

How could a natural catastrophe impact the ecology of a species? The Nicobar megapode and tsunami

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This study on the impact of the 2004 tsunami on the Nicobar megapode *Megapodius nicobariensis*, endemic coastal living bird species in the Nicobar group of islands showed a significant decline (nearly 70%) in the number of individuals when compared to before tsunami populations (Paired sample test, $t=2.061$, $df=14$, $p<0.05$). The tsunami has also adversely influenced the nest-site selection of the megapodes. The post tsunami impact on this species is also expected to be severe, pushing the species into the category of “critically endangered”.

An earthquake with a magnitude of 9.15, with its epicentre at 3.29°N and 95.94°E off the coast of Sumatra with a focal depth of 30 km occurred on 26th December 2004 at 06: 28: 50 hrs. The tsunami waves reached the coast first, causing a phenomenon called draw down, where the sea level dropped considerably. The draw down was followed by the crest of the wave, which resulted in sea inundating land, also known as the run-up. There appears to have been three waves in succession, with the second being the largest. The waters took several days to recede completely, leaving in its wake a devastation of unimaginable magnitude on the people and wildlife of Nicobar islands¹. In the Nicobar group of Islands where endemism is very high in some faunal groups, such as mammals, birds and reptiles, it was expected that the highly diverse coastal biodiversity with high endemism may have been adversely affected by the tsunami. It was also expected that the coastal living Nicobar megapodes might have adversely been affected by the tsunami. Hence, a study was carried out to assess the impact of tsunami on the Nicobar Megapode *Megapodius nicobariensis* after a year of tsunami.

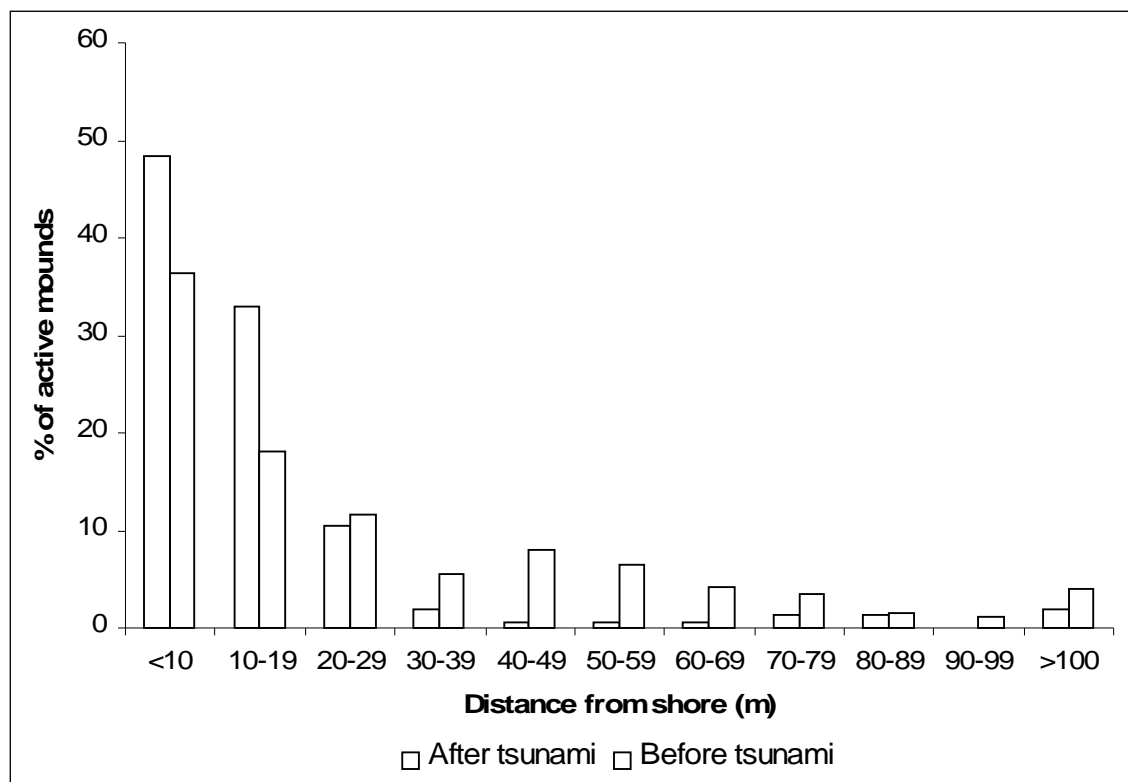
The megapodes are a unique group of birds as they utilise external sources of heat to incubate their eggs². The Nicobar Megapode *Megapodius nicobariensis*, a mound nesting megapode, is endemic to the Nicobar group of Islands in the Bay of Bengal, separated from its nearest congener by a distance of over 1500 km³. The polytypic Nicobar Megapode has two subspecies. *M. n. nicobariensis* Blyth, is present in the Nancowry group of Islands north of the Sombrero channel, and *M. n. abbotti* Oberholser, is found on the Great Nicobar group of Islands lying south of the Sombrero channel⁴⁻⁶.

Historically the Nicobar Megapode occurred on most Nicobar Islands^{4, 7-9} barring Car Nicobar¹⁰, Chaura¹¹ and Bati Malv⁹. There were a few records from the Andaman group of Islands^{4, 10, 12} and from the Coco Islands further north^{7,5}. None of the records from the Andaman group are of recent origin and the species is now believed to be absent there⁹. During 1993-94, the population of *M. n. abbotti* was estimated to be between 3400 and 6000 birds and the number of active mounds at 849⁹. The population of adult breeding birds of *M. n. nicobariensis* was estimated to be between 1200 and 2100 birds and the number of active mounds to be a little over 300⁹. Currently, *Megapodius nicobariensis* is considered as vulnerable⁹.

After the 2004 tsunami, the Nicobar megapode continued to be found on all but two islands viz Trax and Megapode where it had been reported earlier. The Megapode Island was fully submerged due to rise in sea water level after tsunami. The Nicobar megapode was not found on Trax Island and it was believed that the bird probably became extinct here due to tsunami waves.

More than 90% of mound nests were built within 30 m of the shore (Fig.1). This preference for nesting near to the beach is due to the availability of certain sandy-loam substratum¹³. Compared to previous study⁹ the concentration of mounds towards the fringe of the sea shore was high and it might be due to the tsunami which had significantly reduced the potential coastal habitat. Around 16% of active mounds were found within 5 m of the shore which may probably be influenced by high-tide water during full or new moon days. Maintaining mound temperature at a constant rate is important for the successful egg hatching^{13,14,15}, however, influence of sea water on the incubation temperature of these mounds is expected to adversely affect the hatching success of those mounds which are very close to the shore.

Figure 1. Distribution of active mound nests from the sea shore before (1994) and after tsunami (2006).



Of the total 687 km long coastal line of megapode lands, 328 km long coastal forest was identified based on previous study¹³⁻¹⁵ as the ‘Potential Coastal Habitat for Megapode’ and remaining 359 km long coastal forests were identified as ‘Non-conductive coastal habitat for megapode’. It was estimated about 800 breeding pairs of the Nicobar megapode occur on the coastal habitat of the Nicobar islands after tsunami, which is nearly 70% less than what was reported a before tsunami (Table 1).

Table 1. Population status of the Nicobar megapode before and after tsunami.

Island	Estimated no. of active mounds in 1994*	Estimated no. of breeding pairs 1994*	Estimated no. of active mounds in 2006	Estimated no. of breeding pairs 2006	Percentage of differences in breeding pairs before and after tsunami
Great Nicobar	515	1416	203	405	-71
Kondul	11	31	1	2	-94
Little Nicobar	311	855	82	165	-81

Menchal	2	6	6	12	+100
Meroe	1	3	2	4	+33
Pilo Milo	0	0	0	0	0
Trax	3	9	0	0	-100
Treis	4	10	3	6	-40
Nancowry	60	165	7	15	-91
Katchal	69	190	9	17	-91
Camorta	20	55	7	13	-76
Tillanchang	10	28	27	53	+89
Trinket	8	22	26	52	+136
Teressa	119	328	9	18	-95
Bampoka	26	72	13	25	-65
Total	1159	3190	394	788	-75 (overall decline)

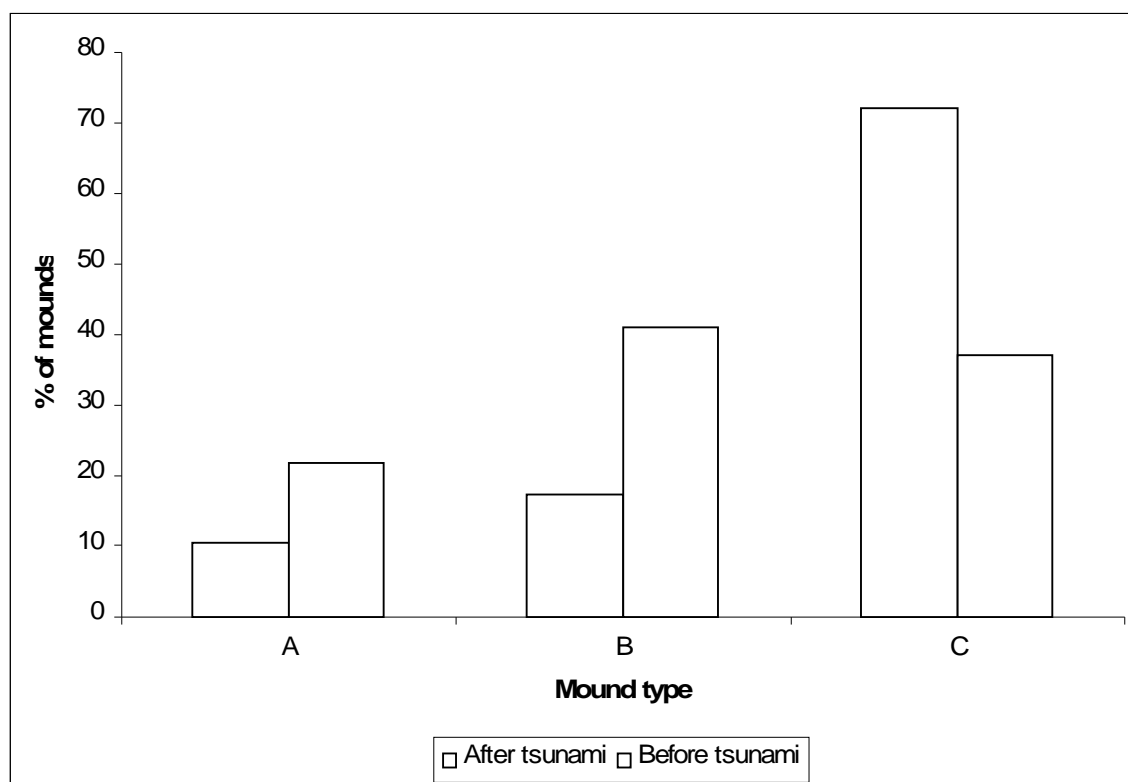
* Source Sankaran, 1995b.

Megapodius nicobariensis nicobariensis occurs on all seven islands of Nancowry group of islands. The potential coastal habitat of this sub species is shrunken and only 37% of the coastal habitat is now available for their mound building. It was estimated to hold 97 active mounds with maximum of 194 breeding pairs on the coastal habitat of these islands. There is no active mound found in the non-conductive coastal habitat of these islands which comprises 63% of total coastal habitat mainly with coconut plantation, mangroves, habitations and mountain cliffs.

Megapodius nicobariensis abbotti occurs on all of the southern group of Nicobars barring Pilo Milo, Megapode and Trax islands where the populations of megapodes either became extinct or too small to detect. Of the 314 kilometer long coast line, 61% of coastal low-lying forests have been identified as the potential coastal habitat of megapodes. On this potential coastal habitat, it was estimated that 286 active mounds were found here. On the non-conductive coastal habitat of this group of islands, 11 mounds have been estimated. Collectively, the total number of active mounds found on the coastal forests of southern group of Nicobars was 297. It has been estimated that a total of 594 breeding pairs occurs on the coastal habitat of these islands.

The Nicobar megapode builds three types of mounds in general^{8,9,14-16}. Of the observed mounds, 55% of mounds were Type C, mounds built at the base of dead trees (Fig 2). A good number of Type A, mounds built on open area were also found. However, the number of Type B, mounds, built at the base of live trees, were less probably due to non-availability of larger live trees on the coastal areas due to tsunami.

Figure 2. Change in the building of mound types of the Nicobar megapode before and after tsunami. After tsunami many mound nests were type C.



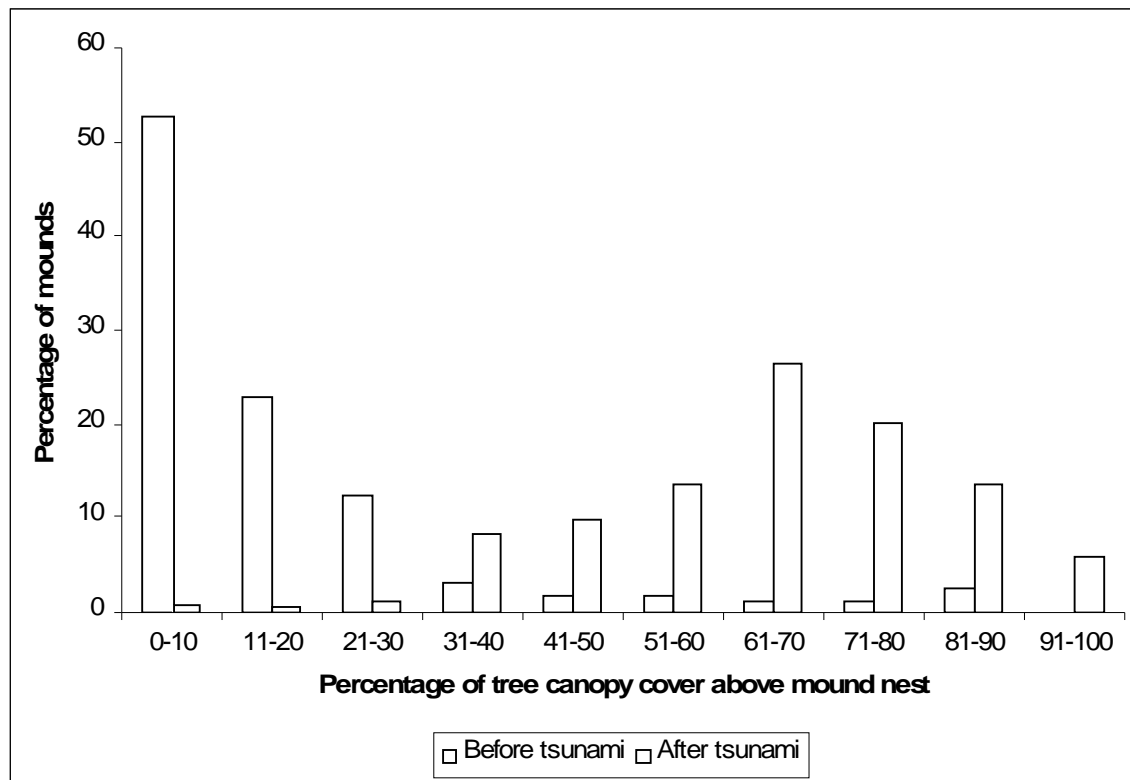
Most of the Type C mounds were one or two year(s) old and smaller in sizes. Mounds varied in sizes between 0.01 m³ and 71.45 m³. Of the observed 217 mounds, majority of mounds (84%) were less than 5 m³ and 67% of mounds were less than one cubic meter in size. Larger mounds such as above 20 m³ in size were less than 6% and all of them were Type A. Since, most of the mounds were new and constructed after tsunami the average size of the mound (3.78±0.62 m³) was smaller when compared to previous survey¹³⁻¹⁵. Type A mounds were found in different size classes. However, type B and C mounds were smaller in sizes.

Among the active mounds, most were smaller in size and it confirmed the fact that most of active mounds were constructed after tsunami and old active mounds near the shore must have been washed away.

It is believed that the temperature generated through fermentation of vegetative materials inside the mound is a major source of incubation temperature¹³, however, ambient temperature is also thought to contribute to the incubation proces. Most of active mounds found on Nicobars were built at the base of available trees on the coastal area. Since most

of trees died due to tsunami waves, green canopy cover over mounds was less or nil (Fig 3). It is expected that all the dead trees (snag) would decompose soon and in that case these type C mounds would become type A mounds. Direct fall of sunlight on the mound through the day may not be good for the incubation mound of the Nicobar megapode, as direct sunlight for a longer period may warm up the mound quickly and killing the embryo. It is a serious concern for the long term survival of this species. However, natural resilience of coastal ecosystem of islands may change this situation provided there is no human intervention.

Figure 3. Change in the mound sites selection of the Nicobar megapode before and after tsunami.



Since the tsunami waves have washed away most of the planted as well as wild coastal coconut and acrecanut palms, plantation of these palms has become important for the future survival of people in this region. There is a lot of possibility that the ongoing plantations would encroach upon the majority of the potential coastal habitats of the Nicobar megapode if the necessary care in this regard is not taken. After the tsunami most of the low-lying coastal areas were submerged and megapodes have built their

mounds in evacuated villages. But when the people started returning, they began hunting the megapodes. More than 95% of coconut plantations on the southern group of Nicobar islands were washed away, which was the major source of income for tribals. In years to come, it is expected that tribals will be left with fishing and hunting of wildlife for their survival apart from livelihood support from the Government. Each tribal family has one to four airguns. The Nicobar megapode was found to be the most favoured targets of these airguns.

The islands are known for their resilience, due to their ability for re-populating habitats and promoting regeneration. However, the restoration of the original biodiversity is possible only if the natural process such as recolonization is facilitated. The aftermath of the tsunami has left the trail of homeless families who need rehabilitation. Finding proper homes and alternate livelihood for them should not undermine ecosystem resilience. Raising plantation crops to generate revenue in the littoral forests should take into account the long term effects of habitat alteration.

Methods:

The Nicobar islands were surveyed between 10 March 2006 and 7 May 2006. As mounds are stationary, inanimate and represent breeding signs, the best way to estimate and monitor the megapode populations is by assessing the number of active mounds those in use^{9,13}. The coastline of 15 islands where the species was reported earlier were surveyed for mounds by following standardized survey protocols⁹. To estimate the total number of active mounds, the coastline of each island was divided into two segments such as 'Potential coastal habitat for megapode (PCHM)' and 'Non-conducive coastal habitat for megapode (NCHM)'. Potential coastal habitat of megapode was identified based on habitat preference of this species^{13,15}. Total available PCHM and NCHM areas of each island were measured by ground-truthing all around the island using a pedometer, GPS, a small boat and the latest satellite habitat imageries.

Variable width belt transects were used to count all the mounds present within sampled area. Length of transect, and distance between the two transects was set according to the size of the islands but it was uniform for any given islands. Average length of belt transect was 2 km, however, in some cases the length of the transects were small due to smaller sizes of islands. Width of the each transect varied depending upon the extent of low lying forest from the shore to near by hills. The census was carried out with seven observers walking at 20 m interval abreast parallel to the seashore. Interior forests of Great Nicobar, Little Nicobar, Kamorta, Katchal and Teressa islands were also sampled with fixed width transect i.e. 140 m width and 1 km long. Total number of active mounds

and abandoned mounds, mound size, canopy cover over mound, substratum of mound, and the distance between high tide mark and mounds were recorded. Mound substratum type was assessed based on Wentworth particle scale.

Active mounds those are in use were identified by signs of recent digging by megapodes or by checking the mound whether the soil was compact and hard with vegetation growth on it (abandoned mound) or loose and easily penetrable with a stick (active mound)⁹.

Since the distribution of mounds was not uniform⁹, PCHM and NCHM coastal areas were sampled separately as a part of stratified sampling. Mound density was also estimated separately for each segment. A total of 328 km long coastal habitat was identified as PCHM in the Nicobar islands; of these, 157.5 km coastal forests were sampled in 80 transects. Of the 80 transects, 68 transects were 2 km long, 10 transects were less than 2 km and two transects were more than 2 km. Of the 358.8 km long NCHM, 77.9 km long coastal stretches have been sampled in 39 transects. In a majority of islands, the standard deviation for 'mean mound density' for a transect was high or in some cases higher than mean; it revealed that the mound distribution within a segment (PCHM) was also not uniform, hence, the mound density of a island was estimated using the following formula:

$$\text{Mound Density (D)} = \left(\frac{N}{S_a} \right) H_a$$

Where N = total number of mounds found in 'S_a', a = type of segments (PCHM or NCHM), S = total area sampled in segment 'a' and H = total area available for segment 'a'.

Megapodes also occur in the interior forests of islands and it is believed that about 20% total population live in these interior forests⁸. Due to difficulty in sampling in the interior forests, less number of transects were laid to count the mounds. A total of 11 transects were laid in the Great Nicobar, four in Little Nicobar, four in Kamorta, three in Katchal, and two each in Teressa and Nancowry islands. Of these 26 transects, mounds were found only in three transects, one from the southern tip of Great Nicobar Islands, and two mounds from two different locations of the Kamorta Islands. Hence, the detection or availability of mounds in the interior forests was small and the interior populations have not been considered in the current population estimates.

The basal circumference, height and diameter of the mounds were measured to estimate their sizes. Mounds were uneven in shape with a cone like appearance. The mound size,

expressed as volume, was derived from the equation for the volume of a cone: $\frac{1}{3}\pi r^2 h$ where 'r' is the radius and 'h' the height, giving an approximate volume of the mound¹³.

References:

1. Sankaran, R. The islands: In: *The Ground Beneath the Waves: Post-tsunami impact assessment of wildlife and their habitats in India* (Wildlife Trust of India, New Delhi, 2005).
2. Jones, D.N., Dekker, R.W.R.J., and Roselaar, C.S. *The Megapodes* (Oxford University Press, 1995).
3. Olson, S.L. The significance of the distribution of the Megapodiidae. *Emu*, **80**, 21-24 (1980).
4. Hume, A.O. Contributions to the ornithology of India. The islands of the Bay of Bengal. *Stray feathers*, **2**, 29-324 (1874).
5. Abdulali, H. The birds of the Andaman and Nicobar Islands. *J. Bombay Nat. Hist. Soc.* **63**, 140-190 (1964).
6. Ali, S. and Ripley, S.D. *Handbook of the birds of India and Pakistan*, (Oxford University Press, Bombay, 1983).
7. Kloss, C.B. *In the Andaman and Nicobar Islands*. (John Murray. London, 1903).
8. Dekker, R.W.R.J. *Status and breeding biology of the Nicobar Megapode Megapodius nicobariensis abbotti on Great Nicobar, India*. (National Museum of Natural History, Leiden, 1992).
9. Sankaran, R. The distribution, status and conservation of the Nicobar Megapode *Megapodius nicobariensis*. *Biological Conservation*, **72**, 17-25 (1995).
10. Butler, A.L. The birds of the Andaman and Nicobar Islands. *J. Bombay Nat. Hist. Soc.* **12**, 386-403 (1899).
11. Abdulali, H. The birds of the Nicobar islands with notes on some Andaman birds. *J. Bombay Nat. Soc.* **64**, 140-190 (1967).
12. Sewell, S.R.B. A survey season in the Nicobar Islands on the R.I.M.S. "Investigator", October, 1921, to March, 1922. *J. Bombay Nat. Hist. Soc.* **28**, 970-989 (1922).
13. Sivakumar, K and R. Sankaran. Incubation mound and hatching success of the Nicobar Megapode *Megapodius nicobariensis*. *J. Bombay Nat. Hist. Soc.* 100 (2&3): 375-387 (2003).

14. Sankaran, R. and Sivakumar, K. Preliminary results of an ongoing study of the Nicobar Megapode *Megapodius nicobariensis* Blyth. *Zoologische Verhandelingen*, **327**, 75-90 (1999).
15. Sivakumar, K. *A study on breeding biology of the Nicobar megapode* *Megapodius nicobariensis*. (Unpublished Doctoral Thesis, Bharathiyar University, India, 2000).
16. Dekker, R.W.R.J. *Conservation and biology of megapodes (Megapodiidae, Galliformes, Aves)*. (Unpublished D.Phil. thesis, University of Amsterdam, 1990).