# A Useful Forecasting Model For The Industry: TropicalStormRisk

Mr David Simmons of Benfield Greig describes the techniques behind the forecasts undertaken by TropicalStormRisk (TSR), a consortium of leading UK-based scientists and insurance experts, producing long-range forecasts of hurricanes, typhoons and tropical cyclones in three major basins, including the Northwest Pacific, and demonstrates how they may be used by the insurance industry.

The recent Shanghai meeting of the Intergovernmental Panel on Climate Change firmly concluded that global climate change is happening, but the consequences of this change are far from clear.

Tropical cyclones are the most costly and deadly natural disaster affecting much of Japan, South Korea, Taiwan, the Philippines, and coastal areas in other Southeast Asian countries. The annual damage bill and fatality rate from tropical cyclone impacts in Southeast Asia 1990-1999 averages, respectively, US$3.3 billion (2000) and 740 deaths.

Substantial inter-annual variability exists in regional tropical cyclone losses. For example, in 1999 and 1997, the US experienced losses of US$8.2 billion and just US$0.16 billion (2000), respectively.

Skilful long-range forecasts of seasonal tropical cyclone strike numbers will benefit society, business and government by reducing the risk, uncertainty and financial volatility inherent to varying active and inactive tropical storm seasons.

## Forecasting Methodologies

Forecasters generally fall into two camps: statistical and dynamical.

Statistical forecasters, such as Professor Bill Gray's group at Colorado State University, acknowledge that the world's climate is a complex system which is yet far from understood. However, they argued that a partial understanding does not preclude long-term forecasts being made with real skill. Historical records are examined in an attempt to find patterns that seem to be linked to hurricane incidence.

In contrast, dynamical forecasters will argue that such methods, based as they are on limited data, are unreliable. Instead, forecasters should seek to understand fully the processes that determine extreme climatic events. These are laudable sentiments, but are dynamic modellers yet in a position to forecast general climatic conditions from nine months out? Even the best, such as that developed and run by the UK Met Office's Hadley Centre, will not claim to be able to produce seasonal forecasts more than a few months ahead.

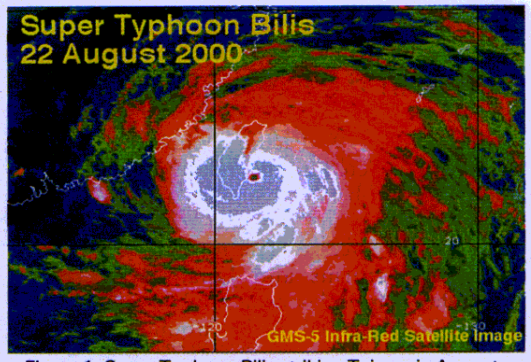


Figure 1: Super Typhoon Bilis striking Taiwan in August 2000 with Category 5 hurricane-force sustained winds of >155mph. The typhoon eye is just visible. TSR successfully predicted in May 2000 that the Japanese tropical storm and typhoon strike totals in 2000 would be below average. (Image courtesy of University of Wisconsin-Madison, US).

## TropicalStormRisk

The aim of the TSR consortium is to get the best of both worlds. The team are confident that they can go "beyond Gray" by using the latest scientific and computational methods to identify new predictors of tropical cyclones. But they also plan to use the Met Office's dynamic climate models to seek to explain and justify how and why observed predictors do influence tropical cyclone activity. It is hoped that consortium members will not only gain access to better long-term forecasts, but also that the work will increase understanding of the cycles and patterns governing tropical cyclone genesis and intensity.

The TSR consortium comprises leading UK insurance industry experts and scientists at the forefront of seasonal forecasting. The TSR insurance expertise is drawn from the UK-based multinational insurers CGNU and Royal & SunAlliance together with Benfield Greig, a leading independent global reinsurance and risk advisory group. The TSR scientific grouping brings together climate physicists, meteorologists and statisticians at the Benfield Greig Hazard Research Centre at University College London and the Met Office.

TSR aims to:

- Improve the accuracy of seasonal tropical cyclone forecasts at all lead times using new statistical and dynamical model techniques;
- Forecast land falling events in addition to overall basin activity;
- Extend forecasts to new territories (eg Southeast Asia and Queensland)

| NWP Pacific Numbers - 2000 | | | |
|---|---|---|---|
| | Intense Typhoon | Typhoons | Tropical Storms |
| Average (± SD) 1971- | 8.2 (± | 17.0 (± | 27.2 (± |
| Actual 2000 | 7 | 14 | 25 |
| TSR Forecast (± SD) 26 May 2000 | 7.0 (± | 14.1 (± | 25.3 (± |
| Chan Forecast (± SD) End June 2000 | na | 16 (± | 28 (± |

| Japan Landfalling Numbers - 2000 | | |
|---|---|---|
| | Typhoons | Tropical Storms |
| Average (± SD) 1971- | 2.5 (± | 4.1 (± |
| Actual 2000 | 2 | 4 |
| TSR Forecast (± SD) 26 May 2000 | 1.8 (± | 3.1 (± |

Figure 2: Comparison of TSR forecast of 2000 NW Pacific tropical cyclones and landfalling Japanese tropical cyclones with actual numbers, the 30-year average and, for NW Pacific only, the forecast of Professor Johnny CL Chan of the City University of Hong Kong.

- Benefit business, government and society by reducing risk and uncertainty.

### Analysis Of The 2000 Season Forecast

The team's 2000 season forecasts proved uncannily accurate. They exactly predicted the numbers of tropical storms, typhoons and intense typhoons in the Northwest Pacific in 2000, and the number of landfalling Japanese typhoons.

### Summary Of The 2001 Season Forecast

The 2001 NW Pacific typhoon season is expected to be relatively quiet. The numbers of typhoons and intense typhoons are expected to be slightly below average. The numbers of tropical storms and Japanese landfalling tropical storms and typhoons are expected to be around average.

This is largely because TSR expect the present weak La Niña or El Niño Southern Oscillation (ENSO) conditions to persist through to the autumn. An updated TSR forecast will be issued in late May 2001.

### Forecast Methodology

Anomalous patterns of sea surface temperatures (SSTs), particularly those associated with the ENSO, are the primary source of tropical atmospheric forcing of NW Pacific typhoon activity on seasonal and interannual timescales.

The TSR primary predictor is forecast August-September 2001 Niño 3.4 region (5°S-5°N, 120°W-170°W) SST obtained from TSR's in-house predictor model. At lead times after April, TSR incorporates other SST regions but these tend to be extra-tropical and cannot be forecast accurately so far from the cyclone season. The TSR January forecast model provides a 15% skill improvement over random chance for NW Pacific typhoon and intense typhoon numbers.

| NWP Pacific Numbers - 2001 Forecast | | | |
|---|---|---|---|
| | Intense Typhoon | Typhoons | Tropical Storms |
| Average (± SD) 1971- 2000 | 8.2 (± 3.4) | 17.0 (± 4.1) | 27.2 (± 4.6) |
| Actual 2000 | 7 | 14 | 25 |
| TSR Forecast (± SD) 5 February 2001 | 6.6 (± 2.2) | 16.2 (± 2.7) | 28.1 (± 2.9) |

| Japan Landfalling Numbers - 2001 Forecast | | |
|---|---|---|
| | Typhoons | Tropical Storms |
| Average (±SD) 1971- 2000 | 2.5 (± 1.5) | 4.1 (± 1.7) |
| Actual 2000 | 2 | 4 |
| TSR Forecast (± SD) 5 February 2001 | 2.5 (± 1.3) | 4.0 (± 1.3) |

Figure 3: 2001 forecast for total expected activity in the Northwest Pacific (NWP) and Japanese landfall. Error is represented as plus or minus one standard deviation.

TSR's methodology differs from other NW Pacific forecasts as it focuses on predicting environmental factors contemporaneous to the coming tropical cyclone season, rather than using only actual information available at the time of forecast. The TSR approach thus retains the fundamental physical link between tropical cyclones and the associated atmospheric circulation patterns as they happen. With the future incorporation of Met Office dynamical forecasts at the shorter leads, the TSR comparative advantage may further increase.

### Conclusion

TSR has built an enviable reputation for the accuracy of its forecasts and robustness of its methodology in its short life to date. TSR is continuing to expand its services and further improve the scientific and technical bases of its forecasts. By applying and enhancing proven forecasting methods to the Pacific cyclone basins, it can not only help insurers better understand the risks they face, but also better meet the varying needs of their stakeholders and customers.

## www.TropicalStormRisk.com

Currently, TSR publishes the following forecasts publicly on its website at www.TropicalStormRisk.com

- **Basins**: Atlantic (ATL), NW Pacific (NWP) and Australian (AUS)
- **Landfalling Cyclones**: US, Caribbean Lesser Antilles, Japan and Queensland
- **Intensities Forecast**: Equivalent of tropical storm strength, typhoon strength and intense typhoon strength.
- **Long-range forecasts**: Issued before start of main renewal season (ATL-October; NWP-January; AUS-April)
- **Pre-season forecasts**: Issued at the start of each basin's main tropical cyclone season (ATL-June; NWP-June; AUS-December).
- **Verification**: Post-season verification of forecasts against actual

The members of the TSR consortium get the benefit of a short lead time before the forecasts are made public.

For 2001, TSR can also offer:

- Monthly updated TSR forecasts for any territory, landfalling area, and strength category listed above. These are available from prior-September to August (ATL), prior-December to August (NWP), and April to February (AUS).
- Specialist Consultancy Services, using the skills and experience of TSR researchers, to develop and run tropical storm forecasts for other areas in your portfolio, perhaps other basins or with finer geographical focus.

### TSR Future Developments And Services

During the coming months TSR scientists will be extending their research programme to investigate the following areas:

- Incorporating Met Office dynamical weather prediction data into the TSR models at short (less than four months) leads. This is consistent with the original innovative objective of linking the best of statistical and dynamical modelling approaches;
- Using regional TSR forecasts as input to catastrophe models. Most catastrophe models do not explicitly allow for trends and cycles in likely frequency of events. The output of a TSR forecast can be used to demonstrate how the probability of financial loss of any given size in the current year is greater (or less) than the long-term average;
- Extending the scope of the forecast to include landfalling cyclones in other East and Southeast Asian territories.