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Mitigation strategies against human-wildlife conflict as perceived by various stakeholders in the state of Assam

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Abstract

Conflict had been occurring between the humans and wildlife since the beginning of time. It had been a major issue that had an adverse negative impact which had resulted in an imbalance in nature. The study was conducted with five stakeholders which consisted of farmer, development worker, forest official, NGO and experts were taken for the purpose of studying the mitigation strategies adopted by them. The main basis of human wildlife conflict was related to destruction of cultivable land, effect of livelihood on agriculture, livestock and allied sectors, loss of life and property and which had interfered with the rights of the individuals or groups, attributable directly or indirectly with animals. The objective of the study was to delineate the mitigation strategies adopted during human wildlife conflict. Elephant was the most frequent animal which came in direct conflict with the farmers and they termed that their population was highly increasing (95.62%) over the years. Since farming (87.50%) was their main source of livelihood therefore they termed that there was 100 percent crop and livestock damage was done and the animals mostly attacked at an interval of 15 days (88.12%) mostly at dusk (44.37%) for more than 1 hour (72.50%). 55.56 percent of the respondents opined that the crop rice was attacked during maturity stage for which they shifted to tea cultivation. The crops damaged over the last three years were rice, tea, vegetables banana, areca nut and colocasia with the highest being damaged was rice with an estimated value of Rs.430500 in the sampled villages. Similarly, the livestock affected were cattle, duck, goat, poultry, pig and buffalo with the highest being affected was cattle at Rs.250000 in the sampled villages. All the farmers (100%) suggested that they used readily available sources such as mashall, crackers and smoke to cope with the situation and different stakeholders suggested different ways to mitigate human wildlife conflict.

Keywords: Human-Wildlife conflict, livelihood, mitigation strategy

Introduction

There had been millions of species which had co-existed on planet Earth. Conflict was bound to arise with the vast difference that one species had with another. Human-Wildlife Conflict (HWC) can be defined as an 'interaction between humans and wildlife where negative consequences, whether perceived or real, had existed for one or both the parties when action of one had an adverse effect on the other party' (Conover, 2001; Decker *et al.*, 2002) [4, 8]. This conflict had been in existence since the beginning of time and had been a major issue of concern since humans and wildlife had been co-existing and been sharing the same kind of resources. The intensity and frequency of human wildlife conflict had been increasing worldwide due to wildlife habitat being used by the human beings, followed by wildlife moving in their territory along with environmental and climatic changes (Gompper, 2002; Treves *et al.*, 2002; Raik *et al.*, 2005; Breitenmoser, 1998; Hunter *et al.*, 2007; Cope *et al.*, 2005; Knight, 2003; Naughton-Treves *et al.*, 2003; Linnell and Broseth, 2003; Regehr *et al.*, 2007) [8, 20, 18, 16, 2, 10, 11, 12, 19]. Increase in the conflict occurs due to excessive overlapping of resources between humans and wildlife (Treves *et al.*, 2006) [21]. HWC was less about competition for limited resources (Engeman and Sterner, 2002; Tzilkowski *et al.*, 2002) [7, 22] in the developed countries whereas the developing regions of the world exhibit great propensity for it due to their rich biodiversity and human developmental characteristics (Madhusudan and Karanth, 2002) [13]. Africa, a biodiversity hotspot had many communities which had co-existed with wildlife without benefitting both and had hampered the humans and the wildlife (O'Connell-Rodwell *et al.*, 2000) [17]. Among the Asian Countries, encounters with snow leopard and wolf were common in Mongolia which led to serious economic losses. In retaliation, the pastoralists resorted to the killing and persecuting both species (Mishra *et al.*, 2003) [14]. In the Amazon Province of Tambopata Peru in South America, wild herbivores caused depredation (Naughton-Treves *et al.*, 2003) [16]. In Canada and USA, wolf caused a huge damage to domestic animals causing death. India is a mega-diverse country because of large climatic and topographic gradient having only 2.4% of the

world's land area and 8% recorded species of plants and animals (MoEFCC, 2014) [15], having 500 wildlife sanctuaries and 100 National parks as wildlife reserves and protected areas. Fragmentation of natural habitat, human settlement, deforestation, and increasing conversion of forest lands into agricultural areas had resulted in negative interaction between humans and wildlife. Elephants attacked 400 people annually which had caused human death (Rangarajan *et al*., 2010) [23]. NE India which covers approximately 274,680 km^2 is being comprised of several states, is home to more than 25% of the world's elephant population (Choudhury, 1999a) [3], a decrease in forest cover had resulted in conflicting situation with them. Assam also covers an area of 78,438 km^2 having one of the richest biodiversity zones in the world. Human wildlife conflict had resulted in about 300 deaths, damaging 8-10 million crops and 10,000-15,000 houses. Similarly, over 200 elephants had died due to human related activities (Bist, 2002) [1]. The habitat changed a lot in the past years due to deforestation and human encroachment in large quantities. This had resulted in a serious hazard creating noticeable behavioral changes in the wildlife. (Gureja *et al*., 2002; Sarma *et al*., 2008) [9, 24].

Human-Wildlife Conflict which was a global problem irrespective of geographical region or climate condition had possessed a serious threat to the survival of many endangered species had affected both the population as well as the ecosystem. It had occurred both in developing and developed countries which had affected both the rural and urban areas. It was not limited to only a certain species rather had consisted of a variety of wildlife. The increase in the growth rate of human population had led to migration of people to land which was earlier the habitat of wildlife. This had led to an increase in human wildlife conflicts in various parts of the world. It was both pervasive in the developed and developing countries. It had occurred frequently both in the rural and urban fringes which had no limitations in the species involved. The main basis of human wildlife conflict was related to destruction of cultivable land, effect of livelihood on agriculture, livestock and allied sectors, loss of life and property and which had interfered with the rights of the individuals or groups, attributable directly or indirectly with animals. This study aims to delineate the mitigation strategies adopted during human wildlife conflict. Five stakeholders which consisted of farmer, development worker, forest official, NGO and experts were taken for the purpose of studying the mitigation strategies adopted by them. Farmers included one hundred and sixty respondents which were affected due to human wildlife conflict as well as 30 respondents were taken from each of the stakeholders of development workers, forest officials, NGO and experts. Several case studies were also conducted to know about the presence of wild animals which mostly came in conflict with the human kind.

It was affirmed that the conflicted animals which were present in all the villages of both the sanctuaries were elephants followed by others. 95.62 percent of the respondents termed that the elephant population was highly increasing which had affected 2935 farmers followed by monkey and leopard which had affected 2760 and 2020 farmers respectively. They were of the opinion that 100.00 percent damage was done to crop and livestock and the crops preferred had variation wherein elephants preferred rice and banana, monkey was interested in banana and vegetables, wild rabbit and porcupine were inclined towards vegetables, wild boar liked colocasia and areca nut was preferred by squirrel. The wildlife attacked at an interval of 15 days (88.12%) mostly at dusk (44.37%) for more than 1 hour (72.50%) and 55.56 percent of the respondents were of the opinion that the crop rice was attacked during maturity stage. The crops damaged were rice, tea, banana, vegetables, areca nut and colocasia whereas the livestock affected over the years were cattle, duck goat, poultry, pig and buffalo. It was observed that 80.62 percent opined that the extent of damage to crops was done by elephant population followed by other animals whereas 61.25 percent opined that the extent of livestock affected was due to leopard population followed by others and about 81.25 percent opined that the extent of damage of property and loss of commodities was done by elephant population followed by others. From the year 2014-17, the number of incidents was highest during 2014-15 with 647 incidents but the highest area damaged was in 2016-17 which was 57.87 ha due to the elephants. Monkey had damaged 6.58 ha with 280 incidents during the year 2014-17. The damage done by wild rabbit was 0.77 ha with 53 incidents during 2016-17. Porcupine had caused 20 incidents in 2015-16 but the total damage was 0.31ha was in 2014-15. The damage done by wild boar was 1.09 ha with 70 number of incidents in 2016-17. The number of incidents done by squirrel was 23 during 2016-17. Leopard had caused 185 incidents during 2014-15 while jackal caused 63 incidents and python caused 156 incidents during 2016-17 respectively. During the year 2014-15, the estimated value of crop damage was highest with tea being damaged was17740kg with total annual cost of Rs.354800, followed by rice which was 14350 kg with an annual cost of Rs.430500,1300 kg of vegetables with an annual cost of Rs.26000, 200 bunches of bananas were destroyed with total annual cost of around Rs. 60000 respectively. But areca nut destroyed was 31 pun with total annual cost of Rs. 3100 in the year 2015-16 and during 2016-17 colocasia destroyed was 350 kg with total annual cost of Rs. 7000 respectively. During the year 2014-15, the estimated value of livestock affected with cattle, goat, pig and buffalo was 50, 90, 7 and 3 incidents with total annual cost of Rs250000, Rs90000, Rs 21000 and Rs30000 respectively. The estimated duck affected was highest during 2015-16 with 80 incidents having total annual cost of Rs. 40000 and the estimated poultry affected was 62 incidents during 2016-17 with total annual cost of Rs.12400 respectively.

Table 1: Mitigation strategy suggested by farmers (N=160)

Sl. No.	Mitigation Strategy	Frequency	Percentage
1.	Creation of an elephant proof trench	156	97.50
2.	Provision for compensation schemes	160	100.00
3.	Impart training/awareness	140	87.50
4.	Reducing shifting (jhum) cultivation	116	72.50
5.	Repairing of boundary road	152	95.00
6.	Presence of permanent source of water for animals	157	98.12

Table 1 shows the mitigation strategies as suggested by the farmers. Mitigation strategies suggested by farmers were

provision for compensation schemes (100.00%), there must be the presence of a permanent source of water (98.12%), creation of an elephant proof trench (97.50%), impart training programmes (87.50%) and the rest 72.50 percent suggested that shifting cultivation must be reduced respectively.

Since elephants are the most frequent animals which mostly came in conflict with the farmers, therefore they suggested that an elephant proof trench must be created. The digging of an elephant proof trench in the periphery areas would prevent them from entering the agricultural fields and residential areas to some extent. Farmers suggested that compensation schemes must be provided to them because they had suffered from crop, injury, and property damage due to human-wildlife conflict. This would help them to uplift their livelihood to a great extent. Farmers suggested that they must be provided training and awareness programmes on the concerned issues so as to cope with the situation and also make them aware about human-wildlife conflict. Shifting (jhum) cultivation must be reduced in the periphery area so that the wildlife does not roam for space into the plain cultivated areas because restricting the wildlife is another mitigation strategy which was suggested by the farmers. Repairing the boundary road could restrict the wildlife in the nearby areas as suggested by them. Also, they said that wildlife mostly strayed into the human habitat in search of food and water. So, the farmers suggested that if there was a permanent source of water for the wildlife, they won't destroy the human habitat.

Table 2: Mitigation strategy suggested by development workers (N=30)

Sl. No.	Mitigation Strategy	Frequency	Percentage
1.	Creation of dump in the periphery	18	60.00
2.	Restoration of the habitat	30	100.00
3.	Banana plantation inside the forest	15	50.00
4.	Restoration of animal corridors	28	93.33
5.	Biological fence	12	40.00
6.	Production of apong (rice beer) should be controlled	16	53.33
7.	Provision for night watchman	15	50.00

Table 2 shows the mitigation strategies as suggested by the development workers. The strategies suggested were restoration of the habitat (100.00%), followed by restoration of animal corridors (93.33%), creation of dump (60.00%), translocation of animals (53.33%) and the rest 50.00 percent suggested provision for night guard and 50.00 percent said about banana plantation inside the forest respectively.

Dump is an unpleasant place wherein waste products are deposited. Therefore, the development workers were of the opinion that if dumps were created in the periphery of the homestead garden, then it would restrict the wildlife to some extent. Development workers believed that if the habitat is restored, then human-wildlife conflict could be mitigated effectively. Habitat restoration was mainly done to identify disturbed habitats and restore native flora and fauna for the continued use of land by humans and wildlife. Bananas which are a favorite among the wild animals must be planted inside the forest so that the animals can have enough there itself and do not have to roam around affecting the village people. Restoration is the action of returning something to a former condition. Therefore, the development workers had suggested that if animal corridors were restored, human-wildlife conflict could be mitigated. Development workers suggested that plantation of biological fence such as lemon could highly restrict the wildlife. In addition to these, lemon could also act as an additional source of income for the human beings. Apong which is a liquor made of rice is a huge favorite among wildlife. They love the smell and cannot resist it. In turn they search for the area where it is prepared and then try to have the liquor from where it is stored. In doing so, a huge loss is incurred in these areas because in order to have it they damage any obstruction that comes their way. Therefore, the development workers suggested that, production of apong (rice beer) must be controlled in the areas affected due to human-wildlife conflict. Development workers also suggested that there should be a provision for night watchman to warn the farmers about the impending danger when the animals move in herds to take precautionary measures against the wildlife.

Table 3: Mitigation strategy suggested by forest official (N=30)

Sl. No.	Mitigation Strategy	Frequency	Percentage
1.	Use of dragon lights (charge light)	24	80.00
2.	Formation of an anti-depredation squad	30	100.00
3.	Encroachment in the protected areas must be stopped	30	100.00
4.	Training must be attended on the importance of wildlife	25	83.33
5.	Restrict felling of trees	30	100.00
6.	Planting of fodder for the wild animals	22	73.33
7.	Bamboo plantation for wild animals	26	86.66
8.	Electric fencing	27	90.00
9.	Watch tower for guarding crops	21	70.00

Table 3 shows the mitigation strategies as suggested by the forest officials which are as follows- formation of an anti-depredation squad, ceasing encroachment in the protected areas and restriction in the felling of trees (100.00%), electric fencing (90.00%), bamboo plantation (86.66%), imparting of training (83.33%), and the rest 80.00 percent also suggested the use of dragon lights, 73.33 percent suggested planting of fodder and 70.00 percent to build watch tower for guarding crops respectively.

They suggested that dragon lights can be used to mitigate human-wildlife conflict. Dragon lights are huge lights having selectable continuous, timer and flash functions. These lights when flashed in the eye of the wildlife, scares the wildlife and in turn they move out of the areas where the lights are being flashed. Formation of an anti-depredation squad was a necessary step to mitigate human wildlife conflict as suggested by the forest officials. Anti-depredation squad is the formation of a group of few farmers of the affected areas who were aware of the consequences of human-wildlife conflict. It is a participatory approach where the people were provided with the necessary training, skills and resources to cope against wildlife. Forest officials suggested that encroachment in the protected areas should be ceased in order to mitigate human-

wildlife conflict. Training must be attended by the farmers on the importance of wildlife in order to understand its importance and to restrict the conflicting situation among them. They were of the opinion that deforestation must be reduced so that the wildlife does not move in the cultivated areas and destroy the agricultural crops. Planting of fodder inside the protected areas in huge quantities for the wild animals was another mitigation strategy which could be easily followed as suggested by them. Bamboo which was a huge favorite among elephants, if planted in large quantities inside the protected areas could mitigate human-wildlife conflict. Electric fencing was another mitigation strategy suggested by the forest officials. If given, it restricts the animals to come near the cultivated areas and in turn does not affect the production of crops. The forest officials were of the opinion that watch tower (Tongi ghor) must be built so as to guard the crops from the attack of wildlife in order to mitigate human-wildlife conflict.

Table 4: Mitigation strategy suggested by NGO (N=30)

Sl. No.	Mitigation Strategy	Frequency	Percentage
1.	Chili paste must be used in a wire	30	100.00
2.	Sound system- voice mob controller	20	66.66
3.	Trip wire system	10	33.33
4.	Planting of alternate crops	5	16.66
5.	Palatable fodder plantation in the boundary	28	93.33
6.	Wildlife population must be controlled	30	100.00
7.	Awareness campaign	30	100.00
8.	Improve the quality of habitat	18	60.00
9.	Plantation must be done in vacant area	25	83.33
10.	Pelting of stones must be forbidden	6	20.00

Table 4 shows the mitigation strategies as suggested by the NGO workers. The mitigation strategies suggested by NGO were- chili paste in wire, population control and public awareness (100.00%), palatable fodder plantation (93.33%), plantation in vacant area (83.33%), sound system-voice mob controller (66.66%), improving the quality of habitat (60.00%), trip wire system (33.33%), and 20.00 percent suggested avoiding pelting stones, 16.66 percent suggested planting of crops as citronella, respectively.

They were of the opinion that chili paste which is made by mixing chili powder with grease and diesel must be smeared on white clothes and ropes to mitigate human wildlife conflict because of its pungent nature. They also suggested that a sound system must be instilled in the villages to warn the villagers about the wildlife. This could be done by installing a voice mob controller which will help them to be prepared for the situation. Trip wire system was another method which was suggested by the NGO workers. In this system, early warning systems are used to detect and alert locals of approaching wildlife. Alternate cropping is done to help the environment by improving the soil and many other things. Therefore, NGO workers suggested that alternate crops such as citronella, mint, patchouli and lemon grass could be planted instead of the plants preferred by wildlife to protect them. It can also be used to get an additional source of income for the villagers. Plantation of fodder which is preferred by the wildlife when offered a choice that is palatable in nature can be used to mitigate human-wildlife conflict in the boundary areas. They also suggested that to mitigate human wildlife conflict population of wildlife must be controlled. This could be done by controlling the population of wildlife which threatens human beings through different means. NGO workers were of the opinion that awareness campaigns which were mainly comprised of campaigns, exhibition and others must be conducted regularly in the villages to educate the affected persons and get them to take actions about the issue relating to human-wildlife conflict. For the wildlife to survive improving the quality of habitat is another option. The specific requirements needed by the animals for improving the quality of life such as food and water for nourishment, cover for water and predators, space to gather food and to attract mates and to move between habitats must be readily followed as suggested by the workers. NGO workers were of the opinion that vacant areas which were not occupied by any kind of plantation must be used by planting necessary plants for the wildlife to survive. This is important to maintain balance between wildlife and the habitat. Villagers must be educated not to pelt stones on the wildlife because it would harm the animals and in turn would turn them ferocious and ultimately lead them to defend themselves by injuring human beings. Therefore, the NGO workers suggested that pelting of stones must be forbidden against wildlife.

Table 5: Mitigation strategy suggested by expert (N=30)

Sl. No.	Mitigation Strategy	Frequency	Percentage
1.	Chili cultivation	30	100.00
2.	Provision of government schemes	24	80.00
3.	Battery operated electric fence	12	40.00
4.	Corporate social responsibility for people	15	50.00
5.	Provision of compensation schemes	30	100.00
6.	Legal provision for sterilizing the monkey population if not available	8	26.66
7.	Habitat translocation	9	30.00
8.	Creation of Community Elephant Refuse	5	16.66
9.	Contamination of elephant's urine	4	13.33
10.	Use of captive animals for regulating behavior of wild animals	10	33.33
11.	Smoke can be used as a deterrent	28	93.33
12.	TGS Analogue	5	16.66
13.	Horse neigh	3	10.00
14.	Co-existence of people with wildlife	22	73.33
15.	Presence of open patches in tea gardens	16	53.33
16.	Bee keeping	14	46.66
17.	Wildlife must move in a single file	8	26.66
18.	There must not be any restriction in the animal corridors such as tracks, etc.	6	20.00

Table 5 shows the strategies suggested by experts which are as follows- chili cultivation, provision of compensation schemes (100.00%), followed by smoke which can be used as a deterrent (93.33%), provision of government schemes (80.00%), co-existence of people (73.33%), presence of open patches in tea gardens (53.33%), help extended by the

corporate houses to the people (50.00%), rearing of honey bees (26.66%), use of unregulated electric wire (40.00%), proper education (33.33%), habitat translocation (30.00%), legal provision for sterilizing the monkey population (26.66%), reduce obstruction such as railway tracks (20.00%), creation of elephant community refuse and TGS Analogue (16.66%), contamination of elephant's urine (13.33%) and horse neigh (10.00%) respectively. If these strategies are implemented, the situation can be managed to a great extent.

Chili cultivation is the growing of chili crop in the boundary of the cultivated area. A paste could be prepared out of chili to mitigate the wildlife. This could be prepared by mixing the chili powder with grease and diesel and make a soft paste out of it. This paste must be smeared and handled on ropes and white clothes. It must be done after every two weeks because the pungency gets reduced when exposed to sun and rain. This was suggested by the experts because elephants get repelled due to the pungent smell ultimately restraining them from destroying the agricultural crops. The experts suggested that the government officials must visit the area affected due to human-wildlife conflict and suggest necessary government schemes which must be approved by the government to prevent as well as reduce this ongoing issue. Experts suggested that battery operated electric fence could also be used as an alternative method because it provides flexibility for precise placement to avoid them. Since the battery-operated electric wire is quick and easy to install, it can be used to protect crops and property. Corporate social responsibility (CSR) is a business approach that contributes to sustainable development by delivering economic, social and environmental benefits for all stakeholders. Since the main purpose of CSR is to drive change therefore, the corporate houses must take responsibility for the affected people due to human wildlife conflict by providing various schemes for their benefit. Compensation is the monetary benefit which is given to an individual who has experienced loss due to human wildlife conflict. Therefore, such compensation schemes must be provided for the people suffering from injury or crop loss as suggested by the experts. Sterilization is a surgery to make an animal unable to produce an offspring. Experts were of the opinion that since the monkey population had been increasing in the recent years therefore legal provision should be made if not available for sterilizing the constantly increasing population of monkeys to some extent. Habitat translocation is a tool for conserving ecosystem services and rebuilding biodiversity. Experts were of the opinion that to save wildlife from threatened areas they are being transferred to much safer places for their survival. Community elephant refuse is an area having a permanent source of water and good quality vegetation which is preferred by the elephants. Experts were of the opinion that if such area could be created at the periphery of the village than the elephants could be restrained from coming to the human settlements. Since bamboo and bananas are a favorite among the elephants therefore if they are planted in such a way which lets them to stay in that particular place having both water and food than human-wildlife conflict could be reduced to a great extent. Elephants keep a mark on their family members with the help of urine. Therefore, the experts were of the opinion that if contamination of elephant's urine is done, then they would get frightened and ultimately this will help them to restrict the animals to a great extent. Experts were of the opinion that regulating the behavior of captive animals was another way to mitigate the conflict. Therefore, regulating their behavior could help to monitor and control the behavior of the wild ones according to the present situation. Forest resources were readily available among the villagers, therefore experts suggested that these resources could be burned and smoke can be used as a deterrent as a defensive strategy for a short term to mitigate human wildlife conflict. Temporal Gland is a unique gland possessed by the elephants which secretes temporin acting as a pheromone used for mating activity. Analogue is using signals or information which is represented by a position. Experts suggested that if Temporal Gland Secretion (TGS) analogue can be synthetically produced by the researchers and given to the local people then they can divert the direction of the elephants ultimately mitigating the conflict to a great extent. For short term mitigation of human wildlife conflict, the sound made by a horse having a prolonged cry which is called a neigh can be effectively used as suggested by the experts. If the sound made by the horses can be recorded and played when the wild animals come for attack, the people could therefore restrict them from destroying the agricultural crops to some extent. Co-existence is the condition of living in harmony despite different interests. Therefore, the experts were of the opinion that when the individuals are educated to help other individuals and their communities to implement non-lethal measures against wildlife therefore both can be benefitted from one another. Experts were of the opinion that in earlier days it was a must to have open patches in the tea gardens so that the wildlife could move around without any obstruction surrounding them. But with time and human settlement near the areas these open patches were cultivated or used for other purpose. Therefore, the experts suggested that if these open patches could be reestablished than it will greatly help in mitigating human-wildlife conflict. Bee keeping is another option to mitigate human wildlife conflict as suggested by the experts. Giant honey bee (*Apis dorsata*) which is known for their aggressive defense strategies and vicious behavior can be readily used. Since, it cannot be domesticated the experts suggested that western honey bee (*Apis mellifera*) could be used to mitigate the conflict. Experts believed that if the wild animals walk in a line by moving one after the other in a single file in the cultivated areas, then human-wildlife conflict could be mitigated to a great extent because it will lead the human beings to know in which direction the wildlife move and in turn take precautionary measures against this before time. Animal corridor is an area of habitat connecting wildlife populations separated by human activities or structures. Therefore, experts were of the opinion that there must not be any presence of railway tracks, roads or others which might act as an obstruction in the animal corridors which will ultimately increase biodiversity among the wildlife and reduce human wildlife conflict to a certain extent.

Conclusion

Human-Wildlife Conflict (HWC) had been a major issue that had an adverse negative impact which had resulted in

an imbalance in nature. This conflict had been in existence since the beginning of time and had been a major issue of concern since humans and wildlife had been co-existing and been sharing the same kind of resources. Therefore, for mitigating human wildlife conflict different stakeholders had given different strategies which if implemented must reduce the issue to a great extent.

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