



## Impact of Tropical Cyclone ‘Nyatoh’ on Indian monsoon during its returning period

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### Rationale & Gap Analysis

The Indian Monsoon is back bone of Indian Economy. Unpredictability of the monsoon is worst affecting the farming in rural area and loss of properties in urban areas, hence large population of India. There are many models in practice to forecast the monsoon and rainfall pattern. Most of the monsoon models proved close to accurate like a multi-model ensemble or Nigam model developed by US based researcher professor Sumant Nigam, Regression Model, Atmospheric General Circulation Model etc. These closure to accuracy models many times have failed to predict the amount of precipitation, severe cloud burst wet draughts and dry drought situations.

The present models are aggregating the observations of different models like Ocean Model, Land model, Glacier model, El Niño and La El Niña etc. These models are predicting the rainfalls accurately in normal situations but if some disturbing situation occurs like storm, cyclone, it disturbs the normalcy. Many times the false predictions can be seen due to these events.

There are many attempts for studying the interrelation between all or some atmospheric parameters and their relation with atmospheric events like Cyclones, Typhoons etc.

Our study is about to finding the parameters which are disturbing the normalcy of Indian monsoon, which are leading to abnormal situations like heavy rainfall, and cloud bursts. We have observed that the Typhoons originated in the Philippine Sea or mid pacific sea.

### Objectives

The purpose of our paper is to find the possible causes of sudden change in the mainstream or normal prediction of rainfall which is followed by some unexpected phenomenon like cloud burst, Heavy rainfall etc. We have tried to study impact of Typhoons on Indian Monsoon especially originated in the Philippine Sea. We also tried to see the correlation between Cloud Burst over the Indian subcontinent and the Typhoons.

Our purpose is to seek the answers of following:

- 1) If there is any pull or push is experienced by the air mass over the Indian Sub continental Land?
- 2) If the experienced pull or push by air mass is due to the Tropical Cyclones activated in Philippine Sea?
- 3) If the cyclone neutralise due to landfall or reduce the angular velocity, then how the air mass behaves?

## Hypothesis

The Philippine Sea mother of most of the typhoons and subtropical cyclones, where every month there is at least one cyclone take birth. Many cyclone reach up to the angular velocity 280 miles per hour. Due to this great velocity these cyclones have ability to pull distant air mass over thousands of kilometres. During the monsoon active period it is the From June to September, natural the wind direction of is towards north and north east ward. If the cyclone existed during this period it will pull excess of moist air mass from the Indian Ocean and gives heavy rain fall. While at the time of returning the monsoon during October to January, air mass moves from North and Northeast to South west with some velocity. If the Cyclone is generated during this period the air mass will move in its opposite direction of normal flow and will reduce its wind velocity. Once the Cyclones are received land fall suddenly the atmosphere receives less pull and release like spring towards its expected or normal path. Thus excess availability of moist air mass (During Arrival Period June to September) or sudden aggregation by changing the usual path (During Departure Period October to January) will provide cloud burst situation over the Indian Subcontinent especially in the shadow region of the monsoon path.

Hypothesis can be summarised as

- 1) The cyclones originated in the Philippine Sea are stronger and may reach more than 280 miles per hour
- 2) These Cyclones has ability to pull distant air mass present on the Indian and Chinese Subcontinent and North American continent due to its geographical location
- 3) The Cyclones disappears suddenly when receives landfall or becomes very mild due to unknown Thermodynamic and Geographical reason.
- 4) The pulled air mass release back into the mainstream Monsoon wind flow after vanishing the Cyclones.
- 5) The released back air mass produces huge disturbance in the mainstream Monsoon wind flows. The confluence of both regular stream and released back air masses accumulate at some place like foothill of mountains of Himalayas or Western Ghats and gives heavy rainfall. Sometimes it leads to heavy cloud burst.

## Research Design / Methodology

We have studied the Tropical Cyclone 'Nyatoh' which was having origin in Philippine Sea at the geographical location at (7N, 153.5E) and was active from 26 November 2021 to 4 December 2021. We have observed the 'Nyatoh' during the active period with interval of 4 hours till it has Sudden disappeared at (30N, 150.5E) in the mid pacific ocean.

The rainfall over the Indian subcontinent was observed from 26<sup>th</sup> November 2021 to 10 December 2021. For this purpose we have referred the local and national newspapers Like

We used the online real-time simulator for our study purpose, which are giving real-time information about the weather conditions and those are open for public use. We have watched the 'Nyatoh' with the help of simulators based on satellite images offered by <https://weather.com/>.

For cross verification and actual wind speed and pressure data we have taken help of the simulator <https://zoom.earth/> .We have also watched the real time direction of wind flow with the help of the website <https://earth.nullschool.net/>

The rainfall data (dates of rainfall) we have collected from various local newspapers. The local newspapers gave us idea about the acuteness of disaster and rainfall. The local News Papers we referred for our study were 'Dinakaran'(Tamil local News Paper) 'Loksatta'(Marathi News Paper) 'Gujrat Samachar'(Gujrati News Paper), 'Anand Bazar Patrika' (Bengali News Paper), We also referred the news from National News Papers 'The Hindustan Times' and Indian Express. The weather news from Weather.com was also helpful for rainfall related information.

We have assumed geographical area of Maharashtra, Karnataka, Odisha, Andhra Pradesh, Telangana, Tamil Nadu, and Kerala state of India for rainfall observation purpose, as it has seen that the monsoon is active over this region in the month of June to January.

### Primary work / Survey:

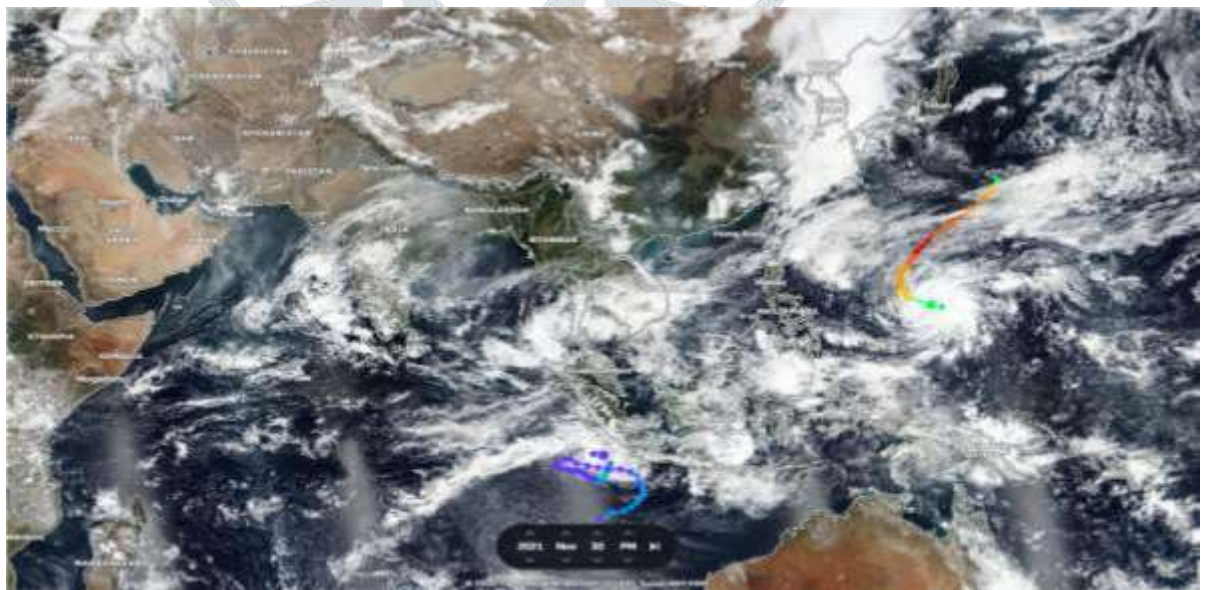
We have observed the 'Nyatoh' Typhoon is originated near Philippine Sea (origin 30N, 150.5E) From 29th November 2021 to 4th December until it vanishes. The Local News Papers and rainfall situations were observed until 10th of December 2021.

On 29 November 2021. Regular wind flow were observed over the Indian subcontinent. The wind direction was from NE to Southward. We can also see the 'Vindhyan' mountains are becoming barrier to pass the wind in north direction. There was also presence of mild Typhoon 'Teratai' in the Java Sea. The 'Teratai' also having little impact on wind flow. (See Figure 1)



**Figure 1. Position of 'Nyatoh' on 29 November 2021**

On 30<sup>th</sup> November 2021 the clouds are pulled northward and northeastward which is abnormal in this period. In the Southern Java the 'Teratai' was also became slightly powerful and the wind speed of 'Nyatoh' also slightly greater than previous day. Also some clouds from Arabian Sea are pulled towards Southern India (See Figure 2)



**Figure 2 Position of 'Nyatoh' on 30 November 2021**

On 1<sup>st</sup> December 2021, there were heavy rainfall observed over the western and north-western part of Maharashtra. The dense clouds also observed over some part of Gujarat and some part of north India which was unusual in regular period. Maharashtra's Western Ghats region (e.g. Mumbai and Raigad) witnessed heavy

rainfall and cloud bust like situation. Southern part of Gujrat also witnessed heavy Precipitation ( Gujrat Samachar 2<sup>nd</sup> December 2021). The

‘Teratai’ typhoon also seen it in turning back from its expected path. The ‘Nyatoh’ has received its angular speed 140 km/hr. on this day. It is observed that the air mass has pulled towards the eye of cyclone the. There were report that the depression is observed at the Bay of Bengal. (See Figure 3)



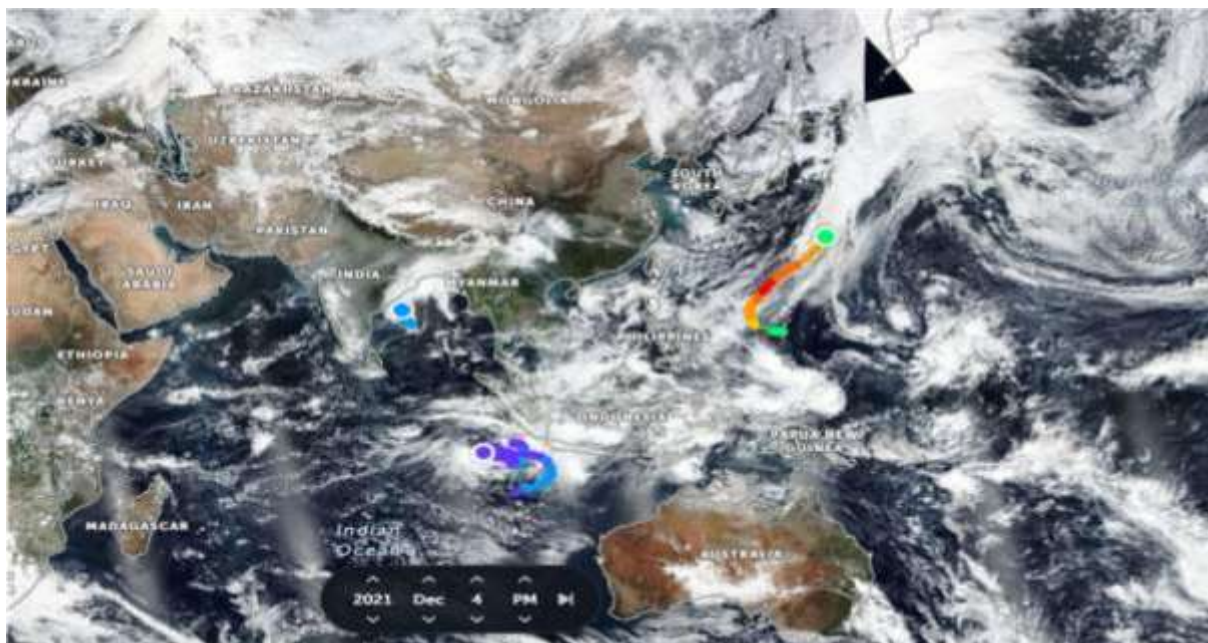
**Figure 3 Position of ‘Nyatoh’ on 1 December 2021**

On 2<sup>nd</sup> December 2021 it is observed that the heavy rainfall continued over the central Maharashtra. It is observed that the low depression produced in to the Bay of Bengal. The low intensity typhoons ‘Jawad’ is originated and started to approach towards Odisha Coast. The air present over the Indian subcontinent started to move towards Bay of Bengal against the regular wind direction. Instead of heavy rain as predicted on 2<sup>nd</sup> December little rainfall receives over the Deccan Platue. It was heavy rainfall received over the some part Odisha and southern part of West Bengal (See Figure 4)



**Figure 4 Position of ‘Nyatoh’ on 2 December 2021**

On 4<sup>th</sup> of December 2021, the ‘Nyatoh’ is about to vanish, after few hours it is observed that the cyclone ‘Jawad’ also vanishing. The Influence of ‘Jawad’ and ‘Nyatoh’ on air mass is also gradually released. The air mass has received momentum in regular direction of monsoon wind flow. The wind started to move in the direction of south and south west progressively. There were heavy rainfall received over to Southern Districts of West Bengal and northern districts of coastal Odisha (See Figure 5).



**Figure 5 Position of ‘Nyatoh’ on 4 December 2021  
Post ‘Nyatoh’ Observations**

It is also observed that after Vanishing the ‘Nyatoh’ and ‘Jawad’ the mild cyclone ‘Teratai’ was only to influence the air mass. If the normal situation would be there, it was expected heavy rainfall on same day of vanishing the ‘Nyatoh’ i.e. 4<sup>th</sup> December or on 5<sup>th</sup> December. But due to presence of ‘Tertatai’ the wind flow slightly shifted its direction and pulled southward from the Bay of Bengal instead of its usual south-east direction.

After 7<sup>th</sup> December the ‘Teratai’ Shifted to Southward and hence its influence over the Bay of Bengal also reduced and the winds shifted toward Indian southern territory. On the 8<sup>th</sup> Heavy rainfall experienced By Odisha Eastern coast followed by Andhra Pradesh and Tamil Nadu’s Costal districts. (Hindustan Times 7 December 2021; 14.The Weather news-weather.com 7 December 2021)

In Normal situation the Tamil Nadu, Karnataka Andhra Pradesh and Odisha are the Indian state which worst affected by Heavy rainfall during returning Period of Monsoon. In regular returning period of Monsoon the Karnataka receives rainfall. It is observed that in this period the Karnataka received less or negligible rainfall. It was due to the influence of the ‘Taratai’, which pulled the air mass in the southern part of Karnataka.

### **Expected Outcomes**

Our study intended to find the possibility of prediction of heavy rainstorms and cloud bursts over the Indian Territory by observing the typhoons originated in the Philippine Sea. We think that our study can give some suggestions to researchers for further development.

Our further study may give some suggestions to the researchers and the disaster managers to avoid or minimize the damage of properties and lives occurs due to cloud burst situations.

From our futuristic study could lead to correlate, the cyclones prediction by use of various models (Masahiro Watanabe and Fei-fei Jin 2002; Roger A Flather, 1991; S.K. Dube, P.C.Sinha et. al. 1985).

Our further study can lead to develop Wave Mechanical Model for rainfall prediction.

### **Benefits to the society/ Inter-disciplinary relevance if applicable**

Over the Indian Territory, It is observed that due to cloud burst and heavy rainfall there are huge financial losses. Millions of peoples affected directly or indirectly. In Maharashtra it is reported that, since 2019 there is more than 14000 crore (about 18% of the state’s fiscal deficit for financial year (FY) 2020-21) has been spent over the compensation. The personal losses of the citizens are in many fold in terms of wealth death casualties.

Our study may beneficiary to the society by preventing the loss of valuable property, by saving lives affected due to flood and cloud burst, and saving government’s unplanned compensation expenditures.

**Application of outcomes / Future scope:**

There is big scope for this hypothesis as there are many parallels are seen

- 1) Cloud burst occurred in Mumbai on 26 July 2005, can be related with the existence of Typhoon 'Haitang' followed by oceanic storm 'Banayan' both originated in Philippine Sea
- 2) Cloud burst occurred in Islamabad on 23 July 2001 may be the result of co-existence of Typhoon 'Yutu' and 'Cong-Ray' originated in Philippine Sea. **Limitations**

- 1) There are many geographical, Geological, Geomorphological, Oceanographic and atmospheric constraints in the study of our hypothesis. The human induced parameters like reservoir, mines, and thermal electric plants and similar may influence the atmospheric parameter.
- 2) The coexistence of two or more than two tropical typhoons, cyclones, oceanic storms or pressure depressions makes the things more complex.
- 3) We can predict either cloud burst possible or not. It is too complex to predict the location so we cannot predict the location of cloud burst. **References**

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