Peak Runoff Index Insurance in Taiwan

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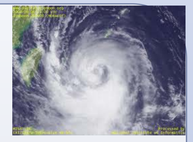
BACKGROUND



◆ **Agricultural Risk in Taiwan**

Typhoons are the major cause of weather-related damages to Taiwan's agricultural sector. The bulk of the damages, however, were not directly attributable to excessive winds, but rather to the flooding and mudslides caused by sustained rainfalls. For example, the deadliest typhoon in history, typhoon Morakot in 2009, produced sustained amounts of rainfall, which triggered mudslides and severe flooding throughout southern Taiwan. Roughly US$4.7 billion in damages to Taiwan agricultural and fishery industries are reported.

◆ **Agricultural Risk Management in Taiwan**

Taiwan agricultural producers lack access to formal insurance and derivative markets, such as futures, options and crop insurance, for the management of production risk in Taiwan. Alternatively, they rely heavily on government disaster assistance, such as natural disaster aid funds and low-rate loans for agricultural producers, in times of catastrophic losses due to typhoons, droughts and floods.

OBJECTIVES

To help protect agricultural producers against catastrophic weather events,

➢ we explore optimal designs for a flood-related index insurance scheme that would be appropriate for agricultural producers in Southwest Taiwan, and

➢ we design and perform an actuarial assessment of a contract that would indemnify agricultural producers in Southwest Taiwan based on peak runoff experienced during a typhoon.

METHODOLOGY

To design a index insurance contract for flood-related losses to agriculture in Southern Taiwan, we consider hydrology cycle for a watershed.

Input of a watershed = storage + output,

where input is the rainfall,
storage are interception, infiltration and groundwater, and
output are evapotranspiration and runoff.

➢ Alternative to conventional rainfall index contract, we design a peak runoff index insurance and assess its actuarial properties with the other two alternatives.

Rainfall-Runoff Model

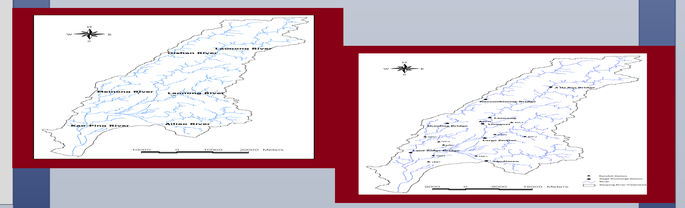
We apply a storage function model proposed by Kimura (1962) to compute runoff of a watershed.

$$S_1 = KQ^p,$$

where S_1 is the discharge storage of rainfall over the watershed,
Q is the flood runoff,
K and p are parameters which must be defined.

✓ We begin by optimizing the parameters of the storage function for single and multiple storms.

✓ Based on a cluster analysis of storm patterns, we estimate regional storage function using multivariate regression techniques, and using Harr's Point Estimation and Monte Carlo Simulation methods, assess uncertainty regarding the storage function parameters.



DATA

Our research employs 1990-2009 weather and flow data from Central Weather Bureau and Water Resources Agency, Ministry of Economic Affairs in Taiwan.

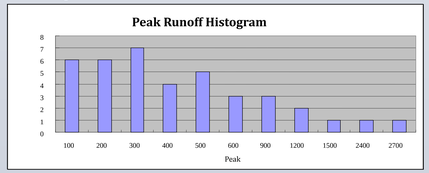
✓ 39 typhoons are selected during the time period.

✓ Typhoon duration starts when a sea warning is issued by Central Weather Bureau and ends as soon as the typhoon warning is terminated.

✓ One flow station, Sandimen, and two rainfall stations in Kaoping River are selected to obtain the rainfall and storage discharge data.

RESULTS

✓ Histogram of Peak Runoff



✓ Correlation Test between proposed weather index vs. agricultural production losses in different regions during the typhoon period

Weather Index	Kaohsiung	Pingtong	Southern Taiwan
Accumulated Rainfall	**0.738**	**0.355**	**0.675**
Average Rainfall	**0.673**	**0.261**	**0.582**
Peak Runoff	**0.767**	**0.490**	**0.757**

✓ Actuarial premium rate for various index insurance contracts

	Average Rainfall	PeakRunoff
Dollar per Point	$25	$5
Trigger Value	50mm/day	100m^3/S
Premium	NT$7,223.40	NT$5,746.90

CONCLUSIONS

➢ Peak runoff index has higher correlation than accumulated rainfall index and average rainfall index to agricultural losses in Southern Taiwan.

➢ To our knowledge, our proposed peak runoff index insurance contract is the first to be designed around a peak river flow index.

➢ Our results indicate that, with optimal choices of contract parameters, an insurance contract based on a peak runoff index can offer excellent coverage against widespread flooding cased by typhoons at reasonable premium rates.

➢ Our paper provides an analysis of a novel index insurance scheme based on peak flows and further provides an empirical basis for further, more general discussion regarding the potential benefits of weather index insurance contracts in Taiwan.

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