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# Estimation of Peoples' Perception on Climate Change Effect on Agriculture: A Participatory and Socio-personal Analysis

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**ABSTRACT**

Climate change has been recognized globally as an ever increasing threat. The economic and social implications of global climate change are the subject of intense national and international study in present day scenario. The present study has delved deeper into the peoples' perception on congenital effect of climate change on agriculture in regards to coastal agro-ecosystem of Odisha. The study has been based on a blend between participatory rural appraisal and a conventional multivariate statistical analysis including correlation coefficient, multiple regression analysis, path analysis, factor and canonical covariate analysis. Almost every year, within a cohort of last 53 years, coastal agriculture of Odisha has experienced brunt of 40 years of drought, flood or cyclones. This has been reflected in the stagnating yield of food crops over the couple of decades, negating the positive impact of modern technology and fertilizer application in the operating farms. The result shows that, the variables like, age (X1), education (X2) & changing expenditure allocation on education (X10), change pattern of watching television, listening to radio, all have been redeemed into a dependable estimator of perception on climate change effect on agriculture.

**Keywords:** Climate change, coastal agriculture, perception.

## INTRODUCTION

The economic and social implications of global climate change are the subject of intense national and international study in present day scenario. Rising CO2 concentrations have lowered ocean surface pH by 0.1 unit since 1750 (Trenberth, 2007). Chilika coastal ecosystem of Odisha presents a huge pool of hydro-ecological, bio ecological, socio-ecological dynamics and trans-formational traits. This has been reflected in the stagnating yield of food crops over the couple of decades. Added to it, the aspects of livelihood changes, migrations, erosion of ichthyofaunal diversity, problems of salinity, decline of productivity *etc.* are making the problem complex and polymorphic.

The change dynamics are more important than the present of change itself. While change dynamics include the past and direction of change as well as of shifts, its impacts on futuristic plan and prospects, is immense.

It has been projected that under the scenario of a 2.5 °C to 4.9 °C temperature rise in India, rice yields will drop by 32 per cent-40 per cent and wheat yields by 41 per cent-52 per cent (OECD, 2002). From a study, it was found that 50 per cent of the fishers have negative perception about the effect of climate change to fish production and only 22 per cent show positive approach to adopt different strategies aiming to reduce adverse effect of climate change (Roy, 2012).

It was paper revealed that access to education, ownership of land and land size of the farmers positively influence the perception on climate change and their decision to adapt to climate change.

## METHODOLOGY

The study was conducted in Puri district of Odisha on 80 farmers of four villages selected randomly.

The statistical tools and techniques used in the present study included mean, S.D., Coefficient of Variance, Correlation of coefficient, Multiple regression analysis, Path analysis and Canonical covariate analysis.

The variables selected and empirical measurement has been given in Table 1. Decadal observations have been carried out.

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**Table 1: Independent Variables**

| Variables | Notation | Score |
|---|---|---|
| Age | $X_1$ | Chronological age |
| Education | $X_2$ | Years of Schooling |
| Family Size | $X_3$ | Number of family members |
| Family Education Status | $X_4$ | Year of Schooling/Family |
| No. of Vehicles changed | $X_5$ | In No. |
| Change in Consumption of Kerosene | $X_6$ | Litre/month/family |
| Change in Consumption of Petrol | $X_7$ | Litre/month/family |
| Changing Family Expenditure | $X_8$ | Rupees/Month/Family size |
| Changing Expenditure Allocation on Farming | $X_9$ | 1-100 Scale |
| Changing Expenditure Allocation on Education | $X_{10}$ | 1-100 Scale |
| Changing Expenditure Allocation on Health | $X_{11}$ | 1-100 Scale |
| Change in Listening to Radio | $X_{12}$ | In hours/month |
| Change in Watching T.V | $X_{13}$ | In hours/month |
| Changing Interaction with Input Dealers | $X_{14}$ | In hours/month |
| Changing Interaction with Extension Agent | $X_{15}$ | In hours/month |
| Change in Farm Size | $X_{16}$ | Holding/ Family size (ha.) |
| Changing Cropping Intensity | $X_{17}$ | In % |
| Changing Cultivable Land | $X_{18}$ | In ha. |
| Change in Fertilizer Application | $X_{19}$ | Kg/Ha. |

Change refers to Decadal change from 1980 to 2010
Dependent Variable: Perceived Climate change effect on Agriculture (Y11) - It refers to change in climate change effect on agriculture as per farmers' perception from 1980-2010 and calculated in 1-100 scale.

## RESULTS AND DISCUSSION

**Table 2: Descriptive statistics of independent variables with respected to Mean, Standard Deviation values.**

| Variables | Mean | SD | CV |
|---|---|---|---|
| Age ($X_1$) | 53.24 | 9.92 | 18.63 |
| Education ($X_2$) | 4.94 | 4.15 | 84.01 |
| Family Size ($X_3$) | 5.07 | 2.13 | 42.01 |
| Family Education Status ($X_4$) | 6.09 | 2.30 | 37.77 |
| No. of Vehicles changed ($X_5$) | 1.94 | 0.86 | 44.33 |
| Change in Consumption of Kerosene ($X_6$) | -2.30 | 1.23 | -53.48 |
| Change in Consumption of Petrol ($X_7$) | 8.59 | 10.45 | 121.65 |
| Changing Family Expenditure ($X_8$) | 637.76 | 462.94 | 72.59 |
| Changing Expenditure Allocation on Farming ($X_9$) | 3.38 | 10.90 | 322.49 |
| Changing Expenditure Allocation on Education ($X_{10}$) | 12.61 | 8.34 | 66.14 |
| Changing Expenditure Allocation on Health ($X_{11}$) | 7.05 | 5.66 | 80.28 |
| Change in Listening to Radio ($X_{12}$) | -26.44 | 34.47 | -130.37 |
| Change in Watching T.V ($X_{13}$) | 39.92 | 23.74 | 59.47 |
| Changing Interaction with Input Dealers ($X_{14}$) | 2.44 | 2.11 | 86.48 |
| Changing Interaction with Extension Agent ($X_{15}$) | 3.54 | 2.62 | 74.01 |
| Change in Farm Size ($X_{16}$) | -0.14 | 0.30 | -214.29 |
| Changing Cropping Intensity ($X_{17}$) | 51.71 | 27.40 | 52.99 |
| Changing Cultivable Land ($X_{18}$) | 0.10 | 0.69 | 690.00 |
| Change in Fertilizer Application ($X_{19}$) | 52.03 | 24.34 | 46.78 |

### Coefficient of Correlation

**Table 3: Coefficient of Correlation(r): Perceived Climate changing effect on Agriculture (Y11) vs 19 independent variables**

| Variables | R value | Remarks |
|---|---|---|
| Age ($X_1$) | -0.3094 | ** |
| Education ($X_2$) | 0.0495 | |
| Family Size ($X_3$) | -0.0097 | |
| Family Education Status ($X_4$) | 0.1180 | |
| No. of Vehicles changed ($X_5$) | 0.1471 | |
| Change in Consumption of Kerosene ($X_6$) | -0.0955 | |
| Change in Consumption of Petrol ($X_7$) | 0.1292 | |
| Changing Family Expenditure ($X_8$) | 0.1310 | |
| Changing Expenditure Allocation on Farming ($X_9$) | -0.1248 | |
| Changing Expenditure Allocation on Education ($X_{10}$) | 0.3081 | ** |
| Changing Expenditure Allocation on Health ($X_{11}$) | 0.1103 | |
| Change in Listening to Radio ($X_{12}$) | -0.0555 | |
| Change in Watching T.V ($X_{13}$) | 0.0656 | |
| Changing Interaction with Input Dealers ($X_{14}$) | 0.1007 | |
| Changing Interaction with Extension Agent ($X_{15}$) | 0.0206 | |
| Change in Farm Size ($X_{16}$) | 0.2215 | * |
| Changing Cropping Intensity ($X_{17}$) | -0.0499 | |
| Changing Cultivable Land ($X_{18}$) | 0.1394 | |
| Change in Fertilizer Application ($X_{19}$) | -0.0494 | |

r>0.220 significant at p=0.05(*)
r>0.287 significant at p=0.01(**)

Table 3 presents the coefficient of correlation between Perceived Climate change effect on Agriculture (Y11) and 19 independent variables. It was found that variable, Age (X1), has recorded strong negative significant correlation whereas variable, changing expenditure allocation on education (X10) and change in farm Size (X16) have recorded positive significant correlation with dependent variable, perceived climate change effect on agriculture (Y11).

**Revelation:** The young farmers are recognising effect of climate change on agriculture more than old age. Increasing expenditure on education leads to higher education and better perception on climate change effect on agriculture. Older traditional farmers are unable to recognise the brunt of climate change on agriculture. So, age and expenditure allocation on education, are two vital factors to estimate perception on climate change. As large farmers suffer from huge loss due to brunt of climate change for their higher farm size. large farmers have greater perception on climate change.

### Regression Analysis

**Table 4: Regression analysis: Perceived Climate change effect on Agriculture (Y11) vs 19 causal variables (X1-X19) Multiple R sq. - 0.2467**

| Variables | Beta | Beta x R | Reg. coef. B | S, error B | t value |
|---|---|---|---|---|---|
| Age ($X_1$) | -0.391 | **49.051** | -0.349 | 0.139 | 2.505 |
| Education ($X_2$) | -0.337 | -6.763 | -0.720 | 0.436 | 1.651 |
| Family Size ($X_3$) | -0.003 | 0.013 | -0.014 | 0.620 | 0.022 |
| Family Education Status ($X_4$) | 0.137 | 6.547 | 0.528 | 0.840 | 0.629 |
| No. of Vehicles changed ($X_5$) | 0.069 | 4.113 | 0.709 | 1.518 | 0.467 |
| Change in Consumption of Kerosene($X_6$) | -0.057 | 2.217 | -0.414 | 1.166 | 0.355 |
| Change in Consumption of Petrol ($X_7$) | 0.133 | 6.970 | 0.113 | 0.146 | 0.775 |
| Changing Family Expenditure ($X_8$) | 0.075 | 3.991 | 0.001 | 0.004 | 0.382 |
| Changing Expenditure Allocation on Farming ($X_9$) | 0.057 | -2.889 | 0.046 | 0.125 | 0.371 |
| Changing Expenditure Allocation on Education ($X_{10}$) | 0.268 | **33.499** | 0.285 | 0.176 | 1.624 |
| Changing Expenditure Allocation on Health ($X_{11}$) | 0.047 | 2.118 | 0.074 | 0.202 | 0.368 |
| Change in Listening to Radio ($X_{12}$) | -0.041 | 0.918 | -0.011 | 0.035 | 0.302 |
| Change in Watching T.V ($X_{13}$) | -0.195 | -5.170 | -0.073 | 0.058 | 1.242 |
| Changing Interaction with Input Dealers ($X_{14}$) | 0.137 | 5.596 | 0.576 | 0.620 | 0.929 |

| | | | | | |
|---|---|---|---|---|---|
| Changing Interaction with Extension Agent ($X_{15}$) | -0.098 | -0.821 | -0.333 | 0.511 | 0.651 |
| Change in Farm Size ($X_{16}$) | 0.031 | 1.517 | 0.918 | 4.687 | 0.196 |
| Changing Cropping Intensity ($X_{17}$) | -0.139 | 2.809 | -0.045 | 0.041 | 1.083 |
| Changing Cultivable Land ($X_{18}$) | -0.028 | -1.603 | -0.364 | 2.402 | 0.152 |
| Change in Fertilizer Application ($X_{19}$) | 0.106 | -2.112 | 0.038 | 0.053 | 0.720 |

Step-down Regression analysis Multiple R sq. = 0.1451

| Variable | Beta | t-value |
|---|---|---|
| Age ($X_1$) | -0.236 | 2.125 |
| Changing Expenditure Allocation on Education ($X_{10}$) | 0.234 | 2.108 |

The table 4 presents the regression analysis to estimate the causal effects of 19 exogenous variables on the respective dependent variable, perceived climate change effect on agriculture (Y11). It has been found that the variables, Age (X1) & changing expenditure allocation on education (X10) have contributed respectively 49.05 per cent & 33.50 per cent variance to the consequent variable, perceived climate change effect on agriculture (Y11). climate change largely affects to agriculture due to its dependency on natural resources. Climate change is a crucial factor in the development of agriculture. Old age farmers can't realize about the effect of climate change on agriculture, whereas perceived climate change effect is more in young farmers. Higher expenditure on education i.e. more the education, more they know about climate change. Young educated farmers are more aware of climate change and they have adequate perception on effect on agriculture than old age farmers. The R-sq. value is 0.2467, it is to imply that, 24.67 per cent of variance embedded in consequent variable, perceived climate change effect on agriculture (Y11) with the combination of 19 exogenous variables.

## Path Analysis

**Table 5: Direct, Indirect & Residual effect; Perceived Climate change effect on Agriculture (Y11) Vs 19 Exogenous Variables Residual effect- 0.7533**

| Variables | Total Effect (r) | Direct Effect (DE) | Indirect Effect (IE)=r-DE | Highest Indirect Effect |
|---|---|---|---|---|
| Age ($X_1$) | -0.3094 | -0.3912 | 0.0818 | 0.1355(X2) |
| Education ($X_2$) | 0.0495 | -0.3373 | 0.3868 | 0.1571(X1) |
| Family Size ($X_3$) | -0.0097 | -0.0033 | -0.0064 | -0.1033(X1) |
| Family Education Status ($X_4$) | 0.1180 | 0.1368 | -0.0188 | -0.2628(X2) |
| No. of Vehicles changed ($X_5$) | 0.1471 | 0.0690 | 0.0781 | 0.0757(X1) |
| Change in Consumption of Kerosene($X_6$) | -0.0955 | -0.0573 | -0.0382 | 0.0805(X13) |
| Change in Consumption of Petrol ($X_7$) | 0.1292 | 0.1331 | -0.0039 | -0.1499(X2) |
| Changing Family Expenditure ($X_8$) | 0.1310 | 0.0752 | 0.0558 | -0.1731(X2) |
| Changing Expenditure Allocation on Farming ($X_9$) | -0.1248 | -0.0120 | -0.1128 | -0.1517(X10) |
| Changing Expenditure Allocation on Education ($X_{10}$) | 0.3081 | 0.2682 | 0.0399 | 0.1230(X1) |
| Changing Expenditure Allocation on Health ($X_{11}$) | 0.1103 | 0.0474 | 0.0629 | 0.0631(X10) |
| Change in Listening to Radio ($X_{12}$) | -0.0555 | -0.0408 | -0.0147 | 0.0806(X13) |
| Change in Watching T.V ($X_{13}$) | 0.0656 | -0.1946 | 0.2602 | -0.1005(X2) |
| Changing Interaction with Input Dealers ($X_{14}$) | 0.1007 | 0.1371 | -0.0364 | -0.0442(X15) |
| Changing Interaction with Extension Agent ($X_{15}$) | 0.0206 | -0.0984 | 0.1190 | 0.0616(X114) |
| Change in Farm Size ($X_{16}$) | 0.1215 | 0.0308 | 0.0907 | 0.0862(X1) |
| Changing Cropping Intensity ($X_{17}$) | -0.0499 | -0.1388 | 0.0889 | 0.0340(X19) |
| Changing Cultivable Land ($X_{18}$) | 0.1394 | -0.0284 | 0.1678 | 0.0826(X10) |
| Change in Fertilizer Application ($X_{19}$) | -0.0494 | 0.1055 | -0.1549 | -0.0854(X1) |

Table 5 showed the path analysis to depict the total direct effect, total indirect effect and residual effect of 19 exogenous variables on the consequent variable, perceived climate change effect on agriculture (Y11).

The table elucidated that variable, age (X1), has exerted the highest direct effect whereas variable, education (X2), has exerted highest indirect effect on the consequent variable, perceived climate change effect on agriculture (Y11).Young farmers are getting more impacted by the perceived climate change effect on agriculture due to their better education.

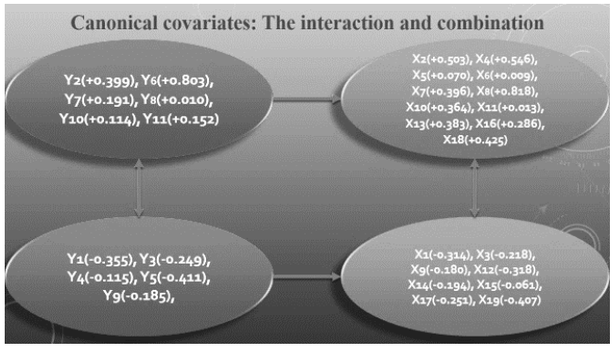
They can efficiently recognise the effect of climate change on agriculture. Educated farmers feel the brunt effect of climate change on agriculture. They know the causes and effect of climate change and that's why they are adopting more modern and appropriate technologies to combat against the brunt of change dynamics.

The residual effect being 0.7533, it is to conclude that even with combination of 19 exogenous variable, a huge portion of variance (75.33%) embedded with the consequent variable could not be explained. So, it would be more effective if more number of variables are included.

## Canonical covariates: The interaction and combination

The model depicts that, from the left side (Set-I) variables (Y), the following consequent variables like, Change in Perceived effect of T.V. (Y2), Change in family income (Y6), Change in weed diversity (Y7), Change in crop disease intensity (Y8), Perceived climate change effect (Y10), Perceived Climate change effect on Agriculture (11), have shown clear choices to select the following exogenous variables i.e. from the right sets of variables like, education (X2), Family education status (X4), No. of vehicles changed (X5), change in consumption of Kerosene (X6), change in consumption of petrol (X7), changing family expenditure (X8), changing expenditure allocation on education (X10), changing expenditure allocation on health (X11), change in watching T.V (X13), change in farm size (X16), changing cultivable land (X18).

**Model-1**




The model shows that, at the first stage, the combination of consequent variables, Y2, Y6, Y8, Y10, Y11, can be branded together as climate change perception, that have selectively been ductile to the set of agricultural modernity variables (X2, X4, X5, X6, X7, X8, X10, X11, X13, X16, X18), which again can be collectively branded as agricultural modernity and similarly, at the stage 2, the consequent variables like, change in perceived effect of radio (Y1), change in perceived effect of input dealer (Y3), change in perceived effect of extension agent (Y4), change in productivity (Y5), change in insect-pest intensity (Y9), have shown clear choices to select the following exogenous variables i.e. from the right sets of variables like, age (X1), family size (X3), changing expenditure allocation on farming (X9), change in listening to radio (X12), changing interaction with input dealers (X14), changing interaction with extension agent (X15), changing cropping intensity (X17), change in average fertilizer dose (X19). It shows that the combination of left side variables (Y1, Y3, Y4, Y5, Y9) can be termed as cosmopolite information on productivity factor and have been ductile to the following set of right side variables (X1, X3, X9, X12, X14, X15, X17, X19), which again can be branded as family resource and interaction character.

**Table 6: Matrix Ranking: Participatory Perceptual Analysis on Dominant Problems Affecting Rural Life in Chilika Social Ecology**

| Attributes Problems | No. of people affected | Severity of impact | Frequency of impact | Score | Rank |
|---|---|---|---|---|---|
| Irrigation | 7 | 7 | 8 | 22 | 2nd |
| Disease-pest attack | 6 | 6 | 7 | 19 | 4th |
| Low quality seeds | 7 | 5 | 5 | 17 | 5th |
| Salinity | 8 | 6 | 7 | 21 | 3rd |
| Climate Change | 9 | 8 | 7 | 24 | 1st |
| Lack of knowledge | 5 | 6 | 6 | 17 | 5th |
| Total | **42** | **38** | **40** | **120** | |

The brunt of climate change is predominated, has been evinced in the participatory matrix ranking by local people. It has been found that the perceived effect of climate changes is the highest followed by lack of irrigation and salinity problem. This shows the natural networking of problems among three negative actors *i.e.* climate change, irrigation and salinity.

**Table 7: Matrix Ranking: Participatory Perceptual Analysis on Choices and Ranking of Rice varieties**

| Attributes Varieties | Production | Cooking quality | Scent | Disease-pest free | Climatic resistant | Profit | Total | Rank |
|---|---|---|---|---|---|---|---|---|
| Nadiarasa | 3 | 6 | 6 | 4 | 3 | 4 | 26 | 7th |
| Tulasibasa | 3 | 7 | 8 | 4 | 3 | 3 | 28 | 5th |
| Padmakeshari | 2 | 5 | 6 | 3 | 3 | 2 | 21 | 8th |
| Ratantudi | 5 | 5 | 5 | 3 | 4 | 5 | 27 | 6th |
| Narada | 5 | 6 | 5 | 6 | 8 | 6 | 36 | 2nd |
| Masuri | 8 | 7 | 5 | 7 | 6 | 8 | 41 | 1st |
| Swarna | 7 | 6 | 4 | 5 | 6 | 6 | 34 | 3rd |
| 1014 | 6 | 5 | 4 | 5 | 5 | 6 | 31 | 4th |
| **Total** | **39** | **47** | **43** | **37** | **38** | **40** | | |

In this participatory analytical process, the local people has selected 7 rice varieties grown in that area. The attributes are, production, cooking quality, scented, disease-pest free, climatic resistant, profit. it has been found that, the variety masuri has splendidly combined production, profit, resilience to climate change and it has ranked first followed by narada, swarna *etc.* according to people perception, the variety narada gives less production than Masuri, Swarna, 1014, but the variety has good resilience to climate change so the variety Narada is so popular in coastal areas.

**Table 8: Matrix Ranking: Participatory Perceptual Analysis on Causes of Environment Degradation**

| Attributes Problems | No. of people affected | Severity of impact | Frequency of impact | Score | Rank |
|---|---|---|---|---|---|
| Deforestation | 7 | 8 | 6 | 21 | 1st |
| Over -netting | 6 | 6 | 7 | 19 | 3rd |
| Vehicles | 5 | 6 | 6 | 17 | 5th |
| Population growth | 5 | 8 | 7 | 20 | 2nd |
| Tourist pressure | 4 | 4 | 5 | 13 | 6th |
| More Boats | 5 | 6 | 7 | 18 | 4th |
| Total | **32** | **38** | **38** | | |

In this participatory analytical process, the local people have pointed out various problems that lead to environment degradation like deforestation, over-netting, vehicles, population growth, tourist pressure, more no. of boats and ranked among them according to some attributes like, no. of people affected, severity of impact, frequency of impact. Deforestation is found as the main contributor towards environment degradation, followed

by Population growth pressure, Over-netting, more no. of boats, etc.

**Table 9: Distribution of respondents according to perceived risks**

**n=80**

| Risk | No. | Rank |
|---|---|---|
| Increase in crop diseases | 63 | 1 |
| Reduction in Agricultural production | 47 | 6 |
| Increase in insect - pest attack | 45 | 7 |
| Increase in incidence of salinity | 52 | 5 |
| Increase in coast of cultivation | 60 | 2 |
| Increase in animal diseases | 45 | 7 |
| Decrease in fish growth rate | 37 | 8 |
| Increase in cost of fish | 54 | 4 |
| Decrease in forest area | 58 | 3 |
| Extinction of certain plants, birds and animal species | 30 | 10 |
| Decrease in Income | 22 | 11 |
| Increase in migration of people | 35 | 8 |

**Table 10: Perception on Change dynamics**

**n=80**

| Factors | No. | Rank |
|---|---|---|
| Climate Change/Global warming | 27 (33.75%) | 5 |
| Increase in Temperature | 72 (90%) | 2 |
| Erratic Rainfall | 67 (83.75%) | 3 |
| Increase in disasters | 75 (93.75%) | 1 |
| Expansion of Sea shore and seal level rise | 43 (53.75%) | 4 |

People by less no. do believe that there is global warming or climate change. But, people in high intensity do believe that, there has been change in temperature, increase in disasters and rainfall has developed an erratic pattern. Still maximum farmers are not aware of climate change or global warming and its worst impact on their livelihood. So, global warming as rhetoric, may not be that socialized as such, but there has been a clear perception on changes of meteorological parameters.

## CONCLUSION

The coastal agriculture Odisha has so far been the worst recipient of the brunt of climate change. The inflicted areas are agriculture, fishery, public health, livestock health and as a whole the normal functioning of social ecology. The study, through a very complex interactional analysis has come to a conclusion that, the farmer respondents having better education, higher size of holding and better expenditure allocation have become a better predictor of the brunt of climate change. Still maximum farmers are not aware of climate change or global warming and its worst impact on their livelihood while they have felt the irregularized rainfall and higher temperature. Educated rural mass, associated with farming, can play the pivotal in creating the greater awareness among the common people and also can mobilize small activist group to act as climate manager rather than the owner of land in combating this impending danger.

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