Changes of Typhoon Hazards and Disaster Loss in China

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Outline

1. Overview

2. Change of Hazards
   2.1 Frequency
   2.2 Central Pressure
   2.3 Intensity
   2.4 Wind
   2.5 Rainfall

3. Change of Disaster Loss
   3.1 Human life loss
   3.2 Direct economic loss

4. Discussion
1. Overview

### Categories of Tropical Cyclone Intensity over North-western Pacific

<table>
<thead>
<tr>
<th>Tropical Cyclone Intensity Category</th>
<th>Beaufort Scale</th>
<th>2-min Mean Maximum Sustained Wind (m/s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tropical Depression</td>
<td>6~ 7</td>
<td>10.8~17.1</td>
</tr>
<tr>
<td>Tropical Storm</td>
<td>8~ 9</td>
<td>17.2~24.4</td>
</tr>
<tr>
<td>Severe Tropical Storm</td>
<td>10~11</td>
<td>24.5~32.6</td>
</tr>
<tr>
<td>Typhoon</td>
<td>12~13</td>
<td>32.7~41.4</td>
</tr>
<tr>
<td>Severe Typhoon</td>
<td>14~15</td>
<td>41.5~50.9</td>
</tr>
<tr>
<td>Super Typhoon</td>
<td>≥16</td>
<td>≥51.0</td>
</tr>
</tbody>
</table>

(Reference: GB/T 19201—2006)
1. Overview

Best Tracks of Tropical Cyclone of North-western Pacific (1949-2010)
2.1 Frequency

- (a) Frequency of all TCs
- (b) Frequency of Landing TCs
- (c) Percentage of Landing TCs
Mean and Minimum of Historical Central Pressure (0.5°×0.5° degree grid)
Mean and Minimal of Historical Central Pressure (0.5°×0.5° degree grid)
# 2.3 Intensity

Statistics of Tropical Cyclone of Different Categories (Landing and Total)

<table>
<thead>
<tr>
<th></th>
<th>TD</th>
<th>TS</th>
<th>STS</th>
<th>TY</th>
<th>STY</th>
<th>SSTY</th>
<th>Sum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>411</td>
<td>251</td>
<td>392</td>
<td>369</td>
<td>281</td>
<td>346</td>
<td>2050</td>
</tr>
<tr>
<td>Landing</td>
<td>88</td>
<td>58</td>
<td>122</td>
<td>133</td>
<td>70</td>
<td>100</td>
<td>571</td>
</tr>
<tr>
<td>Percentage</td>
<td>21.41%</td>
<td>23.11%</td>
<td>31.12%</td>
<td>36.04%</td>
<td>24.91%</td>
<td>28.90%</td>
<td>27.85%</td>
</tr>
</tbody>
</table>
Percentage of Tropical Cyclone of Different Categories (NWP)
2.3 Intensity

Percentage of Tropical Cyclone of Different Categories (Landing China)
## Trend Analysis of Different Categories

$$r_{xt} = \frac{\sum_{i=1}^{n}(x_i - \bar{x})(i - \bar{t})}{\sqrt{\sum_{i=1}^{n}(x_i - \bar{x})^2 \sum_{i=1}^{n}(i - \bar{t})^2}}$$

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<th>TY</th>
<th>STY</th>
<th>SSTY</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>Decrease</td>
<td>Increase</td>
<td>Decrease</td>
<td>Stochastic</td>
<td>Stochastic</td>
<td>Decrease</td>
<td>Decrease</td>
</tr>
<tr>
<td>Landing</td>
<td>Decrease</td>
<td>Increase</td>
<td>Stochastic</td>
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<td>Stochastic</td>
<td>Decrease</td>
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</table>

### All Categories

![Graph of All Categories](image1.png)

### Landing TC

![Graph of Landing TC](image2.png)
Mean and Minimum of Historical MWS (0.5° x 0.5° degree grid)

MWS: maximum wind speed
Mean and Minimum of Historical MWS (1949-2010)
2.4 Wind

Graph showing the ACE and PDI indices from 1949 to 2011 with data points for various years.

- ACE
- PDI

The graph displays fluctuations in ACE and PDI values over the years, with ACE represented by black lines and PDI represented by red lines.

Large spikes and dips are observed, particularly around the years 1951, 1967, and 1989.

The y-axis represents the values of ACE and PDI, with a range from 0 to 25, using units of $0.0001 m^2/s^2$ and $0.00001 m^3/s^3$.
2.5 Rainfall

Rainfall extracted with FY

TRMM rainfall

Rainfall contour with ground obs. and other sources
2.5 Rainfall

Comparison of rainfall with different sources

Rainfall volume based on FY production (0.1 km$^3$)

\[ y = 0.961x - 11.95 \]
\[ R^2 = 0.9043 \]

Rainfall volume based on Yearbook Data (0.1 km$^3$)

\[ y = 1.0365x + 0.8299 \]
\[ R^2 = 0.5955 \]

Hourly rainfall volume based on FY data (0.1 km$^3$)

Hourly rainfall volume based on TRMM data (0.1 km$^3$)
The mean rainfall per TC event during 1951-2009.
2.5 Rainfall

Trend (linear slope) of TC rainfall during 1951~2009
1) Total rainfall: no significant period
2) Maximum annual rainfall per event: weak period of 7 years
3.1 Loss of Life

The chart shows the death toll from 1985 to 2010. The death tolls range from low to high, with a significant peak in 1994. The trend from 1990 to 2000 shows a decrease, indicating a reduction in the death toll over time.
3.2 Economic Loss

Agriculture

affected crop area (10^3 hectares)


Economic Loss (3.2)
3.2 Economic Loss

Building

number of collapsed rooms ($10^4$)

3.2 Economic Loss

- **direct economic loss**
- **direct economic loss (2000 RMB)**

The graph shows the fluctuation of direct economic loss from 1985 to 2010, measured in billion yuan. The black line represents the direct economic loss, while the red line indicates the direct economic loss in 2000 RMB.
4. Discussion

Change of Hazards?
---- No significant change/increase

Change of Life Loss
---- Decrease

Change of Economic Loss
---- Increase? Decrease? Almost constant?

Change of Exposure
---- Great increase due to urbanization and industrialization

---- Vulnerability
---- Decrease, instead of popular “increasing” argument
Tropical Cyclone Systems Under Development

- CycloneWatcher
- CycloneLoss
- CycloneRisk
- http://Github.com/OpenCyclone

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