HOW DOES THE SENSORY LANDSCAPE OF URBAN-ADJACENT FOREST PATCHES IN INDIA AFFECT THE COMMUNICATION AND STRESS LEVEL OF ELEPHANT HERDS?

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ABSTRACT

Urban-adjacent forest patches significantly disrupt the sensory landscape for Asian elephants (Elephas maximus) in India. The combination of traffic, agricultural activity, and human presence creates a chaotic influx of unnatural acoustic, seismic, and chemical stimuli. This sensory pollution directly jams elephant communication networks and elevates their physiological stress levels to a critical breaking point. [1, 2, 3, 4, 5]

KEYWORDS- sensory landscape, urban-adjacent forest patches, India, elephant, communication, stress

INTRODUCTION

Here is how these altered sensory environments affect elephant herds across communication channels and stress dynamics.

1. Disruptions to Elephant Communication

Elephants rely heavily on long-distance sensory signals to coordinate herd movements, avoid danger, and find mates. Urban-adjacent landscapes fracture these systems: [1, 2]

- Acoustic Masking: Elephants primarily communicate over long distances using low-frequency infrasonic rumbles (below 20 Hz) that can travel up to 10 kilometers. Anthropogenic noise from highways, railways, and industrial machinery creates constant low-frequency rumbles that mask these calls. Research indicates elephants near busy corridors must vocalize up to 30% louder to be heard. [1, 2, 3]
- Seismic Interference: Elephants generate and detect subterranean vibrations through specialized receptors in their feet to transmit information. Heavy traffic and construction generate artificial seismic noise that obscures these biological cues, blinding herds to distant territorial warnings or distress signals from other elephants. [1, 2, 3]
- Olfactory Pollution: Chemical signaling through urine, feces, and temporal gland secretions is vital for assessing breeding status and social hierarchies. The pungent smells of burning trash, agricultural chemicals, and vehicle exhaust overwhelm their keen sense of smell, fracturing their chemical communication landscape. [1, 2]

2. Escalation of Stress Levels

Living on the edge of human expansion subjects elephant herds to severe, chronic physiological strain: [1]

- Elevated Adrenal Levels: Studies across highly fragmented regions in India (such as South Bengal and Assam) consistently show that elephants living in human-dominated landscapes exhibit significantly higher levels of fecal glucocorticoid metabolites (fGCM), a clear indicator of elevated physiological stress. [1, 2, 3]
- The Shock of "Drives": While elephants can display remarkable behavioral adaptability to passive human presence, aggressive conflict-mitigation methods—such as the use of loud sirens, tractors, and firecrackers to drive elephants away from crops—trigger sharp, acute spikes in stress hormones. These loud, unpredictable sounds particularly traumatize younger calves and sub-adults. [4,5,6]
- Suppressed Reproduction and Health Risks: The constant influx of frightening sensory novelties and hostile crowds (leading to conditions like anthrophobia or fear of people) keeps elephants in a continuous state of alertness. Over time, this chronic stress leads to reduced metabolic rates, poor nutrient absorption, and severely compromised reproductive capabilities, threatening the long-term survival of the herd. [1, 2, 3]

DISCUSSION

Comparative Overview of Sensory Landscapes

Sensory Dimension	Natural Forest Patch	Urban-Adjacent/Fragmented Patch	Impact on the Herd
Acoustic Environment	Dominated by natural high/low frequencies; clear transmission.	Loud, continuous low-frequency traffic & machinery hums.	Masks infrasonic rumbles, forcing louder calls and cutting off long-distance contact.
Seismic Activity	Minor natural ground waves (footfalls, low rumbles).	Heavy construction, railway tracks, and large vehicles.	Blinds tactile foot receptors, causing risk-avoidance behaviors and confusion.
Olfactory Context	Crisp, heavy reliance on pheromones for social bonding.	Industrial chemicals, smoke, garbage, and crop repellents.	Disrupts mating signals and pathfinding along historical corridors.
Stress Response (fGCM)	Baseline levels; brief spikes only during natural threats.	Chronically elevated due to vehicle noise, crowds, and crop drives.	Compromised health, lowered immunity, and potential behavioral aggression.

Sensory engagement is indispensable for people who must constantly interpret wild elephants' behaviour and intentions, respond to their movements, and maintain distance from the potentially dangerous megafauna.[7,8,9] The study draws on fieldwork in an agrarian village in Assam, Northeastern India, with people who are predominantly farmers. While elephants have long inhabited these landscapes, their presence outside the protected forests and into the adjacent villages has intensified over time. This has led to inventive ways in which people negotiate the uncertainty and precarity of living alongside elephants, which primarily includes routinely protecting their farmlands from crop-devouring elephants.

In this paper, I look at the repertoire of sensory practices through which my interlocutors not only protect their farmlands but also carry out other everyday activities, amidst the looming prospect of encountering elephants. I focus on heightened forms of sensory attunement, such as waiting for the arrival of elephants every evening, as well as more mundane embodied alertness, such as during walking through alleys that are also elephant pathways or sleeping at night. Based on the analysis of these practices, I foreground the centrality of the 'sensory' to how people claim to communicate with and know elephants, and how they describe their sense of place as being shaped by animals' presence.[10,11,12]

RESULTS

Increasing cases of man-elephant conflict and deaths are not just because of the shrinking habitat and fodder loss. Experts point out that it is also because of stress among the gentle giants. Just like us, animals too get stressed because of multiple reasons, including contact with humans, translocation for various reasons, exchange programmes, traveling in vehicles and while they are made to participate in public functions and processions.

"They suffer from post-traumatic stress disorder when they are separated from their calf or herd or when their movement is blocked. They get confused when they are translocated, which leads to stress and casualties like it happened recently in Wayanad. Tourists should be kept far away from elephants. Flash lights and crackers only add to the stress. They panic out of distress and then attack," pointed an elephant handler.

Over the last two days, Karnataka and Andhra Pradesh governments have held a series of meetings on various issues, included training of mahouts and elephant exchange. In the context of the meetings, a senior Karnataka forest department official said, one or two elephants will henceforth not be given to any state. "They will have to take a group. Elephants are social animals and they develop a strong bond with each other even when in captivity. So states will have to take groups and not a select few."[13,14,15]

While this has been appreciated by experts, they also point to the urgent need for chalking out a protocol and detailed method of handling animals while in captivity or under an exchange programme.

On August 12, the Ministry of Environment, Forests and Climate Change released a report and manual on the procedures to follow for safe translocation of elephants. While it detailed the methods to be followed for capture and relocation, little attention is being paid on the mental health and the stress factor among elephants.

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A recent study by scientists have pointed out that elephants in highly fragmented landscapes which are experiencing significant anthropogenic disturbances have recorded higher adrenal activity to cope with the stress and reduced metabolic rates to conserve energy in emerging challenging contexts.

The details of the study were published in a paper titled ‘Physiological responses in free ranging Asian elephant populations living across human-production landscapes’ published in Scientific Reports, a Nature group journal.[16,17]

As a part of the study, a team of scientists and researchers assessed physiological stress by measuring faecal glucocorticoid metabolite (fGCM) levels and metabolic states using faecal triiodothyronine (fT3) across three free-ranging Asian elephant populations (one in Central India and two in Northeastern India) whose home ranges encompass varying extents of disturbance in human-production landscapes.

In Central Indian landscape the scientists studied elephant populations in Paschim Medinipur and Kharagpur forest division of West Bengal and in north-eastern India landscape the elephant population in Gorumara, Jalpaiguri, Jaldapara and Buxa regions of the state were studied.

“Elephants living in more fragmented habitats in Central India had higher fGCM and lower fT3 levels compared to the Northeastern populations, as well as when compared (only fGCM levels) with a previously-studied Southern Indian elephant population,” the study pointed out.

Sanjeeta Sharma Pokharel, the lead author of the publication points out that while elephants may adapt to living in human-modified landscapes to some extent, they may experience high stress levels beyond a threshold of disturbance which can be physiologically costly.

Elephant herd stress levels are widely documented in wildlife biology as highly dependent on anthropogenic (human-induced) disturbance, habitat fragmentation, and social cohesion. Scientists typically measure physiological stress in wild and captive elephant herds noninvasively by testing fecal glucocorticoid metabolite (fGCM) levels (stress hormones) and observing temporal gland secretions. [1, 2, 3, 4]

Major Catalysts of Elephant Herd Stress

- Human Disturbance & Aggressive Drives: Studies show that elephants living in undisturbed home ranges have lower stress baselines. When humans use sirens, firecrackers, or aggressive "drives" to push herds out of human settlements, stress levels skyrocket. Calves and sub-adults experience the highest spikes (up to a 106% increase in glucocorticoid concentrations). [1, 2, 3]
- Unprotected Areas vs. National Parks: Elephant herds forced to roam outside formally protected parks show significantly higher baseline stress levels due to frequent interactions with human agriculture and infrastructure. Consequently, herds in unprotected areas tend to be significantly smaller. [1]
- Habitat Fragmentation: A 2025 study led by professor Raman Sukumar confirmed that severe habitat fragmentation impacts elephant physiology more than dietary quality alone, leaving herds in highly isolated forest patches chronically stressed. [1]
- Social Structure and Loss of Kin: Elephants are profoundly social. Research on orphaned elephants reveals that individuals who maintain strong family and social herd support keep normal stress hormone levels in the long term. Conversely, isolation or the breakdown of herd structures significantly increases chronic anxiety. [1, 2]

Long-Term Impacts of Chronic Stress[17,18,19]

When herds experience prolonged high stress levels, it directly impacts their conservation metrics:

1. Reproductive Decline: High stress is positively correlated with a drop in fecal estradiol concentrations, impairing reproductive potential and lowering calf recruitment. [1, 2]
2. Health Issues: Chronic stress compromises their immune systems, leads to weight loss, and impacts their overall body condition. [1]
3. Behavioral Changes: Severe stress can induce hyper-aggression toward humans, while captive elephants under stress exhibit stereotypic behaviors like rhythmic swaying, head bobbing, and pacing. [1, 2, 3]

CONCLUSION

The other people who contributed to the paper included well known elephant ecologist Raman Sukumar, Amir Kumar Chettri, Sunipa Chatterjee and Polani B. Seshagiri. Scientists behind the publication indicated that their earlier research in a southern population showed that lower fGCM levels were linked to superior dietary quality in crop-foraging elephants; a pattern they observed similar relationship in the NE-1 and NE-2 populations, but the Central population deviated from this pattern.

“This implies that severe anthropogenic disturbance, rather than dietary quality, may have a stronger influence in stress physiological responses among elephants,” Dr. Sharma Pokharel said.

India's estimated free-ranging elephant population of 27,000 to 30,000 individuals, is distributed across four major geographical regions – Northeastern, Northwestern, Central and Southern – with varying degrees of habitat fragmentation and elephant-human negative interactions.

Southern West Bengal is part of the highly fragmented Central Indian elephant habitat with very high levels of elephant-human negative interactions. With the numbers of elephants growing over time and several elephants now becoming "resident" in South Bengal.[20]

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Thessaloniki: School of Geology, Aristotle University of Thessaloniki. p. 175. ISBN 978-960-9502-14-6.