

## Analysis of news reports of road accidents from in and around Bhagwan Mahavir Wildlife Sanctuary and Mollem National Park, Goa's largest protected area

### Abstract

Within Goa's largest protected area forest a proposal for widening the NH4A highway (running from Panaji in Goa to Belgavi in Karnataka) was given clearance virtually amidst the pandemic. A significant portion of this highway (13km) falls within the Bhagwan Mahavir Wildlife Sanctuary and the Mollem National Park (BMWS and MNP). It will involve the cutting of 12,097 trees and diversion of approximately 31.015ha of forest. The BMWS and MNP fall within the Western Ghats which is one of the four biodiversity hotspots in India. As per the Traffic Department of Goa, there have been 216 accidents on the Anmod-Mollem Ghat section of the highway causing 84 deaths. The Power Minister of Goa has attributed this to the narrowness of the highway and contends that the expansion of the highway in the protected area will reduce the number of accidents. In order to ascertain the proportion of the 216 accidents that occurred in the 13km-stretch running through the protected area, as well as to determine if the accidents were related to the narrowness of the roads, we analyzed news articles from roughly the same time period (2011 to 2019). The articles were analyzed for eight variables, i.e., area of accident, year of publication, date, deaths (number of people) caused by the accident, number of injuries caused by the accident, description, newspaper in which the article was published and cause of the accident. Our analyses found no significant relationship between the number of accidents and the narrowness of the road. In other words, the rationale for proposed expansion of the NH4A in BMWS and MNP can therefore not be tied to curbing accident rates and will have negative implications on this fragile ecosystem. The same highway is not being expanded in Kali Tiger Reserve in Karnataka which is contiguous with this forested landscape.

## Introduction

The Bhagwan Mahavir Wildlife Sanctuary (BMWS) and Mollem National Park (MNP) are threatened because of three large destructive projects, two of which were granted virtual clearances amidst a global pandemic.

The double tracking of the South Western Railway line from Castlerock to Vasco, the four lane-ing of the NH4A through 13km of the forest, and the laying of a 3.15km 400kv transmission line would considerably impact Goa's largest protected area. The three projects will collectively require the cutting of 59,000 trees in BMWS and MNP.

## Background of the region and the proposed expansion project

The National Highway 4A connects the state of Goa and Karnataka, running from Panaji to Belgavi, and is about 153km in total length. Of this, 83km falls within Karnataka and about 70.075km falls within Goa; 13km of the highway in Goa, beginning at the state border, falls within the BMWS and MNP.

In Karnataka, the work of widening the NH4A is being carried out by the National Highways Authority of India, but the road expansion does not include the stretch within Kali Tiger Reserve. This is specifically attributed to Kali Tiger Reserve being defined as a critical wildlife habitat under the Wild Life (Protection) Act of 1972. In Goa, however, the Public Works Department plans to include

the protected areas (BMWS and MNP) in the expansion despite these being critical wildlife habitats.

At present the road passing through the protected area is a double lane road having a carriageway of 7m, and right of way (RoW) of 12m. The proposal to widen the highway within the BMWS and MNP seeks to widen the existing double lane highway into a 4 lane highway with a total carriageway of 14m and RoW of 26m, largely by creating completely new roads held up on viaduct structures (Aarvee Associates 2016a).

The project would therefore involve not just widening of certain sections but creating new infrastructure in pristine and previously untouched parts of the BMWS and MNP. This proposal involves the cutting of 12,097 trees (Aarvee Associates 2018) and the diversion of about 31.015ha of protected forest area (6.75 in the BMWS and 24.265 in MNP). The estimated cost of the project is INR 59,400 lakhs (Aarvee Associates 2016b).

## Background of the biodiversity of the Bhagwan Mahavir Wildlife Sanctuary and Mollem National Park and the potential impact of a road widening project

The BMWS and MNP cover a combined area of 240km<sup>2</sup> of forests in Goa's Western Ghats. Both protected areas have been classified as Important Bird and Biodiversity Areas by the

Bombay Natural History Society as well as the UK's Birdlife International Society (Rahmani, A.R. et al. 2016).

The reasons for this are evident from the remarkable biodiversity of this region, which is also why the Western Ghats is one of only four biodiversity hotspots in India (Chandawarkar 2020). The BMWLS and MNP alone have 721 species of flowering plants, over 100 of which are endemic (Dinesh et al. 2020).

The protected regions also host at least 219 species of butterflies, 80 of odonates, 418 species of moths, 49 of fish, 36 of amphibians, 52 of reptiles, 60 of mammals, and an incredible 236 bird species.

Many of these species are endemic to the Western Ghats; these include 18 butterfly and odonate species, 18 fish species, and 18 bird species. Many of the species the BMWS and MNP hosts are also Schedule I protected species, including 11 mammal species such as Goa's state animal, the Gaur *Bos gaurus*, and 25 bird species such as the Critically Endangered Indian Vulture *Gyps indicus*.

Furthermore, new species endemic to the Western Ghats are constantly being discovered. In Goa alone,

seven new species of amphibians were found over the last 20 years (Dinesh et al. 2020). Thus, it is clear this region supports a biodiverse ecosystem and a number of important species that are conservation priorities, as well as likely undiscovered species valuable to science.

The potential expansion of the NH4A would pose a significant threat to these species through further habitat fragmentation. This is the process by which a large expanse of habitat (such as a forest) is carved up into several smaller patches of smaller areas, isolated them from each other. This can lead to habitat isolation and affect vital wildlife corridors for movement of species (Fahrig 2003).



*Fejervarya Gomantaki*, one of the the endemic amphibians in the protected area discovered in Goa in recent years. © Omkar Dharwadkar

One of the primary ways habitat fragmentation takes place is through linear infrastructure projects such as roads (Nayak et al. 2020). In fact, it has been estimated that each extra kilometer of road causes the loss of at least 10ha of habitat (Laurence et al. 2020).

The Western Ghats' closed canopy forests are particularly susceptible to being damaged by such projects due to the diversity of species that depend on the complex structure of these forests, which is altered by roads (Raman 2011). In such a biodiverse area such as the BMWS and MNP, this can have tremendous implications on the long-term survivability of numerous endemic and endangered species.

The risk to the complex ecosystems that sustains these forests is also a risk to the ecosystem services they provide to humans. These crucial services, the better supply of which is highly correlated to biodiversity richness, include the maintenance of water supply, water purification, and supporting populations of pollinator species (Brockerhoff et al. 2017).

Fragmentation of habitat also means that species become more vulnerable to becoming roadkill (Crooks et al. 2017), in particular reptiles and amphibians (Selvan 2012). Given that seven new species of amphibians have been discovered in Goa in recent years, it

can be surmised that such a project could negatively impact yet unknown species, which would be an irreversible loss to science. The threatened mammal and bird species in the BMWS and MNP are also susceptible to becoming roadkill (Selvan 2012).

The damage is not limited to fauna alone. Local flora become vulnerable in a more fragmented habitat, as invasive species of plant and animal make their way into newly disturbed forest land (Prasad 2009). Fragmentation also makes habitats prone to erosion, also contributing to extirpation of species (Prasad 2009).

Thus, if such a project could have significant implications to the long-term survivability of the local biodiversity (and thereby ecosystem services to human beings), the benefits of the project should also be clear and significant, and be put forth transparently to the general public.

## Rationale

According to the records of the Traffic Police Department of Goa, there have been 216 accidents on the Anmod-Mollem Ghat section of the NH4A between 2011 and 2019, causing 84 deaths (see appendix 1A). Now renamed NH748, this highway runs from Panjim in North Goa to Belgaum in Karnataka (National Highway 748 2019). The Power Minister of Goa claimed that the expansion of the highway in the BMWS and MNP would reduce

accidents, insinuating that these accidents were due to the narrowness of the road (Chandawarkar 2020). This analysis was conducted to ascertain what proportion of the 216 accidents occurred in the 13km stretch that runs through the protected area, as well as to determine whether the cause of these accidents was related to the narrowness of the road or other issues.

## Hypothesis

Upon analysis of the available data, we will determine that the accidents in Mollem are largely unrelated to the narrowness of the roads, so a road expansion project on the NH4A would not be useful to reduce accidents. Most of the accidents will also be determined to have occurred outside the BMWS and MNP such that a road expansion in the protected area of Mollem would be ineffective at curbing accidents along the NH4A.

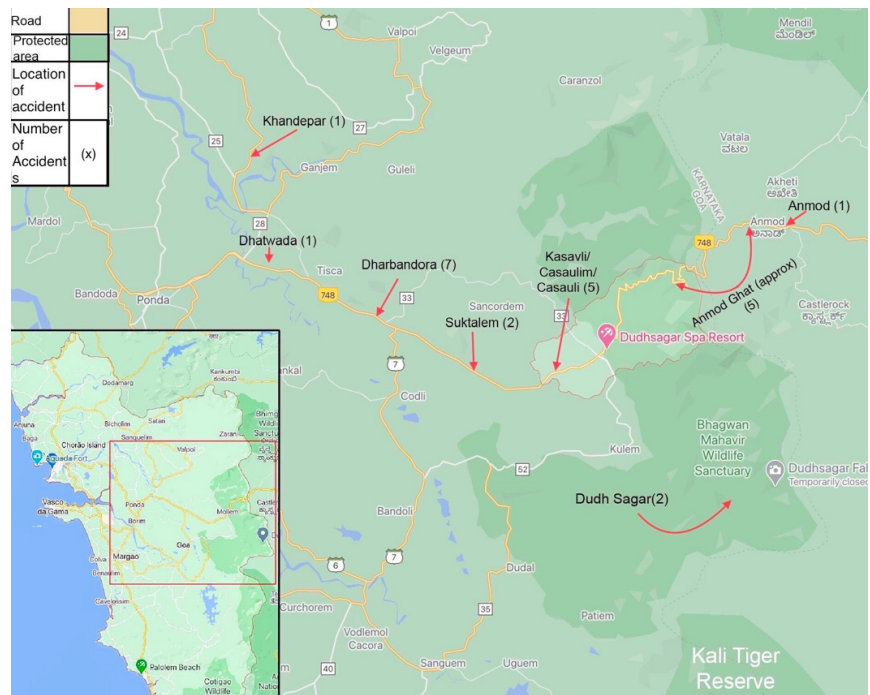
## Procedure

A database called Lexis Nexis was used to obtain the articles used in the analysis. First we searched “Bhagwan Mahavir (and Mahaveer) Wildlife Sanctuary” with keywords such as “dead”, “death”, “accident”, “fatal” and “vehicle crash”. The same procedure was repeated replacing Bhagwan Mahavir Wildlife Sanctuary with Mollem National Park.

Any articles which mentioned accidents between Belgaum and

Ponda/Mollem/Dudhsagar/ Anmod Ghat, were taken into consideration. Through this process, a total of 45 articles were identified for our research.

Upon analysis of the articles, it was determined that only 25 of the 45 articles discussed specific accidents on the Anmod-Mollem ghat section of the NH4A (and its vicinity) that occurred between 2011 and 2019. Each article in this set was analyzed for the following eight variables:



**Fig. 1. Map of locations with number of accidents at each, as determined via google maps.**

1. Area in which it took place.
2. Year in which the article was published.
3. Date.
4. Deaths (number of people) caused by the accident.
5. Injured (number of people) caused by the accident.
6. Description (brief) of the accident.
7. Newspaper in which the article was published and;
8. Cause of accident.

The analysis of this subset (termed subset A) was primarily drawn from the data recorded for variables 1, 2, 4, 5, and 8. Google mapping technology was also used after the initial analysis to determine which of these accidents occurred in the BMWS and MNP.

For those locations which could not be found via Google Maps, people familiar with the area, Omkar Dharwadkar (who has worked in the protected area) and Mangesh Gaonkar (from Dhargem, a village in Mollem), were consulted. In this way, the locations of 24 of the 25 accidents, in relation to the stretch of the NH4A crossing through the BMWS and MNP, were determined. One article did not specify the location of the accident within the Mollem region, so it was excluded from the location-based analysis.

The location-based analysis also revealed that two of the accidents we had articles for took place in the BMWS and MNP, but

not along the NH4A, so the data from those articles (and accidents) was removed from prior and subsequent analyses. As a result, Subset A was reduced to 23 articles for analysis (see the summary table in appendix **1B**).

Another seven of the total set of 45 discussed the general issue of accidents and road problems in Mollem and along the NH4A. The qualitative and quantitative data in these articles was deemed useful by the research team, and so were analyzed separately from the 25 related to specific accidents along the Anmod-Mollem Ghat section of the NH4A as subset B (see the summary table in appendix **1C**).

The five variables drawn from subset B for analysis were the same as variables 1, 2, 3, and 7 used for subset A, as well as one new variable; important information that the article contained (with regard to its relevance to road accidents in Mollem).

Of the remaining 13 articles (of the original 45), seven discussed accidents that did not take place along or in the vicinity of the Anmod-Mollem Ghat section of the NH4A; two involved Mollem residents, one involved a vehicle en route to Mollem, three occurred on the NH4A which runs through Mollem but not on the Mollem section, and one referenced an earlier similar accident in Mollem. Two others discussed accidents that

occurred prior to 2011. Another one was related to a likely homicide in Mollem. And, lastly, three articles were repeats. All of the 13 were therefore excluded from the analysis.

The 30 articles that ended up being analyzed as part of either subset A or B were primarily from the Times of India and Herald, but also included one from the Navhind Times, one from Diligent Media Ltd.'s Daily News and Analysis (DNA) and two from United News of India (UNI). Images of articles were placed in appendices to provide extra information. Where applicable, the reader is directed to view the relevant appendice(s) for reference, through brackets at the end of the appropriate sentence.

## Results

The 23 articles in subset A took place over an approximate seven year period, from January 10 2011 (when the earliest article was published), to 14 January 2018 (when the most recent article was published). Of the original set of 45, no articles from 2019 were determined to fit into subset A.

Collectively, the 23 accidents mentioned (representing approximately 10.65% of the total 216 accidents recorded on the road in this time frame) resulted in a total of 24 deaths (~28.6% of the total 84) and 52 people injured. For 12 of these accidents the cause is not mentioned.

However, for the remaining 11 accidents, representing 12 (50%) of the deaths in the subset, and 40 (~76.9%) of the injuries, 10 can be attributed to driver error.

Six (causing five deaths and 38 injuries) cite speeding as the cause for these accidents (see appendix **2A** for examples). Another four (causing five deaths and one injury) cite the driver losing control of the vehicle (see appendix **2B** for examples). Finally, one (causing one injury) cited as the cause that a driver was on the wrong side of the road.

Only one of the 11 accidents (causing two deaths) cites lack of road space as a reason for the accident. In this case, it was because the truck involved was making space for an oncoming car and fell into the ravine bordering that Anmod ghat road (see appendix **2C**).

Following this analysis, the location-based analysis of subset A using google maps was conducted, which further supported the hypothesis (see fig. **1** in the **Procedure** section).

Of the 22 accidents drawn from subset A for which the location along the Anmod-Mollem ghat stretch of the NH4A was provided (representing 21 deaths and 47 injured), only five (~22.7%) were found to have potentially taken place along the NH4A in the Mollem protected area.

These five accidents were responsible for six (~28.6% of the 21) deaths, and seven (~14.9% of the 47) injuries (see appendix **1B**). All five accidents occurred along the Anmod Ghat road, which extends outside of the protected area as well (see fig. **1** in the **Procedure** section).

For only one of these five accidents, the one taking place along a ravine as mentioned earlier, can the cause be deemed the narrowness of the road. Two of others can be attributed to driver error (one citing speeding and the other citing the driver losing control of the vehicle). The causes for the other two were not explicitly stated in their articles.

The other 17 accidents (~77.3% of the 22), responsible for the massive majority of deaths and injuries (~71.4% and ~85.1%, respectively) were confirmed to have not taken place on the stretch of the NH4A in the protected area.

The analysis of subset B indicated a number of other reasons for accidents other than narrowness. An article included in Subset B published in October 2011 stated that the NH4A road widening project was necessary to prevent accidents such as the 50 or 60 occurring annually at the time due to iron ore mining traffic (see appendix **2D**). MP Sardinha was cited making a similar claim in a Times of India article published in August

2020. However, in addition to the data in subset A suggesting that road-widening would not impact the rate of accidents and that most were not in the protected area, another article in subset B provides further insight into the cause of recent mining traffic related accidents along this road. An article published in June 2020 spoke of Usgao locals' concerns that ore transportation in the monsoon was leading to more accidents due to "poor visibility" coupled with spilled ore on the road, and truck drivers "dangerously" overtaking two-wheelers on the slippery roads putting the lives of riders "at risk" (see appendix **2D**).

Of the remaining four articles in subset B, two others that were published in 2019 and 2020 provide further evidence that other issues with the roads contributed to the accidents in the region. One points out the major pothole issue on the Mollem to Vasco road, with patchwork not even having begun as of September 2019. The other discusses how locals have noticed that speeding vehicles have resulted in accidents on NH4A. However, it should be noted that the locals requested a road expansion in the belief that such a project would solve the issue. Of the last two articles in the subset, one cited Chief Minister Sawant's claim in February that the NH4A widening project would be completed in a year, and the other pointed out that the project would "result in habitat loss and impact wildlife."



## Discussion

The results of the analysis based on cause of accidents showed that, of the 11 accidents included in the analysis, only one could be attributed to the narrowness of the road.

This seems to support the hypothesis, as the logical conclusion of these results is that a road expansion would not have prevented the vast majority (~91.7%) of the accidents we analyzed based on the causes mentioned in their articles. The location-based analysis indicates a similar conclusion, given that only a small minority of the accidents we analyzed (five of the 22, or ~22.7%) potentially took place in the protected area, with only one of those clearly attributable to road narrowness.

It should be noted that even the articles for the five accidents which potentially took place in the protected area, all of which were on the Anmod Ghat road, did not specify

which point on the Anmod Ghat road they took place. Given that that stretch of road extends outside of the protected area as well, it is possible that some or all of these accidents did not take place in the protected area either.

From the above analyses, it seems the road widening project on the NH4A in the Mollem protected area would not be effective at curbing the rates of accidents, and accident-related deaths and injuries along this road, or even target the area responsible for most incidents. Therefore, all the available data from subset A supports the hypothesis.

The results of the analysis of subset B also support the hypothesis. Of the reasons for accidents mentioned, such as iron ore transportation issues in monsoon, potholes and speeding, none would be solved or even mitigated by a road expansion.



Dead green vine snake that sadly became roadkill due to passing cars. This was on the 13km section of the NH4A in the Bhagwan Mahavir Wildlife Sanctuary and Mollem National Park. ©Omkar Dharwadkar.

In fact, in the article in which locals complained about iron ore transportation, it was also mentioned that several fatal accidents were caused by mining traffic in earlier years as well, but those were not monsoon-related. The article did not cite the reasons for those previous accidents. While we must admit that one of the articles cited Usgao

locals requesting an expansion of the NH4A, it is important to mention they did so because they believed it would curb the consequences of speeding. Evidence indicates this would not be effective, and in fact the contrary is often true i.e. wider roads are often correlated to higher rates of speeding (Noland 2003) (as will be discussed further in the conclusion).

However, the 23 accidents we have data for are only approximately 10.65% of the reported 216 accidents that occurred along the Anmod-Mollem section of the road between 2011 and 2019. And for 12 of those, we do not know the cause of the accidents (though at least eight of the 12 did not take place on the section of the NH4A in the protected area). These limits of our sample also limit the potential for extrapolation of our results, indicating a need for further research.

## Conclusion

The results of our analysis of the quantitative and qualitative data from the articles in subsets A and B show that, judging from the available data, there is no evidence to support the idea that a road widening project on the NH4A would reduce accidents in the region. That said, our analysis is only a starting point to provide information on all the accidents that occurred from 2011 to 2019 on the Anmod-Mollem ghat section of the NH4A. We were limited to using as our

sample the accidents reported on by the media, as the Public Works Department (the user agency) has no detailed information about these accidents publicly available.

There is a need for future research, as mentioned earlier. There is also a need for the government itself to release important information to facilitate such research before advancing these projects, and to demonstrate the reasoning behind them.

However, all available data supports the hypothesis, i.e., supports the conclusion that a road widening project on the NH4A in the Mollem protected area would not reduce accidents. There is no available data that does not support the hypothesis. In fact, given the evident issue of speeding that has been causing accidents, a road expansion could worsen the problem. A study by the Sam Higginbottom Institute of Agriculture, Technology and Sciences at Allahabad determined that the main cause of road accidents in India is speeding (Singh et al. 2015).

At least in the USA, wider lanes have been correlated to greater speeding and increased accidents, according to a study from Rutgers University (Noland 2003). The study puts forward that when there are wider lanes, “drivers may feel safer and reduce cautionary behaviour” leading to the increased rates of accidents seen on wider roads in America. It

was also posited that expanded roads led to up to an extra 900 accident-related fatalities per year in the USA (Noland 2003).

It is outside the scope of our research to propose any road related policy. But given that the project would cause significant ecological damage and risk the long-term survivability of numerous endemic and endangered species, and is based on an at best questionable claim, we must advise that it be put on hold at least until conclusive research proves its efficacy.

We must also advise that due diligence in procedure could be followed, such as in the case of the stretch of the NH4A in Karnataka. In Karnataka, the road passing through Kali Tiger Reserve is not being expanded, and that reserve is contiguous with the BMWS and MNP.

One possible alternative approach we recommend is for the state government to send representatives to the Ministry of Environment, Forests and Climate Change to re-evaluate these projects. They could also ask the Goa Forest Department to get the user agencies to rework their present proposals to put forth a working model (with livelihood and ecological tourism data) to show why an existing wide double road with 7m carriage needs to be made into a broader highway within a 13km segment of Goa's largest protected area.

There is also no data recorded on the intensity and volume of traffic through this protected area yet, which would be essential for proving the necessity (or lack thereof) of the NH4A expansion project in the protected area. Furthermore, the environmental impact assessment granted to the project has some serious issues, as identified by a detailed project report submitted by more than 30 scientists to the Central Empowered Committee of the Supreme Court (Punjabi et al. in press).

This report pointed out several problematic scientific statements in the Road EIA. For example, the EIA states that the road expansion will not affect faunal species, instead suggesting that species "may increase in number because of the road structures as the project will not obstruct their movement but rather can create new habitats for them" (Arvee Associates 2018).

As discussed in the **Background of the biodiversity of the Bhagwan Mahavir Wildlife Sanctuary and Mollem National Park and the potential impact of a road widening project** section of the paper, habitat fragmentation due to roads, which would become a worse issue with an expansion, is a major problem with severe impacts on the survivability of faunal species. There are also other concerns, as mentioned in the same section. We were unable to find a scientific basis for that statement in the EIA.

We would also advise research into alternate solutions directed at clearly identified accident-causing issues such as speeding, keeping in mind that wider roads could exacerbate the same.

It should also be noted that seasonal travellers that visit the area for nature-based tourism are unlikely to demand a highway, and when this route is blocked, they already access the border through other routes such as Chorla Ghat (Travel and Tourism Association of Goa 20 July 2020). This should be considered in any research into the necessity (or lack thereof) of the NH4A expansion project.

However, keeping all of the above in mind, the final result of our study is that, for the time being, our hypothesis seems proven.

## References

**Aarvee Associates (2016a).** Executive Summary. *Forestclearance.Nic*, [forestsclearance.nic.in/DownloadPdfFile.aspx?FileName=0\\_0\\_81191211291Projectdescription.pdf&FilePath=../writereaddata/Addinfo/](http://forestsclearance.nic.in/DownloadPdfFile.aspx?FileName=0_0_81191211291Projectdescription.pdf&FilePath=../writereaddata/Addinfo/).

**Aarvee Associates (2016b).** Wild Life Report. *ForestsClearance.Nic.In*, [forestsclearance.nic.in/admin/useragency\\_report\\_w.aspx?pid=FP/GA/ROAD/19978/2016](http://forestsclearance.nic.in/admin/useragency_report_w.aspx?pid=FP/GA/ROAD/19978/2016). Accessed 18 December 2020.

**Aarvee Associates (2018).** *Environmental Impact Assessment for the Wild Life Clearance for Four Laning of Existing Goa/Karnataka Border - Panaji-Goa Section of NH4A (New NH748) from Km 84.133 to Km 97.000 in the State of Goa on BOT (Toll) Basis under NHDP-III (Anmod-Mollem Section)*, 82pp.

**Brockerhoff, E.G., L. Barbaro, B. Castagneyrol, D.I. Forrester, B. Gardiner, J.R. Gonzalez-Olabarria, P.O.B. Lyver, N. Meurisse, A. Oxbrough, H. Taki, I.D. Thompson, F. van der Plas & H. Jactel (2017).** Forest biodiversity, ecosystem functioning and the provision of ecosystem services. *Biodiversity and Conservation* 26: 3005–3035. <https://doi.org/10.1007/s10531-017-1453-2>.

**Chandawarkar, R. (2020).** Infra Projects in Mollem Generate Heat at Virtual Debate. *OHerald*, Herald, [www.heraldgoa.in/Cafe/Infra-projects-in-Mollem-generate-heat-at-virtual-debate/16486](http://www.heraldgoa.in/Cafe/Infra-projects-in-Mollem-generate-heat-at-virtual-debate/16486). 03 September 2020.

**Crooks, K. R., C.L. Burdett, D.M. Theobald, S.R.B. King, M. Di Marco, C. Rondini & L. Boitani (2017).** Quantification of habitat fragmentation reveals extinction risk in terrestrial mammals. *Proceedings of the National Academy of Sciences* 114(29): 7635–7640. <https://doi.org/10.1073/pnas.1705769114>.

**Datar, M. & P. Lakshminarasimhan (2011).** Endemic plants of Bhagwan Mahaveer National Park, Goa-an analysis based on their habitat, phenology and life form types. *The Indian Forester* 137: 1451–1456.

**Dinesh, K.P., C. Radhakrishnan, B.H. Channakeshavamurthy, P. Deepak & N.U. Kulkarni (2020).** A Checklist of Amphibians of India with IUCN Conservation Status. Version 3.0. updated till April 2020. available at <http://zsi.gov.in> (online only).

**Fahrig, L. (2003).** Effects of Habitat Fragmentation on Biodiversity. *Annual Review of Ecology, Evolution, and Systematics* 34(1): 487–515. <https://doi.org/10.1146/annurev.ecolsys.34.011802.132419>.

**Fernandes, A.P., G. Punjabi, A. Jayadevan, A. Borker, D. Halali, E. Purdie, F.D. Patel, H. Gawas, H. Gawas, H. Gauns et al. (2020).** *Inadequacy of Environment Impact Assessment for Projects in Bhagwan Mahavir Wildlife Sanctuary and National Park A Peer Review*.

**Global Biodiversity Hotspots with Special Emphasis on Indian Hotspots.** *ENVIS Resource Partner on Biodiversity*, [http://www.bsienvnis.nic.in/Database/Biodiversity-Hotspots-in-India\\_20500.aspx](http://www.bsienvnis.nic.in/Database/Biodiversity-Hotspots-in-India_20500.aspx). Accessed 14 November 2020.

**Laurance, W. F., M.W. Goosem & S.G.W. Laurance (2009).** Impacts of Roads and Linear Clearings on Tropical Forests. *Trends in Ecology & Evolution* 24(12): 659–669. <https://doi.org/10.1016/j.tree.2009.06.009>.

National Highway 748 (India). *Wikipedia*, Wikimedia Foundation, [en.wikipedia.org/wiki/National\\_Highway\\_748\\_\(India\)](https://en.wikipedia.org/wiki/National_Highway_748_(India)).

**Nayak, R., K.K. Karanth, T. Dutta, R. Defries, K.U. Karanth & S. Vaidyanathan (2020).** Bits and pieces: forest fragmentation by linear intrusions in India. *Land Use Policy* 99: 104619. <https://doi.org/10.1016/j.landusepol.2020.104619>.

**Noland, R.B. (2003).** Traffic fatalities and injuries: the effect of changes in infrastructure and other trends. *Accident Analysis & Prevention* 35(4): 599–611. [https://doi.org/10.1016/s0001-4575\(02\)00040-4](https://doi.org/10.1016/s0001-4575(02)00040-4).

**Prasad, A.E. (2009).** Tree community change in a tropical dry forest: the role of roads and exotic plant invasion. *Environmental Conservation* 36(3): 201–207. <https://doi.org/10.1017/s0376892909990257>.

**Rahmani, A.R., Z. Islam & R. Kasambe (2016).** Important Bird and Biodiversity Areas in India - Priority Sites for Conservation (Revised and updated). Bombay Natural History Society, Indian Bird Conservation Network, Royal Society for the Protection of Birds and BirdLife International (U.K.).

**Rahman, T.R.S. (2011).** Nature Conservation Foundation, *Framing Ecologically Sound Policy on Linear Intrusions Affecting Wildlife Habitats: Background Paper for the National Board for Wildlife, Ministry of Environment and Forest, India*.

**Selvan, M. (2012).** Roadkill animals on national highways of Karnataka, India. *Journal of Ecology*

and *The Natural Environment* 4(14): 363–365. <https://doi.org/10.5897/jene11.068>.

**Singh, N., E. Ali, A.F. Denis, A. Herbert & F.E. Kujur (2015).** Identification and improvement of highway accident causes and safety management strategies. *Journal of Academia and Industrial Research* 3(8): 346–347.

**Travel and Tourism Association of Goa (20 July 2020).** Letter to Central Empowered Committee on Concerns regarding Forest Land Diversion for NH4A highway expansion, Railway double tracking, and laying of LILO transmission line through Bhagwan Mahaveer Wildlife Sanctuary and Mollem National Park.

## Acknowledgements

We thank Meghna Agarwala, Assistant Professor of Environmental Studies at Ashoka University and Nandini Velho, a faculty member of Srishti Institute of Art, Design and Technology for their insights on the manuscript. We would also like to thank Shashank Srinivasan and Arjun Menezes of Technology for Wildlife for their help in mapping the locations of the accidents via google maps. We thank Omkar Dharwadkar of the Goa Bird Conservation Network and Mangesh Gaonkar of Dhargem for their assistance in locating areas mentioned in the accident articles that we had trouble finding on Google Maps.

## Rohan Menezes<sup>1</sup> & Lisann Dias<sup>2</sup>

<sup>1</sup> Intern at MyMollem, Goa, India and BA candidate at Dartmouth College, Hanover, NH 03755, USA.

<sup>2</sup> Master's in Public Policy student, St. Xavier's College, Mumbai 400001, Maharashtra, India.

Emails: <sup>1</sup> rohan.a.menezes.23@dartmouth.edu,

<sup>2</sup> lisannnds@gmail.com (corresponding author).

## Appendix 1. Data Tables used for Analysis.

### Appendix 1A. Traffic Police Report on Accidents on Anmod-Mollem Ghat section of NH4A from 2011-19.

- Annexure - A. Colly -

#### Details of accidents in Anmod - Mollem Ghat section of NH-4A.

: Records maintained by Traffic Police Department, Goa.

Year	Total Accidents	Fatal		Grievuos		Slight		Minor
		Accidents	Killed	Accidents	Killed	Accidents	Killed	Accidents
2011	23	01	02	01	01	00	00	21
2012	32	01	01	00	00	04	20	27
2013	20	00	00	01	02	05	10	14
2014	20	01	01	00	00	03	03	16
2015	36	04	05	03	06	01	01	28
2016	38	03	03	01	01	02	04	32
2017	26	03	04	04	10	01	01	18
2018	18	01	02	00	00	01	06	16
2019	03	01	01	00	00	00	00	02

TOTAL 216 NOS.

Note: Anmod - Mollem Ghat section was closed for traffic after December 2018 because of upgradation and construction of NH-4A in the jurisdiction of Karnataka due to non availability of diversion roads.

  
E.L.XV (N\*)

Image 1. Number of accidents per year on Anmod-Mollem Ghat section of the road per gradation of seriousness.

Appendix 1B. Subset A Summary Tables (One Full, then one with only Accidents potentially in the Protected Area).

**Subset A: Accidents along the Anmod-Mollem Ghat section of the NH4A (/NH748)**

No.	Area	Year	Date	Deaths	Injured	Description	Newspaper Herald (H) Times of India (TOI)	Cause of Accident (NM=Not Mentioned)	Potentially In Protected Area? Y/N/U (Undetermined)
1	Anmod Ghat	2011	January 10	2	0	Truck fell into ravine while trying to make way for other car	TOI	Road narrowness	Y
2	Kasavali	2011	June 5	1	1	Truck collides with sumo jeep	H	NM	N
3	Dharbandora	2011	September 20	2	0	Duo crushed by falling truck when it skidded off road and they tried to jump out	TOI	Lost control of vehicle	N
4	Casaulim	2011	October 17	2	0	Truck hit car	UNI (United News of India)	NM	N
5	Suktollem	2011	October 18	2	0	Empty mining tipper truck rammed into car	TOI	Speeding	N
6	Dharbandora	2011	October 21	1	0	Driver lost control of truck and hit tree	TOI	Lost control of vehicle	N
7	Dharbandora	2012	July 13	0	1	Car hits motorcycle	H	NM	N
8	Dharbandora	2012	August 30	1	0	Speeding tipper truck hit man	TOI	Speeding	N
9	Suktalem	2013	April 29	1	0	Man lost control of motorcycle	TOI	Lost control of vehicle	N
10	Cansaulim	2013	September 20	0	1	Collision between containers	H	Driving on wrong side of road	N
11	Dharbandora	2013	October 6	1	0	Hit-and-run	H	NM	N
12	Casauli	2013	October 12	0	2	Speeding tempo hits car	TOI	Speeding	N
13	Dharbandora	2013	December 13	0	2	Two trucks collided	H	NM	N
14	Usgao	2015	February 6	1	0	Hit-and-run (presumed), victim was also drunk	TOI	NM	N
15	Anmod Ghat	2015	February 19	1	0	Collision between truck and container trailer	TOI	NM	Y
16	Cansaulim	2015	February 19	1	3	Car hit tree	TOI	NM	N
17	Anmod Ghat	2015	August 10	1	1	Collision of bus and motorbike at curve	TOI	Lost control of vehicle	Y
18	Kerya, between Ponda bus stand and Shigao	2015	September 6	0	30	Speeding truck tried to overtake bus, saw oncoming truck so turned and hit bus	H	Speeding	N
19	Mollem	2016	March 12	3	5	Truck and land cruiser jeep collided	H	NM	U
20	Anmod	2016	April 10	1	0	Collision of tempo and two-wheeler	TOI	NM	N
21	Dharbandora	2017	April 5	1	0	Collision of bus and motorbike	H	NM	N
22	Between Mollem and Anmod Ghat	2017	June 22	0	0	Trailer carrying wheel loaders turned turtle	DNA (Diligent Media's Daily News Analysis)	NM	Y
23	Anmod Ghat	2018	January 14	2	6	Speeding truck hits car while attempting to overtake	UNI	Speeding	Y
				<b>Total</b>	<b>24</b>	<b>52</b>			

Image 2. Each article of Subset A with each of the eight variables recorded.

# Highlight

Subset A Subsection: Accidents potentially inside Protected Area								
No.	Area	Year	Date	Deaths	Injured	Description	Newspaper Times of India (TOI)	Cause of Accident (NM=Not Mentioned)
1	Anmod Ghat	2011	January 10	2	0	Truck fell into ravine while trying to make way for other car	TOI	NM
2	Anmod Ghat	2015	February 19	1	0	Collision between truck and container trailer	TOI	NM
3	Anmod Ghat	2015	August 10	1	1	Collision of bus and motorbike at curve	TOI	Lost control of vehicle
4	Between Mollem and Anmod Ghat	2017	June 22	0	0	Trailer carrying wheel loaders turned turtle	DNA (Diligent Media's Daily News Analysis)	NM
5	Anmod Ghat	2018	January 14	2	6	Speeding truck hits car while attempting to overtake	UNI (United News of India)	Speeding
<b>Total</b>				<b>6</b>	<b>7</b>			

**Image 3. Subsection with the five accidents that potentially took place in the protected area — all on the Anmod Ghat road, which extends outside of the protected area as well.**

## Appendix 1C. Subset B summary table.

Subset B: Articles related to the accident situation along the NH4A (/NH748)						
No.	Area	Year	Date	Imp. info	Newspaper Herald (H) Times of India (TOI)	
1	Mollem	2011	October 24	NH expansion in Mollem is needed quickly as it has been pending since 2006, and will stop 50-60 mining traffic accidents annually on that road	TOI	
2	Goa	2019	September 1	Bad pothole situation in many Goan roads, patchwork not yet begun on Mollem-Vasco road	H	
3	Bhoma-Farmagudi	2020	February 7	Locals want Bhoma-Farmagudi road widened to reduce accidents due to speeding on the road causing traffic for thousands of vehicles	H	
4	Dharbandora	2020	February 26	CM Sawant said four lane NH work from Belgaum to Mollem would be completed within a year	H	
5	Mollem	2020	June 11	Clearance granted to three projects in Bhagwan Mahavirand Mollem protected areas harming wildlife and causing habitat loss	Navhind Times	
6	Usagao, Mollem-Ponda road	2020	June 18	Usgao locals fear ore transportation during monsoon will cause accidents due to visibility issues, slippery roads and risky overtaking by ore trucks	H	
7	Mollem	2020	August 22	MP Sardinha says govt should acquire pvt forests to protect them, implement projects to prevent accidents, says govt can plant trees to replace ones cut	TOI	

**Image 4. Each article of subset B with each of the five variables recorded.**



## Appendix 2. Images of articles for examples and reference.

### Appendix 2A. Speeding accidents.

8/23/2020 Two crushed to death in Mollem car mishap

Nexis Uni® Menu  Sign In | Register

Document: Two crushed to death... Actions Select Language Disclaimer

Go to All terms 6 Search Document

< 6 of 53 Results list >

### Two crushed to death in Mollem car mishap

[Export Citation](#)

The Times of India (TOI)

October 18, 2011 Tuesday

Copyright 2011 Bennett Coleman & Co. Ltd. All Rights Reserved

**Section:** GOA

**Length:** 123 words

#### Body

Ponda: Two persons died on the spot in road mishap at Suktollem **Mollem** on the Goa-Karnataka national highway on Sunday afternoon. Both the driver and the occupant of the car were crushed to **death**.

Ajay Kumar, 28, a resident of Andhra Pradesh, who worked as an area sales manager of Maruti cars was returning to Karnataka in the official car driven by Chandu Chawhan, 35, a resident of Hubli, when an empty mining tipper truck rammed into them at Suktollem crushing the duo to **death**, police sources said.

The truck which was on its way to Dharbandora was speeding and did not see the oncoming car. The driver of the truck, Suraj Desai, a resident of Madhalawada Sancorda in Dharbandora, has been detained.

For Reprint Rights: timescontent.com

#### Classification

<https://advance-lexis-com.ezproxy.cul.columbia.edu/document/?pdmfid=1516831&crd=ef3b5554-6adc-47e4-85de-0841ec9a24b8&pddocfullpath=%2...> 1/2

Image 5. 2 killed as speeding mining truck hit car (TOI, October 18 2011).

8/23/2020

Driver held, released in hit-and-run

Document: Driver held, released in hit-and-...

Actions

Select Language



Disclaimer

< 37 of 53 | Results list >

## Driver held, released in hit-and-run

Export Citation

The Times of India (TOI)

August 30, 2012 Thursday

Copyright 2012 Bennett Coleman & Co. Ltd. All Rights Reserved

**Section:** GOA

**Length:** 168 words

### Body

PONDA: Ponda police arrested tipper truck driver Sagar Parulekar, 35, resident of Collem for knocking down pedestrian Sadanand Kerkar, 58, and killing him on Saturday.

Parulekar had fled from the accident site.

Kerkar was standing near Dharbandora panchayat office at **Mollem-Sancorda-Usgao** junction when he was hit by the speeding truck.

Kerkar was severely injured and was admitted to Goa medical college and hospital (GMC) at Bambolim, where he succumbed to injuries on Monday night. He had severe head injuries, police said.

Ponda police have registered a case under Sections 279 (rash and negligent driving), 304 - A (culpable homicide not amounting to murder) of Indian Penal Code (IPC) and Section 134 A & B (fleeing without providing medical aid and informing the police) of Motor Vehicle Act.

Soon after Kerkar's **death**, police picked up Parulekar from his home. He was later released on bail. Police have handed over body to Kerkar's family after an autopsy on Tuesday.

For Reprint Rights: timescontent.com



### Classification



<https://advance-lexis-com.ezproxy.cul.columbia.edu/document/?pdmfid=1516831&crld=e80afb49-4827-4e8c-9481-b26b5fbd8f26&pddocfullpath=%2F...> 1/2

Image 6. Speeding truck kills pedestrian (TOI, August 30 2012).

## Appendix 2B. Accident due to losing control of vehicle.

8/23/2020 Bogmalo youth dies in Mollem road accident

Document: Bogmalo youth dies in Mollem r... Actions Select Language Disclaimer

< 1 of 71 Results list >

### Bogmalo youth dies in Mollem road accident

[Export Citation](#)

The Times of India (TOI)

August 10, 2015 Monday

Copyright 2015 Bennett Coleman & Co. Ltd. All Rights Reserved

**Section:** GOA

**Length:** 200 words

#### Body

PONDA: Kumar Nemappa Pawar, 21, of Bogmalo, Vasco, succumbed to grievous injuries that he had sustained in a hit-n-run case at Anmod Ghat in **Mollem**.

Pawar, a native of Bagalkot, Karnataka, was returning from his native place on a two-wheeler when a NEKSRTC passenger bus knocked him down.

Soon after the mishap, the bus driver, Rajkumar Lamani, 32, of Madinal, Muddebihal-Bijapur, Karnataka, fled from the spot without giving medical aid to the victim and informing the police.



He was later traced at Ponda by Ponda police and handed over to Collem police. The bus was proceeding to Karnataka, while

the victim was on his way to **Mollem**. On reaching a curve on the road at Anmod Ghat, the bus driver lost control over his vehicle and it dashed against Pawar's bike.

Pawar sustained grievous injuries and succumbed to them on the way to the Dharbandora primary health centre. Videsh Naik, a resident of Dabolim, who was riding pillion with Pawar, was also injured seriously and admitted to the Goa medical college and hospital, Bambolim, for treatment.

Collem police arrested the bus driver, Lamani, under several sections of the IPC and MV Act. He was later released on bail.

For Reprint Rights: timescontent.com

<https://advance-lexis-com.ezproxy.cul.columbia.edu/document/?pdmfid=1516831&crd=5cac6496-cd3c-4f3a-ae48-0ea2edc60ba5&pddocfullpath=%2F...> 1/2

Image 7. Bus drivers loses control of vehicle and hits bike, causing death of rider (TOI, August 10, 2015).

8/23/2020

Driver, cleaner crushed to death under toppled truck

Document: Driver, cleaner crushed to deat...

Actions

Select Language



Disclaimer

< 24 of 53 | Results list >

## Driver, cleaner crushed to death under toppled truck

Export Citation

The Times of India (TOI)

September 20, 2011 Tuesday

Copyright 2011 Bennett Coleman & Co. Ltd. All Rights Reserved

**Section:** GOA

**Length:** 211 words

### Body

<p>

PONDA: A driver and cleaner were crushed to **death** under their toppled truck at Dharbandora on Sunday.</p>

<p>

Police sources said the duo attempted to escape from the truck after they noticed it skidding off the road.</p>

<p>

The goods truck was proceeding from **Mollem** to Usgao. When it reached Durgini-Dharbandora, the 25-year-old driver, Umashankar, a resident of Bihar, lost control over the vehicle. He and the 22-year-old cleaner Manoj Singh, a resident of Jharkhand, immediately attempted to jump out of the vehicle to save their lives. However, the duo were crushed beneath the toppled truck.</p>

<p>

Other truck operators passing by summoned a JCB excavator and retrieved the vehicle. They tried to rescue the duo, but both had died on the spot, said police sources.</p>

<p>

Ponda police have retrieved the bodies and preserved them at the Goa Medical College (GMC) and hospital mortuary at Bambolim. They have also informed the respective families of the incident. After the victims' families come to Goa, autopsies will be conducted, police sources added.</p>


<https://advance-lexis-com.ezproxy.cul.columbia.edu/document/?pdmid=1516831&crld=e130333f-5e51-4669-b091-6373f8b0e487&pddocfullpath=%2F...> 1/2












**Image 8. Truck driver loses control of vehicle, he and passenger jump out but are crushed as truck falls (TOI, September 20 2011).**

## Appendix 2C. Accident related to road-narrowness.

8/23/2020 Two die as truck falls into Anmod ravine

Nexis Uni® Menu ▾  FN ▾ Sign In | Register

Document: Two die as truck falls i... Actions ▾ Select Language ▾  Disclaimer

     Go to ▾ All terms 4 ▾   Search Document 

< 49 of 53 | [Results list](#) >

### Two die as truck falls into Anmod ravine

 [Export Citation](#)

The Times of India (TOI)

January 10, 2011 Monday

Copyright 2011 Bennett Coleman & Co. Ltd. All Rights Reserved

**Section:** GOA

**Length:** 240 words

#### Body

PONDA: Two persons were killed on the spot when the truck in which they were proceeding to Belgaum fell into a 100 m-deep ravine along the Anmod ghat on the Goa-Karnataka highway.

Collem police said the accident occurred when the truck tried to make way for an oncoming vehicle on Friday night. It skidded off the edge of the road and plunged into the ravine.

The bodies of driver Jagdish Gurappa Goddi, 35, resident of Navalgond-Dharwad in Karnataka, and cleaner Basavraj Maruti Budnoor, 22, resident of Anandnagar, Hubli, were recovered on Saturday morning after a search was launched.

Collem PI Manoj Mardolkar said the empty national permit truck (KA 25 B 9967) was proceeding towards Belgaum when the fatal accident took place.

According to police, at the time of the mishap, the truck was on a sharp turn on Anmod ghat, about 12 km from **Mollem** check-post and 2 km from Dudhsagar.

Though the driver and cleaner jumped out of the vehicle they hit a sharp rocky cliff

<https://advance-lexis-com.azproxy.cul.columbia.edu/document/?pdmfid=1516831&crld=1cc995f7-76f3-43da-935b-f00c57bb0600&pdodocfullpath=%2Fs...> 1/2



Image 9. Truck moved to make way for other vehicle and fell into ravine (pg.1, TOI, January 10 2011).

8/23/2020

Two die as truck falls into Anmod ravine

resulting in their immediate **death**. Mardolkar said the post mortem report confirmed that the **death** was due to multiple fractures and damage to the cervical bone and spinal cord.

The bodies have been handed over to the families of the deceased after autopsies conducted at Goa Medical College and Hospital at Bambolim on Saturday afternoon.

"The truck is damaged. A high-powered crane is required to pull it out of the ravine," Mardolkar said.

For Reprint Rights: timescontent.com

## Classification

---

**Language:** ENGLISH

**Publication-Type:** Newspaper

**Subject:** AUTOPSIES (78%); **DEATH & DYING** (78%); TRAFFIC ACCIDENTS (78%); ACCIDENTAL FATALITIES (78%); BONE FRACTURES (77%); SAFETY, ACCIDENTS & DISASTERS (77%)

**Industry:** TRAFFIC ACCIDENTS (78%)

**Geographic:** GOA, INDIA (89%); KARNATAKA, INDIA (73%); INDIA (90%)

**Load-Date:** January 9, 2011



About  
LexisNexis®

Privacy  
Policy

Cookie  
Policy

Terms &  
Conditions

Copyright ©  
2020  
LexisNexis.





<https://advance-lexis-com.ezproxy.cul.columbia.edu/document/?pdmfid=1516831&crld=1cc995f7-76f3-43da-935b-f00c57bb0600&pddocfullpath=%2Fs...> 2/2









Image 10. Truck moved to make way for other vehicle and fell into ravine (pg.2, TOI, January 10 2011).

## Appendix 2D. Locals fear mining will cause accidents.

8/23/2020 Usgao locals fear ore transportation during monsoon will lead to accidents

Nexis Uni® Menu ▾  FN ▾ Sign In | Register

Document: Usgao locals fear ore ... Actions ▾ Select Language ▾  Disclaimer

     Go to ▾ All terms 2 ▾   Search Document 

< 2 of 16 | Results list >

### Usgao locals fear ore transportation during monsoon will lead to accidents

 Export Citation

Herald (Goa) (India)

June 18, 2020 Thursday

Copyright 2020 Herald Publications Pvt. Ltd. All Rights Reserved

**Length:** 329 words

**Dateline:** PONDA

#### Body

PONDA, June 18 -- The mining transportation of royalty-paid ore may have provided employment to truck owners, truck drivers and other mining dependents, however, the locals in the Usgao-Dharbandora mining belt feel that the ore transportation during monsoon is dangerous and fear that this will lead to accidents.

Demanding control on the speed of trucks, they claimed that the drivers are often involved in overtaking dangerously to increase the number of trips.

They informed that earlier during the mining season, the ore transportation used to stop during monsoon.

They complained that several ore laden trucks are transporting ore from Dharbandora to the Usgao-Arona mining belt. Though there is gap maintained by trucks during transportation, the locals said during heavy rains on account of poor visibility it becomes difficult for other vehicles especially riders to give way. It has been raining heavily now and the monsoon will be at its peak in July.

They further complained that the truck drivers overtake dangerously on the slippery roads  
[https://advance-lexis-com.ezproxy.cul.columbia.edu/document/?pdmfd=1516831&crd=9bfb3e58-e2e1-41b9-92a6-53462abfcef&pdocfullpath=%2F...](https://advance.lexis-com.ezproxy.cul.columbia.edu/document/?pdmfd=1516831&crd=9bfb3e58-e2e1-41b9-92a6-53462abfcef&pdocfullpath=%2F...) 1/3



Image 11. Mining during monsoon causes accidents, locals say (pg.1, Herald, June 18 2020).

8/23/2020

**Usgao locals fear ore transportation during monsoon will lead to accidents**

They further complained that the truck drivers overtake dangerously on the slippery roads thereby putting the lives of two-wheeler riders at risk.

Chetan, who commutes on a two-wheeler from **Mollem** to Ponda, said the truck laden with ore is covered with plastic; however some of it spills on road and makes the road slippery.

Dharbandora resident Ankush Naik said, "This is first time mining has continued during the monsoon. Earlier, the ore transportation used to stop by May-end or in the first week of June. It is learnt that mining transportation will continue till July and this may make situation dangerous for riders. Though transportation is necessary, at the same time taking care of locals' lives is also important."

Few years ago, when mining was at its peak, several **fatal** accidents occurred in mining belt.

Published by HT Digital Content Services with permission from Herald Goa. For any query with respect to this article or any other content requirement, please contact Editor at [contentservices@htlive.com](mailto:contentservices@htlive.com)

## Classification

---

**Language:** ENGLISH

**Publication-Type:** Newspaper

**Subject:** MONSOONS (90%); TRAFFIC ACCIDENTS (78%); ACCIDENTAL FATALITIES (72%); SAFETY, ACCIDENTS & DISASTERS (72%); WEATHER (72%)

**Industry:** TRUCK DRIVERS (90%); TRAFFIC ACCIDENTS (78%); MEDIA CONTENT (62%)

**Geographic:** GOA, INDIA (93%); INDIA (92%)

**Load-Date:** June 18, 2020



About  
LexisNexis®

Privacy  
Policy

Cookie  
Policy

Terms &  
Conditions

Copyright ©  
2020  
LexisNexis.



<https://advance-lexis-com.ezproxy.cui.columbia.edu/document/?pdmfid=1516831&crtd=9bfb3e58-e2e1-41b9-92a6-53462abfcef&pddocfullpath=%2F...> 2/3

Image 12. Mining during monsoon causes accidents, locals say (pg.2, Herald, June 18 2020).