife populations were assessed with approaches suitable for each species. The number of large mammals was assessed using transect sampling, pugmark identification, camera trapping (1,200 trap-nights), and dung count surveys in accordance with recognised methods (Karanth & Nichols, 1998; Plumptre, 2000). Waterbird populations were evaluated using seasonal point counts, extensive wetland surveys during migration, and roost counts for congregatory species (Bibby et al., 2000). The quantity of small mammals was assessed using live-trapping programs and burrow counts as indications of the prey basis for predator populations.

2.5 Economic Analysis

The economic study used benefit-cost assessment to compare expenditures in management interventions with the advantages of conflict reduction (Boardman et al., 2006). Management costs including infrastructure building (check dams, fences, water harvesting structures), labour expenditures, vegetation restoration programs, monitoring operations, and community participation efforts. Benefits were assessed as mitigated losses from diminished conflict, appraised by conservative market-oriented methodologies. The analysis used five-year projection periods with an 8% discount rate

suitable for Indian rural development settings (Government of India Planning Commission, 2011).

2.6 Community Perception Survey

Structured surveys were given to 1,247 households to find out how people in the community felt and how tolerant they were. The households were divided into groups based on how far they were from wetlands: within protected areas (0–2 km, n=287), adjacent communities (2–5 km, n=394), nearby villages (5–10 km, n=312), distant communities (10–20 km, n=176), and control communities beyond 20 km (n=78). Using standardised indices, survey tools examined support for conservation, tolerance for animals, experiences with conflict, perceived costs and benefits of wetlands, and willingness to take part in management activities (Kaltenborn et al., 2006; Manfredo, 2008). The wildlife tolerance index (on a scale from 0 to 10) included answers from several situations where wildlife was present, caused little harm, and was willing to cohabit.

2.7 Statistical Analysis

Statistical investigations used generalised linear models to investigate the associations between management quality and conflict variables, while adjusting for wetland size, agricultural area, human population density, and regional characteristics. Species-specific studies used mixed-effects models using wetland as a random factor. Data on community perception were analysed by ordinal logistic regression for categorical outcomes and linear regression for continuous tolerance metrics. The conflict intensity index was computed as a composite metric that normalises incident frequency, economic effect, and the percentage of impacted households. All analyses were conducted using R statistical software version 4.0.3, with a significance threshold of $\alpha = 0.05$ (R Core Team, 2020).

3. Results

An examination of crop damage patterns in 46 wetlands shown significant correlations between management quality and the amount of human-wildlife conflict (Table 1). Well-managed wetlands (n=4) covering 3,200 hectares of contiguous agricultural land encountered little conflict, with just 28 ± 8 annual crop damage occurrences leading to economic losses of ₹12.4 \pm 3.7 lakhs per annum and a conflict intensity index of 2.1. These effectively managed sites preserved sufficient habitat quality, food resources, and water availability within protected boundaries, significantly diminishing wildlife incentives to enter agricultural zones through thorough management practices such as vegetative buffer zones, alternative food provision during critical

periods, consistent water level management supporting aquatic vegetation and invertebrate populations, and strategic installation of check dams and water retention structures.

Table 1 Crop Damage Incidents in Relation to Wetland Management Quality

Management Category	Number of Wetlands	Adjacent Agricultural Area (ha)	Annual Crop Damage Incidents	Crop Loss Value (₹ Lakhs/year)	Conflict Intensity Index
Excellent Management	4	3,200	28 ± 8	12.4 ± 3.7	2.1
Good Management	9	6,800	94 ± 21	38.7 ± 9.2	4.8
Moderate Management	14	10,500	287 ± 56	124.6 ± 28.4	8.7
Poor Management	11	7,900	476 ± 89	218.3 ± 47.6	14.3
No Active Management	8	5,400	623 ± 112	289.7 ± 61.8	18.9

The rising level of conflict across management categories shows that wetland degradation is pushing animals into agricultural areas in search of food and other resources. Wetlands that weren't actively managed had the most conflicts, with 623 ± 112 incidents per year, ₹289.7 ± 61.8 lakhs in economic losses, and a conflict intensity index of 18.9. This is more than 22 times the number of incidents and 23 times the amount of economic damage that occurred in wetlands that were well managed. This terrible increase is due to the destruction of habitats, the loss of natural food supplies, and the lack of water, which forces animals, especially herbivorous mammals and birds, to depend primarily on crops grown by humans.

Statistical analysis showed a strong negative correlation ($r = -0.91$, $p < 0.001$) between management quality scores and conflict intensity. For every 10-point increase in management score, there

was an 18.3% decrease in conflict incidents, even when controlling for wetland size, agricultural area, and regional factors. The data demonstrate that every unit improvement in wetland management quality yields proportional reductions in human-wildlife conflict, establishing wetland conservation as an effective conflict mitigation strategy providing dual benefits of biodiversity conservation and rural livelihood protection.

Species-specific conflict study of seven significant animal species demonstrated surprisingly uniform conflict reduction responses to good wetland management, with reductions ranging from 79.4% to 86.5% across several taxonomic groupings and conflict types (Table 2). This consistency indicates that habitat-based conflict reduction works efficiently across species exhibiting diverse ecological needs and behavioural characteristics.

Table 2 Species-Specific Conflict Patterns and Wetland Habitat Quality

Species	Primary Conflict Type	Well-Managed Wetlands (incidents/year)	Poorly Managed Wetlands (incidents/year)	Conflict Reduction with Management
Nilgai	Crop raiding	12 ± 4	89 ± 18	86.5%
Wild Boar	Crop damage, property damage	18 ± 6	127 ± 24	85.8%
Blackbuck	Crop grazing	8 ± 3	47 ± 11	83.0%
Indian Wolf	Livestock predation	3 ± 1	21 ± 6	85.7%
Jackal	Livestock predation, poultry	7 ± 2	34 ± 9	79.4%
Bar-headed Goose	Crop grazing (winter)	14 ± 5	76 ± 16	81.6%
Common Crane	Crop damage (wetland margins)	9 ± 3	58 ± 13	84.5%

The Nilgai, the biggest antelope species in Rajasthan, had the highest absolute levels of conflict while simultaneously showing the most significant response to management measures, with incidences decreasing from 89 annually in poorly managed wetlands to only 12 in well-managed areas, indicating an 86.5% drop. This significant enhancement illustrates the nilgai's reliance on wetland resources for hydration, forage, and refuge during warm periods. When these resources are properly preserved inside protected wetland regions, nilgai populations mostly inhabit natural environments instead of pursuing agricultural resources.

Conflicts with wild boars decreased by 85.8% due to effective management, illustrating the

opportunistic foraging behaviour of this omnivorous species, which transitions from agricultural regions to natural wetland habitats when sufficient food items, such as tubers, aquatic plants, and invertebrates, are present. The significant decrease in conflict for carnivores, such as the Indian wolf (85.7%) and jackal (79.4%), indicates that well managed wetlands bolster prey numbers, hence alleviating predator pressure on cattle. Healthy wetland environments sustain populations of small animals, birds, and other natural prey species that fulfil carnivorous nutritional needs without requiring cattle predation.

The substantial decrease in conflict for migrating water birds, such as the bar-headed geese (81.6%) and common crane (84.5%), underscores the need of

preserving wetland habitat quality during wintering seasons when these species aggregate in great numbers. Effectively maintained wetlands provide enough natural feed, reducing the birds' need on farmed products. The results indicate that wetland management serves as an efficient, non-lethal technique for mitigating conflicts by addressing the underlying causes of human-wildlife interactions via the preservation of natural resources in protected areas.

The economic analysis of wetland management interventions demonstrated that all evaluated techniques provide significant positive returns by mitigating human-wildlife conflicts, hence offering robust economic rationale for conservation initiatives (Table 3). The benefit-cost ratios of 7.0:1 to 10.4:1 for individual treatments, and 8.3:1 for combined methods, indicate that wetland management is an economically viable investment that promotes both conservation and rural development goals.

Table 3 Economic Analysis of Wetland Management Investment vs Conflict Costs

Management Intervention	Annual Investment (₹ Lakhs)	Conflict Reduction (%)	Annual Savings from Reduced Conflict (₹ Lakhs)	Net Benefit (₹ Lakhs)	Benefit-Cost Ratio
Water level management	8.5	34%	78.2	69.7	9.2:1
Vegetation restoration	12.3	42%	96.7	84.4	7.9:1
Buffer zone creation	15.7	48%	110.5	94.8	7.0:1
Alternative water sources	6.8	28%	64.4	57.6	9.5:1
Community engagement	4.2	19%	43.7	39.5	10.4:1
Integrated management	47.5	83%	393.5	346.0	8.3:1

Community engagement programs yielded the most favourable benefit-cost ratio (10.4:1) while achieving a moderate reduction in conflict (19%). These cost-effective interventions (₹4.2 lakhs annually) foster local stewardship, enhance tolerance for wildlife, and augment the efficacy of other management strategies through participatory methods. The supply of alternative water sources attained a remarkable benefit-cost ratio of 9.5:1, underscoring the significant role of water shortage as a catalyst for conflict in Rajasthan's desert landscape. Modest expenditures in check dams, water collecting systems, and livestock water stations significantly reduce animal encroachment into anthropogenic settings.

Vegetation restoration necessitates a significant investment of ₹12.3 lakhs, although it results in notable conflict reduction of 42% and robust economic returns of 7.9:1 by supplying natural feeding, cover, and nesting supplies that fulfil animal biological needs within wetland confines. The establishment of a buffer zone constituted the most substantial single-intervention expenditure (₹15.7 lakhs) and achieved the most significant independent reduction in conflict (48%), yielding a favourable return of 7.0:1. It served as a spatial barrier,

delineating wildlife core habitats from agricultural zones while offering transitional habitat.

The comprehensive management strategy, including all interventions at a total expenditure of ₹47.5 lakhs, accomplished a significant decrease in conflict (83%) and yielded yearly savings of ₹393.5 lakhs by mitigating crop damage, animal losses, property damage, and human injuries. The 8.3:1 benefit-cost ratio indicates that comprehensive wetland management is an economically viable investment that simultaneously promotes conservation aims and rural development goals. These results could guide policy choices about wetland conservation financing, illustrating that conservation expenditures provide quantifiable economic benefits while providing ecological services, safeguarding biodiversity, and improving rural lives. An investigation of community perceptions revealed intricate correlations among proximity to wetlands, experiences of conflict, and support for conservation, which guide successful management techniques (Table 4). These patterns illustrate that the efficacy of wetland protection is fundamentally contingent upon understanding and correcting regional disparities in community attitudes and experiences.

Table 4 Community Perceptions and Tolerance Levels

Community Category	Distance from Wetland (km)	Support for Conservation (%)	Wildlife Tolerance Index	Conflict Experience (incidents/household /year)	Willingness to Participate in Management
Within protected area	0-2	87%	8.4	0.8	92%
Adjacent communities	2-5	64%	6.2	2.4	71%
Nearby villages	5-10	48%	4.7	4.1	53%
Distant communities	10-20	73%	5.9	1.2	44%
Control (no wetland)	>20	41%	3.8	0.3	28%

Communities living in protected areas exhibited the greatest conservation support (87%) and wildlife tolerance (8.4), despite encountering some conflict (0.8 incidents per household per year). This indicates that ongoing engagement, conservation education, benefit-sharing mechanisms, and participatory management effectively foster positive conservation attitudes, even among populations facing challenges of human-wildlife coexistence. These communities acknowledge wetland ecological services such as water supply, livelihood resources, cultural significance, and ecotourism prospects that mitigate conflict expenses. The very high desire to engage in management (92%) indicates a robust conservation ethic and an awareness that active involvement allows for the formulation of management plans that meet community issues.

Proximate communities (2-5 km) encountered the highest levels of conflict (2.4 incidents per household per year), leading to a moderate decline in conservation support (64%) and tolerance (6.2), underscoring the urgent necessity for focused conflict mitigation in these interface areas where human-wildlife interactions are most pronounced. Adjacent communities (5-10 km) exhibited the least conservation support (48%) and tolerance (4.7), although encountering moderate conflict levels (4.1 occurrences per family per year), thus indicating a notion of enduring conflict costs without obtaining compensating benefits from wetlands.

Distant communities (10-20 km) exhibited more conservation support (73%) compared to neighbouring villages, although encountering some disagreement. This phenomenon may be attributed to the psychological buffer afforded by distance, which facilitates an awareness of wetland assets. Control communities devoid of wetland exposure had the lowest levels of support (41%) and tolerance (3.8), so affirming that the presence of well-managed wetlands may augment rather than undermine community conservation views. These results highlight the need of tailored engagement techniques according to proximity, focused conflict resolution in high-conflict areas, and benefit-sharing frameworks that guarantee populations facing coexisting difficulties also get substantial wetland advantages.

4. Discussion

This research presents substantial evidence that the quality of wetland management serves as a principal factor influencing the degree of human-wildlife conflict in semi-arid areas. The 22-fold disparity in conflict occurrences between well-managed and uncontrolled wetlands illustrates that habitat conservation serves not just as a biodiversity preservation strategy but also as a pragmatic and efficacious means of mitigating human-wildlife conflict. This observation is consistent with theoretical expectations from optimum foraging theory, which posits that animals preferentially use environments that provide the highest resource accessibility in relation to energy expenditure and predation risk (MacArthur & Pianka, 1966; Stephens & Krebs, 1986). When wetlands have enough water, food, and shelter, animal populations may meet their biological needs in protected regions. This makes them less likely to go into risky agricultural areas.

The steady rise in conflict intensity throughout management categories shows a threshold effect, where modest habitat degradation leads to faster conflict escalation. This trend indicates that wetland conservation initiatives must sustain management quality beyond essential levels to achieve significant conflict reduction, rather than acquiescing to moderate degradation as a tolerable compromise. The result is in accordance with ecological threshold theory, which shows that ecosystem degradation typically has non-linear dynamics and rapid changes between different stable states (Scheffer et al., 2001; Folke et al., 2004).

Our findings expand upon prior studies that examined habitat quality-conflict interactions in forest ecosystems by applying them to wetland environments, therefore filling a critical knowledge need, particularly considering wetlands' vital significance for animals in arid areas (Sitati et al., 2003; Hoare, 1999). Our research shows that habitat-based conflict mitigation principles work across many different types of species, including large herbivores, carnivores, and migratory waterbirds. This is different from forest-based studies that only look at elephants or primates raiding crops.

The extremely consistent conflict reduction (79-87%) across seven species with different ecological needs shows that efficient wetland management

tackles basic limiting factors impacting numerous species concurrently. For herbivorous species such as nilgai, blackbuck, wild boar, and migrating waterbirds, sustaining sufficient water and plant resources in wetlands mitigates the principal incentives for agricultural land use. The remarkable 86.5% drop in nilgai conflict shows how important it is to have enough water in semi-arid Rajasthan, where this large-bodied antelope needs a lot of water every day (Jhala, 1997). In the summer, when natural water sources dry up, nilgai populations gather around the remaining bodies of water. If these are not available or are damaged, the animals spread out into agricultural areas in search of water and tasty plants.

For carnivorous species such as the Indian wolf and jackal, methods for reducing conflict work indirectly by increasing the number of prey animals. Well-maintained wetlands provide strong populations of small mammals, birds, and reptiles that these predators can eat (Jhala, 1993; Macdonald, 1983). When there is enough natural food for carnivores to fulfil their energy needs, they eat a lot less cattle. This finding supports the "alternative prey hypothesis" suggesting that carnivore-livestock conflict intensity inversely correlates with wild prey availability (Meriggi & Lovari, 1996; Palmeira et al., 2008).

The substantial decrease in conflict among migratory waterbirds (bar-headed geese 81.6%, common crane 84.5%) during wintering seasons illustrates the need for habitat management to account for seasonal population dynamics and resource needs. During migration, waterbird groups need a lot of food. When wetlands have enough natural food in the form of aquatic plants and invertebrates, farmers use far less of their crops (Fox et al., 2005). This discovery is especially relevant for conservation since the wetlands in Rajasthan are home to globally important populations of waterbirds that are protected by treaties like Ramsar and other bilateral migratory bird agreements (Vijayan, 1991).

The good benefit-cost ratios for all management measures show that wetland conservation is economically sound, which might affect policy choices and how money is spent. The 8.3:1 return on integrated management approaches shows that wetland conservation has clear economic benefits just by reducing conflict. This doesn't even include other ecosystem services like cleaning water, recharging groundwater, storing carbon, supporting fisheries, and providing recreational opportunities (Costanza et al., 1997; Mitsch & Gosselink, 2015).

The discovery that inexpensive community involvement initiatives provide the most favourable benefit-cost ratios (10.4:1) with a modest expenditure (₹4.2 lakhs) indicates that social interventions serve as highly effective solutions for conflict resolution. This is in line with the rising understanding that effective conservation has to include human factors

like attitudes, tolerance, and engagement, not only biological or technological solutions (Bennett et al., 2017; Redpath et al., 2013). Community involvement fosters local stewardship, makes people more likely to follow conservation rules, makes it easier to share information on animal movements and conflict occurrences, and produces social capital that helps long-term conservation goals.

The large returns from providing water (9.5:1) show that water shortage is the main cause of conflict in semi-arid Rajasthan. This study indicates that simple, cost-effective measures to establish alternate water sources may significantly mitigate conflict by tackling essential resource constraints. Check dams, water collecting structures and livestock water points need a little amount of money to build, but they have big advantages since they cut down on rivalry between people and animals for limited water supplies (Agrawal & Narain, 1997).

Even though the cost of creating a buffer zone is the highest for a single intervention (₹15.7 lakhs), it has the best return on investment (7.0:1) and reduces conflict by 48%. Buffer zones serve as geographical barriers that minimise interactions between wildlife and humans, while also offering transitional habitats that maintain animal populations without direct competition from agriculture (Newmark et al., 1994; Hansen & DeFries, 2007). The economic feasibility of buffer zones indicates that landscape-scale design, which includes geographical separation between essential animal habitats and intense agricultural zones, is a prudent investment for places susceptible to conflict.

These economic results should help the government decide how to spend money on wetland protection. People frequently say that current conservation expenditures are unfairly high costs that come in the way of development goals (Balmford & Whitten, 2003). Our findings indicate that wetland protection yields quantifiable economic benefits that surpass investments, reinforcing the notion that conservation and development are complementary rather than conflicting goals. Policy makers may justify wetland protection expenditures by showing how they reduce conflict while also helping to maintain biodiversity, meet international treaty responsibilities, and safeguard important ecosystem services.

The intricate interplay of wetland proximity, conflict experience, and conservation attitudes elucidates essential insights for socially sustainable conservation. The discovery that communities in protected areas exhibit the strongest conservation support (87%) while facing some conflict undermines the oversimplified notion that conflict always diminishes conservation views. The findings indicate that when communities derive tangible benefits from wetlands, such as access to water, livelihood

resources, and involvement in management decisions, they cultivate positive conservation attitudes that endure moderate levels of conflict (Infield & Namara, 2001; Baral & Heinen, 2007).

The identification of neighbouring communities (2-5 km) as having the most conflict (2.4 incidents/household/year) with less tolerance underscores the need for prioritisation of these interface zones. This trend corresponds with edge effect theory, which posits that wildlife-human interactions are concentrated along habitat edges where species ranges intersect with human activities (Woodroffe & Ginsberg, 1998). To keep people's attitudes from becoming worse, which might hurt support for conservation as a whole, conservation plans must focus on these high-conflict areas with strong mitigation measures, compensation programs, and benefit-sharing systems.

The relatively low conservation support among adjacent villages (5-10 km, 48%) despite moderate conflict levels reflects a "costs without benefits" view, where populations feel the effects of animals without getting any benefits from the existence of wetlands. This study underscores the need of expanding benefit-sharing initiatives beyond the confines of local protected area borders to include a wider range of impacted communities. Mechanisms might include employment in conservation initiatives, rights to resource extraction for non-timber products, income sharing from ecotourism, and preferential access to alternative livelihood programs (Rao et al., 2002).

The positive link between support for conservation and readiness to participate shows that giving communities meaningful ways to become involved in conservation makes them more likely to care about the results. Communities may go from being against conservation to being active stewards if they use participatory management methods that really take into account local knowledge, priorities, and decision-making power (Berkes, 2004; Pretty, 2003). The 92% desire to participate among communities in protected areas shows that people may form very strong relationships when they see conservation as being in their best interest.

5. Conclusion

This comprehensive study across 46 wetlands in Rajasthan demonstrates that wetland management quality serves as a critical determinant of human-wildlife conflict intensity in semi-arid landscapes. The information provided demonstrates three significant conclusions that enhance both conservation research and effective wildlife management. There is a high negative correlation between the quality of wetland management and the degree of conflict. For example, well-managed wetlands have 96% fewer crop damage occurrences and economic losses than uncontrolled wetlands. This big drop backs up our main premise

and shows that protecting habitats is a good, non-lethal way to reduce conflict that gets to the source of the problem instead of just addressing the symptoms. The impressive consistency of conflict reduction (79-87%) across seven species from different taxonomic groupings and ecological guilds shows that habitat-based mitigation measures work well with a wide range of animals. This study indicates that wetland management tackles essential resource constraints impacting several species concurrently, rather than necessitating species-specific measures. The efficacy encompasses huge herbivores in search of water and pasture, predators necessitating sufficient prey populations, and migrating waterbirds reliant on seasonal supplies, illustrating the all-encompassing character of habitat-based methodologies. The proven positive economic returns, with integrated management yielding 8.3:1 benefit-cost ratios, position wetland conservation as a financially sound investment rather than a fiscal liability. These results provide conservation proponents with persuasive economic rationale to endorse policy suggestions and financial distributions, illustrating that conservation and rural development are synergistic goals rather than conflicting ones. In addition to these main results, studies of how people in the community see things show how important spatial targeting and social interaction are. The fact that interface zones (2-5 km from wetlands) have the most conflict but still get moderate support for conservation shows that we need to put strategic interventions in place and share benefits in a way that makes sure affected communities get real benefits from wetland conservation. Even when there is disagreement, 87% of people in protected areas favour conservation. This shows that participatory management and benefit sharing may create positive attitudes that can handle barriers to cohabitation. These findings carry significant implications for conservation policy and practice. In semi-arid areas, protecting wetlands should be a top priority. This is not only good for biodiversity, but it is also a practical way to reduce conflict that has clear economic and social advantages. Conservation initiatives need to use integrated strategies that amalgamate habitat management, community involvement, and focused interventions in areas of significant conflict. Policymakers need to acknowledge wetland conservation investments as fiscally prudent expenditures that provide returns via conflict mitigation, ecological service delivery, and rural livelihood improvement. The research indicates that successful conservation requires transcending protected area borders to tackle landscape-scale dynamics, including human-wildlife interactions, community views, and socioeconomic circumstances. To be successful, you need to work with local communities, make sure that everyone gets a fair

share of the benefits, and provide people real chances to take part in management decisions. Wetland conservation provides scalable solutions for semi-arid areas worldwide that are dealing with the same problems of water shortages, increased farming, and conflicts between people and animals. As climate change makes competition for resources more intense and habitat loss happens faster, it will become even more important to keep wetland ecosystems healthy. This study offers an evidence-based framework for policies and initiatives that concurrently safeguard biodiversity, improve rural livelihoods, and develop resilient social-ecological systems that can sustain both human and animal populations. To go ahead, we need to keep working on wetland conservation, make sure there is enough money for management interventions, build stronger collaborations with communities, and adapt management to changing circumstances. Society may make smart choices that help both conservation and development goals by seeing wetlands as important infrastructure that provides many functions, such as reducing conflict, protecting biodiversity, ensuring water security, and supporting livelihoods. This research shows that wetlands may be important for long-term cohabitation between people and animals in areas where water is hard to get provided they are managed properly.

6. Limitations and Future Research

There are a few things to keep in mind while looking at these results. First, the observational research approach, while yielding significant real-world insights, cannot conclusively determine causality despite robust correlations. Experimental manipulations that systematically modify management interventions might enhance causal inference but encounter practical and ethical limitations in applied conservation scenarios. Future investigations may use quasi-experimental methodologies to compare conflict trends before to and subsequent to management actions in designated locations.

Second, our economic study mainly looks at the direct market benefits of reducing conflict by preventing agricultural losses and livestock predation. A more thorough economic evaluation would include non-market benefits including lower risks of injury and death, the psychological costs of living in a war zone, the value of ecological services, and the indirect economic impacts of tourism and regional development. A longer benefit-cost analysis that takes into account these larger values would probably show that protecting wetlands is even better for the economy.

Third, the five-year research period, while significant, may not include long-term dynamics such as the effects of climate change, population

transitions, and the evolution of agricultural techniques. Long-term monitoring programs that look at conflict patterns over many decades would help us see how things change over time and let us respond to changing situations in a flexible way (Lindenmayer & Likens, 2010).

Fourth, our species-specific studies concentrated on seven principal conflict species and did not thoroughly evaluate the whole wildlife community reactions to management measures. Future study investigating comprehensive biodiversity responses, including small mammals, herpetofauna, and invertebrates, would provide a more thorough knowledge of the ecological implications of wetland management.

Finally, our research focused on the wetlands of Rajasthan within a particular semi-arid framework. Generalisation to other areas, wetland types, and climatic circumstances need confirmation via comparative research conducted in varied geographic contexts. Investigations that expand these studies to tropical, temperate, and other semi-arid areas would validate the wider relevance of our results.

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