"Conceptual Study on Securitizing Weather-related Risk in India"

Dr.Bharath V
Guest Faculty, Department of Studies in Commerce,
University of Mysore, Manasagangothri, Mysore, Karnataka-570006
Email:bharathv@commerce.uni-mysore.ac.in

Abstract

This article makes an initial attempt to study the conceptual framework about weather derivatives instrument for absorbing weather-related risk. The study examines the potential of these instruments as standardised framework for transferring weather risks form hedgers to investors/speculators in the capital market. There is a need to create a sustainable weather risk market for the economy to absorb the weather-related risk. The weather risk market can provide an opportunity for integrating weather-index-based insurance markets with the capital markets. Weather derivatives can be an innovative product in Indian capital markets. It has a vast potential for creating sustainable weather risk markets to hedge, arbitrage and speculate uncertain weather-related events. The development of these markets requires detailed research and regulatory support. The designing and pricing of weather derivatives are challenging issues that need to be address.

Key words: Securitization, weather-related risk, weather derivatives, capital market, index-based insurance.

1. Introduction

Weather-related risk has an enormous impact on businesses' prospects. Extreme weather events are costing India $9-10 billion annually and climate change is projected to impact agri-productivity with increasing severity from 2020 to the end of the century (Vishwa Mohan, 2017). Extreme weather events like droughts, floods, cyclone, temperature and weather-related risk may cause significant financial losses. This kind of direct impact has been cyclical each year and cannot control weather-related events. The traditional way of protection against extreme weather conditions has always been insurance, which covers the loss in exchange for a premium payment. Securitizing the weather-related risk has the potential to mobilize the power of the capital markets by expanding reinsurance capacity and providing hedging tools in the event of major natural catastrophes and extreme weather. For example, recently new financial instruments linked to weather conditions like CAT bonds and weather derivatives have become popular. Since 1990, weather derivatives were developed to hedge against variability caused by weather-related risks. Weather derivatives are financial contracts, where payoffs are based on weather-related events. There is an increasing demand for market-based products like weather derivatives. Developed markets like the US, Britain, Europe, and Japan have already introduced exchange-traded weather derivatives products.

India needs weather derivatives instruments to reduce risks associated with extreme weather events. However, these derivatives are still in a stage of infancy. The designing of weather derivative product has attracted the attention of many researchers. The present study aims to throw more light on these issues.

2. Weather-related risk in India

India is exposed to a wide range of weather-related risks such as droughts, floods, storms, landslides, and extreme temperatures. India’s economic losses from weather-related events have doubled over the last thirty years (Charanjit,et al., 2019). A report of McKinsey Global Institute has found that economic damage incurred by Mumbai (India) from flash floods could be almost double by 2050. Therefore, Floods are the most economically damaging weather-related events, costing more than all other disaster events combined. From 1998 to 2017, 10 out of 14 extreme weather-related disasters were floods, causing economic damage of approximately US $45 billion and killing over 27000 people and affecting more than 370 million people (Charanjit., et al 2019) in India.

2.1 Impact of Weather-Related Risk on Economic Sectors

Indian economy is extremely sensitive to monsoon outcome. Panagariya (2009) pointed out that India's economy is highly vulnerable to climate change. It is estimated that 70 percent of agriculture losses occur either due to drought or floods (Parchure, 2002). The extreme weather fluctuations could significantly impact agriculture and other enterprises, including power generation, agri-insurance, finance, agri-processing, etc. The Effective management of monsoon risk is essential for achieving sustainable development of the economy.

(a) Agricultural and Allied Sector

The agricultural sector contributes fourteen percent of the GDP, and nearly sixty percent of the workforce depends on agricultural activities for their livelihood. More than sixty percent of the Indian agricultural area still depends on the performance of monsoon (rainfall). The south-west monsoon is critical to the kharif season crop. "Year-to-year fluctuations in summer monsoon rainfall all over India have a strong impact on the variability of aggregate Kharif food grain production" (Parthasarathy et al.,1992; Gadgil,1996). The Rabi season starts after the south-west monsoon. Rainfall occurring at the end of the monsoon season provides stored soil moisture and sometimes irrigation water for the Rabi crop. Therefore, the south-west monsoon is accountable for both kharif and Rabi crop production in India. If the southwest monsoon is delayed by a few days, it can adversely affect agricultural production.

(b) Aviation Industry

Weather-related risks such as heavy rainfall, storms, rising sea level, and monsoon wind patterns adversely impact the aviation sector. The impact of weather-related events on the Indian aviation sector will vary according to geography, climate, and circumstances. Compared to other transport modes, the aviation industry has been facing extreme weather events leading to reduced aircraft performance, changing demand patterns, damage to infrastructure, cancellation costs for operators, and maintenance costs for airport authorities and operators.

(c) Fiscal Burden

An adverse monsoon causes increased government spending due to provision for write-off farm loans, relief packages, and restoration of damaged infrastructure. The nationwide loan waiver was announced in 1990 at Rs.10,000 crore and in 2007-08 budget, the finance minister announced Agriculture Debt Waiver and Debt Relief Scheme for small and marginal farmers was Rs. 52,500 crores. The scale of farm loan waivers has seen an exponential increase since 2014-15, around ten states have announced loan waivers aggregating Rs.2.4 lakh core since 2014-15 (Radheshyam Jadhav 2021). Therefore, monsoon plays a vital role in the deciding budget expenditure.

(d) Stock Market

Normal monsoon creates a positive sentiment among the investors. The stock market reacts to the Indian Meteorological Department (IMD) monsoon forecasts. A deficit rainfall forecast will result in a decrease in the stock market the following day. A normal rainfall forecast will result in some gains in the market. The reaction from the investors depends on the IMD forecast. Therefore, deficit/excess monsoon rainfall significantly impacts the stock market.

3. Weather risk management products

The weather risk management product makes it possible to mitigate the impact of weather-related risk through risk transfer instruments. The products comprises of three risk management instruments traditional crop insurance scheme, weather-index-based insurance, and weather-index-based derivatives. The weather risk management products continues to expand, but the reinsurer needs an integrated approach for the future growth of this vital segment of our economy.

3.1 Weather-index based insurance

The crop insurance scheme is one of the most important risk management tools available for Indian farmers, given the high degree of uncertainty and risk involved in agriculture. Crop insurance programmes face multiple challenges and are extremely vulnerable to weather-related risks such as droughts and floods. During the past five decades, crop insurance programmes have tried to protect farmers' interests by providing them with protection against weather-related risks. Crop insurance operates on both an area basis and an individual basis. Yield-based insurance schemes, such as the National Agricultural Insurance Scheme (NAIS) and the Modified National Agricultural Insurance Scheme (MNAIS), make

up most of the market for crop insurance. These schemes employ crop-cutting and aerial surveys to gauge the amount of yield loss incurred by the farmer due to droughts, floods, or other natural catastrophes. This often results in high transaction and damage assessment costs to the insurer. In 2016, the government introduced two new restructured crop insurance schemes as a replacement of old schemes: Pradhan Mantri Fasal Bima Yojana (PMFBY) and the Restructured Weather-Based Crop Insurance Scheme (RWBCIS). A brief history of evolution of crop insurance schemes in India is presented in Table 1.

Table 1: Summary of Evolution of Crop Insurance Schemes in India

Year	Crop insurance name	Salient features
1972	Experimental Crop insurance scheme	Individual farm level
1979	Pilot Crop Insurance Scheme (PCIS)	Area-based approach; the participant was voluntary for loanee farmers.
1985	Comprehensive Crop Insurance Scheme (CCIS)	Homogeneous area-based approach, compulsory for loanee farmers.
1999	National Agricultural Insurance Scheme (NAIS)	Both area-based and individual farm approach. It covers all-natural calamities for localized conditions.
2007	Weather-based Crop Insurance Scheme (WBCIS)	It was based on weather parameters like drought, floods.
2010	Modified National Agricultural Insurance Scheme (MNAIS)	Area approach to village panchayat level. It allows private sector participation.
2013	National Crop Insurance Programme (NCIP)	All schemes were combined (WBCIS, MNAIS)
2016	Pradhan Mantri Fasal Bima Yojana (PMFBY)	Replacement of MNAIS scheme. It is an area-based yield index insurance scheme—a reduction in the cost of the premium. Participation of farmers is voluntary.
2016	Restructured Weather-Based Crop Insurance Scheme (RWBCIS).	Replacement of WBCIS scheme. Reduction in the cost of the premium. Participation of farmers is on a voluntary basis.

Source: author's compilation

Chakravarti J.S designed the first crop insurance scheme in 1920, which was area-based and rain-gauge station-specific. After independence, the government introduced the first individual approach scheme in 1972, which was an experimental crop insurance scheme. The General Insurance Corporation of India (GIC) implemented the scheme on an experimental basis across the states. This scheme covered cotton, wheat, groundnut, and potato crops. The participation of farmers was on a voluntary basis. The loss assessment was

based on the individual farmer’s level. This scheme's performance was not satisfactory as loss assessment of an individual farmer’s status was unrealistic.

Prof. Dandekar suggested a Pilot Crop Insurance Scheme (PCIS) in the year 1979. This scheme was based on an area-based approach. Initially executed as a pilot scheme in the three states only, it was extended to twelve states. The scheme was only for loanee farmers who can participate on a voluntary basis. The scheme covered cereals, millets, oilseeds, cotton, potato, and grams. From 1979-85, the scheme insured 6.27 lakh farmers and collected Rs.196.95 lakhs as premium. The compensation made under this scheme was Rs.157.05 lakhs. The main concern of this scheme was lack of awareness and lack of access to institutional credit.

Comprehensive Crop Insurance Scheme (CCIS) was the first crop insurance scheme introduced on a nationwide scale in 1985. The scheme was operated on a homogeneous area basis. This scheme was made compulsory for the farmers who had taken a short-term loan from the financial institutions. During 1985-1999, a total premium of R.403.5 crores was collected and Rs.2,319 crores settlements were made. The losses were reported in 27 out of 29 monsoon seasons. The claim was more than the premium received under this scheme.

National Agricultural Insurance Scheme (NAIS) was implemented from Rabi 1999-2000 seasons. Agriculture Insurance Company of India Ltd. (AICIL) took over the implementation of the NAIS. The NAIS scheme was based on an area approach to measuring the widespread calamities and individual approaches for localized calamities such as floods, cyclones, landslides, and hailstorms. This scheme was made compulsory for the farmers who availed a loan from the financial institution and it was voluntary for non-loanee farmers. The NAIS's major issues shortcomings were related to financial viability, adverse selection, and higher premiums. NAIS had operational problems and failed to induce farmers to accept it. Later, the government introduced weather-based index insurance as an alternative.

Modified National Agricultural Insurance Scheme (MNAIS) was introduced during 2010-11 rabi season on a pilot basis. MNAIS was a replacement for the NAIS scheme. This scheme's participation was very low due to high premium rates, lack of accurate crop yield data, lack of awareness and publicity among farmers, and less sum assured. Pradhan Manti Fasal Bima Yojana (PMFBY) has been rolled out for farmers to minimize crop loss due to unseasonal or excessive rainfall. The government implemented the scheme in 2016. PMFBY is a replacement for the NAIS and MNAIS scheme. The scheme compensates for the

damages to the crops due to unseasonal cyclones, hail, and storm damage on an individual basis. The premium paid by the farmers is very low. PMFBY scheme provides full sum insured to the farmers for crop loss in any kind of natural calamities. The Government of India has introduced innovative schemes for crop insurance. However, these schemes failed to meet the expected results due to the low policy implications, lack of awareness among farmers, poor performance of implementing agencies.

Weather Index-Based Insurance

Index-based insurance contracts in agriculture have emerged as an alternative to traditional crop insurance. These are linked to the underlying weather risk defined as an index based on historical data (for example, for rainfall, temperature, snow, etc.) rather than the extent of loss (for example, crop yield loss). Weather insurance is an innovative product that can be used for situations ranging from sales promotions to income stabilization, unlike regular insurance, which would only cover physical damage, weather insurance protects against additional expenses or loss of profit from a specific weather event.

There are substantial coverage gaps in terms of farmers' benefits and crops being covered under the state-sponsored and heavily subsidized NAIS scheme, a multi-peril, area-based crop insurance scheme that was mandatory for loanee farmers. Gross regional disparities in farmers terms covered the premium collected, claims reported, and claims settled. A financial innovation that promised to overcome the existing crop insurance scheme's problems was index-based weather insurance.

The pilot for the Weather-Based Crop Insurance Scheme (WBCIS) began in Kharif in 2007. WBCIS is a subsidized weather-indexed insurance program, in which the premium subsidies were shared equally by the State and the Centre Governments. Since inception, it has been made compulsory for farmers who avail a loan (loanee farmers), though it was also available to other farmers (non-loanee farmers) through the same financial institutions such as banks, insurance agencies, and authorized representatives of Agricultural Insurance Company of India (AIC) Limited. Weather indexed insurance schemes assume deviations in weather conditions as a proxy for yield loss and compensate for the assumed loss. They indemnify the farmer against smaller variations in weather parameters, compared to yield insurance schemes. Typically, the rainfall volume, number of rainy days, dry spell and wet spell, temperature, humidity, sunshine, and wind speed are considered. The index is usually created with a specific geographic region in mind, which results in more accurate correlations

between the yield and the parameters considered. When these parameters cross their predetermined minimum and maximum thresholds, pay-outs are automatically released to the farmers, resulting in almost zero damage assessment costs. The merits of rainfall based contracts over crop insurance are summarized below:

1) Lower moral hazard and adverse selection
2) Lower administrative costs since no on-farm inceptions are needed, and no individual loss adjustments are required.
3) Reduce the need to track yields or financial loss (one need only measure rainfall). The insurance can be sold to anyone who has income connected to the rainfall event, including bankers, agricultural traders and processors, farm input suppliers, shopkeepers, consumers of basic commodities, and agricultural workers.
4) It can be sold as a simple certificate in low denominations
5) Facilitate the development of other kinds of insurance to handle independent risk.

However, the weather Index-based insurance suffers from the following limitations:

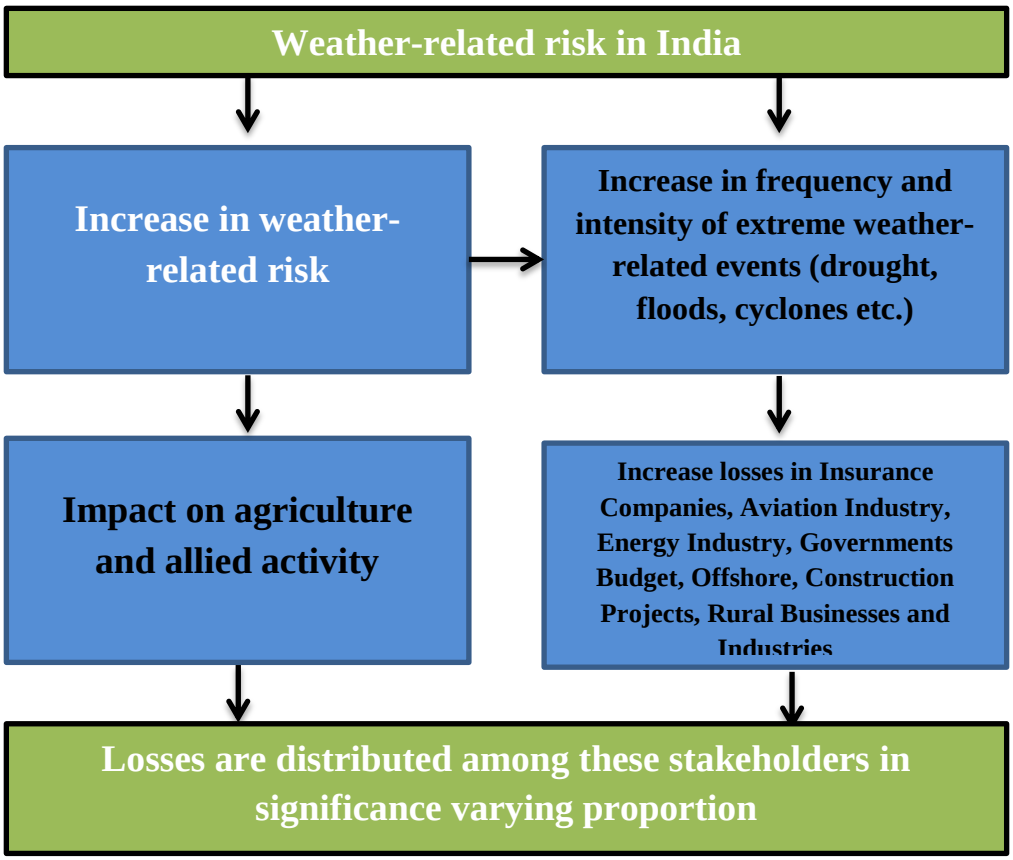
1) The need to have reliable and secure rainfall measures for a large geographical area.
2) The need to model intertemporal weather events such as El Nino.
3) The possibility of mistakes in the selection of the critical rainfall periods and other contract design features.
4) The high degree of correlated risk, making it necessary to have reinsurance.

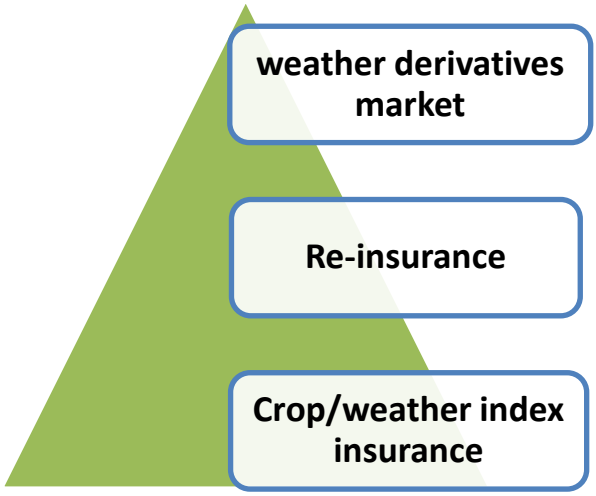
4. An Ecosystem of Weather Risk Market

Weather risk management strategies can generally be categorized as risk mitigation, risk transfer, risk diversification, and retained risk management. These risk management strategies may be the opposite, as seen in the crop insurance scheme experience, but risk mitigation and risk coping strategies may be overcome by weather-related loss events in the absence of risk transfer. Developing systems whereby insurance transfers highly correlated and catastrophic losses out of the community, bank and non-banking institutions facilitate savings and borrowing to assist in coping with more frequent and less severe events, is at the core of designing effective systems weather risk management.

The ecosystem of risk markets comprises three interdependent and complementary components: (1) crop/ weather index insurance at the ground level, (2) reinsurance markets that are critical for the expansion of crop/ weather index insurance markets, and (3) weather derivatives markets.

Figure 1 : Ecosysetem of Weather Risk Markets





Source: Kotreshwar (2014)

Crop/rainfall index insurance is a commonly used risk-transfer mechanism for rainfall risk around the globe. But many crop insurance products applied in different countries are not successful due to the transaction cost of delivering insurance products to lower-income

countries. The crop insurance scheme is repeatedly plagued by high administrative costs, which spatially correlated risk, moral hazard, and adverse selection.

Securitization will help to reduce insurance market deficiency in several ways. This technique will help to transfer the insurer's risks to the capital market. The capital markets can provide a greater risk-bearing capacity than the reinsurance market. In the case of low-frequency, high probability events often prove difficult for insurer/reinsure. Risks correlated within the insurance/reinsurance market may be uncorrected with other risks in the Indian economy. For example, the risk of property catastrophes such as cyclones and earthquakes leads to covariance of risk within the insurance /reinsurance industry, but these risks are largely uncorrected with the economic factors that can drive capital markets. Therefore, if such risks can be passed directly to capital markets, it would be possible to reduce the premium cost. The low covariance with other investment risks also makes the contract attractive to investors for purposes of diversification.

The ecosystem of rainfall risk markets is incomplete in the absence of rainfall derivatives markets that would facilitate hedging rainfall risk by a wide range of stakeholders. Rainfall derivatives can be an innovative product in the Indian stock market. It has a vast potential for creating sustainable rainfall risk markets in India. The trading platform allows participants to buy or sell contracts based on deficit/excess indices for settlement on a future date.

5. Securitization of Weather Risk

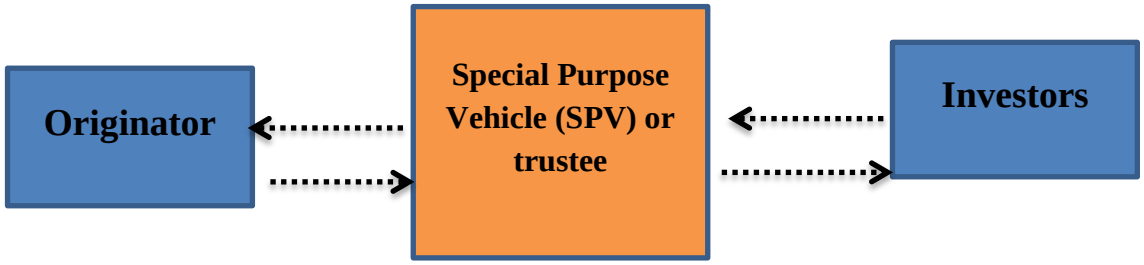
Securitization is a risk management tool used to reduce unsystematic risk, which is associated with individual assets. It is a process of transformation of illiquid assets into liquid assets. The illiquid assets like mortgages, auto loans, and weather-related risk are transformed into liquid assets that are marketable securities sold in the securities market or stock market. It has been very popular since the 1970s. The rapid growth in the securitizing of assets increases and raises interesting issues regarding securitization benefits and cost.

According to Andreas (2008), it is the process in which certain types of assets are pooled so that they can be repackaged into interest-bearing securities. The securitization of risk has the potential to mobilize the power of the capital markets by expanding reinsurance capacity and providing hedging tools in the event of major natural catastrophes and extreme weather. To do this, risks pertaining to natural catastrophes and weather are packaged into some form of a standardized financial product that can be bought or sold in capital markets. Securitization of assets can lower risk, liquidity and improve economic efficiency.

US Banks were the first to start securitizing home mortgages in the 1970s. In the beginning, mortgage-backed securities were seen as relatively safe, and banks were allowed to give out more mortgage loans to potential homeowners. This practice created a boom in the US's housing sector, resulting in a tremendous increase in house prices across the country. Wall Street investment banks extended this idea. They implement the same concept with other types of assets. They realized that securitization has drastically increased the number of financial assets available in the market without raising any real economic variable.

Securitization is a structured process of pooling loans, and other receivables are packaged and sold in the form of asset-backed securities to the investors to raise the required funds from them. A company with loans or other income-producing assets identifies the asset it wants to remove from its balance sheet and pools them into what is called the reference portfolio.

Fig 2 : Process of Securitization



Source: Author complied

Identify the asset originator loans or bill receivable in its portfolio and prepare a pooling of assets to be securitized. The maturity of selected assets represents one homogeneous lot. The originator's underlying securities backed these assets receivable in the form of mortgage, pledge, etc. After identifying pooled securities by the originator, transfer an asset from the originator to the issuing vehicle, i.e., Specific Purpose Vehicle (SPV) or the trustee. Generally, a financial institution will perform as SPV and also the issuer of the securities to the investors. The issuer finances the acquisition of the pooled assets by issuing tradable, interest-bearing securities sold to capital market investors. The investors will receive fixed or floating rate payments from a trustee account funded by the reference portfolio's cash flow.

Securitization and reinsurance approaches are used for certain types of risk, such as the risk of high probability events like large catastrophes. The traditional method of managing risk through internal diversification by the insurer and reinsurer. This method works better when probable losses are relatively small. Whenever there is a high probability event, securitization may be the most efficient solution. High potential losses increase, securitization beings to substitute for reinsurance, but reinsurance may be inefficient for the highest level of risk reinsurance. While, for large losses, correlated risk, securitization may be the only solution.

6. Risk-sharing through Capital Market

A whole new class of weather-related financial instruments has been introduced recently to transfer natural disasters to the capital market. Capital markets provide an additional layer of protection over and above the traditional insurance/reinsurance process. These instruments are designed to hedge the risk associated with natural disasters like cyclones, hurricanes, and earthquakes. These instruments are popularly known as insurance derivatives. Insurance derivatives are financial instruments whose value is determined by the performance of an insurance-specific index (i.e.,underlying). Investors can buy in the capital market. This type of derivatives has been traded since the Chicago Board of Trade (CBOT) introduced them in 1992. Insurance Derivatives are useful for insurance/reinsurance companies to minimize their losses due to natural disasters such as cyclones, hurricanes, earthquakes, etc.

(a) Catastrophe Bond (CAT Bond)

The CAT bond is an instrument that is used to hedge the risk of catastrophic events. The CBOT first developed CAT bonds in 1992. Insurance companies use this instrument as an alternative to traditional reinsurance. These bonds are general floating rate bonds, issued by insurance companies through a financial institution. The investors who invest in the CAT bond continue to get the fixed coupon rate as long as the catastrophe event does not take place. If the event does occur, the principal will be forfeited, and the insurer will use the money to pay the insurance claim. The investors want to invest in this bond as the returns from the bond are largely uncorrelated with the returns of other financial assets. Therefore, the investors' can choose this bond as an option for better diversification.

(b) Weather Derivatives

A Weather-index-based derivative is a type of parametric contingent claim contract whose pay-off schedule depends on a measure of Weather (rainfall) index such as meteorological outcomes, such as inches/mm of rainfall, at a specific location during the

contract period. The contract specifies a specific event or threshold that triggers payments and a payment schedule as either a lump-sum payment or a function of index values beyond that threshold. A range of derivatives contracts can be issued on well-specified weather variables or a single or multiple specific weather events. The most common types of derivatives contracts are futures and options. Suppose the weather variables are highly correlated with economic loss. In that case, weather -index-based derivatives on appropriate rainfall parameters can be used to hedge against such loss effectively. The weather derivatives contract can be written on various weather parameters, which are traded like financial assets. Therefore, the weather derivatives market provides opportunities for covariate rainfall risks to be transferred and managed either as part of a diversified global weather risk portfolio or at the national level where weather-related risks are potentially uncorrelated with those in other geographic areas. Table 3 lists out major points difference between weather-index-based insurance and derivatives.

6.1 Comparison of Weather Index-Based Insurance and Derivatives

Table 3: Lists out Major Points Difference between Weather Index-Based Insurance and Derivatives.

SL No.	Nature of difference	weather index-based insurance	weather index-based derivatives
1	Issuer/seller	Insurer	Investors selling the derivative contract same as a financial derivative contract.
2	Insured	Only farmers	Farmers and other stakeholders.
3	Coverage /underlying	Based on weather parameters like drought, heavy rainfall.	Based on the rainfall index, such as Deficit/Excess rainy days.
4	Settlement /claim	The difference of the actual and threshold level	The difference of the actual index and the strike price of the contract.
5	Issuer's risk	Usually limited exposure	Always limited exposure
6	Typical risk covered	Typically covers high-risk, low-probability events.	It covers low-risk, high probability events
7	Determination of the price of the contract	Usually, the premium rate is fixed by the government.	Determined by market demand and supply.
8	Tradability	Non-tradeable	Publicly traded or exchange-traded
9	Loss assessment	Less cost	No cost

	cost		
10	Transparency	High	Very high
11	Government financial support	Strong support needed from the Government	No support is needed for investors and other stakeholders. There is a need for strong financial support for farmers.
12	Basis risk	Existed	Existed

Source: Author's compilation

Weather index insurance is different from Weather -index-based derivatives, even though both are used for the same purpose. A significant difference is that Weather index derivatives can be purchased and sold by anyone. In comparison, Weather -index-based insurance can be insured by the farmers and sold by the insurers.

Weather derivatives are a type of index-based contract whose pay-off depends on the occurrence or non-occurrence of specific weather events. Weather risk markets are in the process of development. Weather -Index-based derivatives contracts potentially offer many advantages compared to index-based insurance. Both index-based instrument's pay-offs are based on a widely available and objectively measured index; there is no need for farm-level loss adjustment. This will reduce transaction costs compared to traditional crop insurance.

The government regulates Index-based insurance's price (premium rates). While Weather -index-based derivatives price is determined by market demand and supply and the fair price of a contract. The Weather -index-based derivatives are publicly traded in the open market, and daily market values are easily available through marking to the market facility. So, it is more transparent than Weather index-based insurance. But Weather index insurance cannot be traded, and daily market data is not available for the insured.

Index-based insurance is also generally intended to cover damages due to infrequent high-loss events rather than limited loss, high probability events such as adverse weather conditions. Weather derivatives covers low-risk, high-probability events. For example, a company might use Weather derivatives to hedge against adverse weather-related events, the same company would also most likely purchase an index-based insurance policy for protection against damage caused by a flood or hurricane (high-risk, low-probability events).

To claim a loss under an index-based insurance contract, the insurer decides the pay-out based on the actual weather in a location. If the actual is below the agreed threshold, the farmers get their compensation. However, the payout from derivative is directly based on the

underlying risk factor (e.g., rainfall), which is usually measured by an objective third-party agency, such as the Indian Meteorological Department of India. This will eliminate the need to prove that the loss is weather -related and that no one could influence the payout.

An index-based weather derivative is a financial contract used to manage weather conditions like deficit and excess rainfall. The pay-outs or settlement of contracts depends on the weather index. The weather index is the value that is calculated based on the rainfall data. The value of weather contracts depend on the value of underlying, i.e., weather index measured using some standard metrics. While risk covered in the index-based insurance is based on the weather parameters like drought and heavy rainfall.

The buyer must pay the premium for a specific event for a particular period. The seller of the index-based weather derivatives accepts the risk of weather events by receiving the premium. The buyer receives the pay-out if the index crosses the predetermined threshold before the end of the contract period. The weather -index-based derivatives are more cost-effective for low probability events and highly liquid instruments. These can be bought and sold by both the hedgers and speculators. However, the portfolio managers and other investors should be attracted to index-based contracts because the returns on these instruments are largely uncorrelated with returns on traditional financial instruments like stock, commodity etc.

Weather Index-based derivatives contracts are designed to provide efficient means of risk transfer rather than risk pooling, systemic risk is not a problem. Hence, the index contracts work even better when the risk being transferred is somewhat systemic.

Index-based insurance schemes have experienced considerable challenges across India in achieving adequate participation. The lack of participation may be due to several factors since developing an index-based insurance scheme involves many complex parts. The purchasing insurance must be charged to an acceptable price (acceptable premium). Additionally, a new problem that arises with index-based insurance is basis risk. The basis risk refers to the mismatch between pay-offs based on the weather index and the farm's actual losses.

The purchase and sale of weather -index-based insurance need just shared knowledge. In contrast, trading in weather -index-based derivatives requires market familiarity and

investors' analytical skills. So, an ordinary farmer cannot afford this instrument unless aggregated and traded by an expert.

6.2 Hedging Opportunities for Enterprises across Different Industries.

Agriculture, energy, retailing, travel, leisure, and entertainment are among industries vulnerable to rainfall risk. As rainfall variability becomes a growing source of business risk, managing rainfall risk has become a key component of creating shareholder value. Companies typically use rainfall derivatives to hedge the risk associated with extreme weather events. End-users of rainfall derivatives include farmers, and enterprises across different industries.

(a) Agriculture Sector

Agricultural production and agribusinesses are exposed to many weather-related risks such as drought, floods, temperature, snowfall, etc. Indian government's fully subsidized crop insurance programme provides crop producers with protection against many weather-related risks. However, the programme is plagued with moral hazards and adverse selection problems. The agriculture community in India is still facing exposure to losses associated with weather-related risks. Weather derivatives are financial contracts that allow farmers to hedge themselves against variations in the Weather occurrence.

(b) Energy Sector

Energy is one of the essential components of economic infrastructure development. Its continuous and adequate supply to agriculture and other industries is crucial for the rapid growth of the Indian economy. A poor energy scenario acts as a strong deterrent in attracting foreign direct investment. At the present stage, when the Indian economy is trading on an accelerated growth path, the county cannot overlook this problem. Weather derivatives are designed to hedge the financial loss due to variability in daily climatic conditions. In the power sector, Weather risk is volume risk as both demand and supply for power depend on weather-related factors. Sharma, & Vashishtha, (2007) The introduction and widespread use of weather derivatives in the energy sector may be expected to mitigate much of the energy producers' problems.

(c) Insurance/Reinsurance

The Weather derivatives could be used to avoid bankruptcy or to significantly lower own capital. Reinsurers can also benefit by transferring their own risk and eliminating extreme weather-related events.

(d) Diversification Opportunities

A Weather derivative contract provides portfolio diversification to the investors. Weather derivatives are highly uncorrelated with financial products and could be used to balance an investment portfolio. Moreover, it provides a high return that will satisfy most risk-takers.

(g) Exploiting Speculative Instincts

Monsoon on betting is very different from cricket betting. The bookie community (the illegal betting market) across the country, who will visit the city to accept bets and cash-in on the monsoon season. According to punter (bookies), Delhi, Mumbai, Kolkata, Guwahati, Bhopal, Indore and Jodhpur are among some of the centres where monsoon betting is high. The turnover on monsoon betting could be more than close to Rs.25000 crore expected to change hands (NDTV report, 2011; & Palak Shah 2015). It is reported that a flourishing monsoon betting market does exist, through the illegal betting market. The introduction of Weather derivatives in the capital market creates a platform for the punter (bookies) to participate legally in monsoon trading. Weather derivatives can be an innovative product in Indian capital markets. This market has a vast potential for creating sustainable weather risk markets by streamlining the massive monsoon speculative tendency.

7. Role of Weather Derivative Market in India

- Securitisation of weather-related risk aims to create weather derivative instruments that could empower the ecosystem of trading and absorbing weather-related events.
- The weather-sensitive sectors can use weather derivatives to effectively hedge weather-related events.
- Weather derivatives can be a n attractive tool for speculators to satiate their instincts by betting on adverse weather outcome.
- Like CAT bonds, weather derivatives constitute potentially a distinct asset class and hence could be an added arsenal in the hands of investors for enriching their portfolios.

8. Challenges Facing to Introduce Weather Derivatives in India

Securitisation of weather risk involves several critical steps:

1. There is a need to evaluation of risk profile of weather parameters like rainfall, temperature.

2. Defining standard metrics which could serve as building blocks for constructing weather derivative contracts.
3. Measurement of empirical values of weather Indices.
4. Defining a model weather derivative contract.
5. Analysis of theoretical foundations for pricing weather derivatives.
6. Understanding the perception of stakeholders about the feasibility of weather derivative market in India.

9. Conclusion

The above discussion has been dealt with weather-related risk, its management, weather risk markets, and risk-sharing through capital markets instruments and weather derivatives. Amongst various weather parameters for Indian economy, rainfall plays a vital role. The monsoon (rainfall) is critical for the development of the economy of India. It is seen that impact of monsoon (rainfall) on the performance of various economic sectors. Therefore, there is a need to create a sustainable weather risk market for the economy to absorb the weather-related risk. The weather risk market can provide an opportunity for integrating weather -index-based insurance markets with the capital markets. Weather derivatives can be an innovative product in Indian capital markets. It has a vast potential for creating sustainable weather risk markets to hedge, arbitrage and speculate uncertain weather-related events. The development of these markets requires detailed research and regulatory support. The designing and pricing of weather derivatives are challenging issues that need to be address.

10. Reference

Andreas, Jobst. "What is Securitization." *Finance & Development* 45.3 (2008).

Bharath,V., & Kotreshwar,G. (2020). Evaluating Rainfall Risk Profile of Indian Subcontinent Based on Index Metrics. *Indian Journal of Finance and Banking*, *4*(2), 38-50.

Charanjit Singh, Cristina Rumbaitis Del Rio, Vidya Soundarajan, Vandana Nath and Shivaranjani. V (2019) Assessing India's mounting climate losses to Financial Institutions. *Action on Climate Today*. Retrieved from https://www. preventionweb.net/publications/view/63287

Gadgil S and Gadgil S (2006). The Indian monsoon, GDP and agriculture. *Econ. Political weekly*,41, pp 4887-1895.

Kotreshwar G., (2006), Managing monsoon risk in India: Why not monsoon derivatives?, *The ICFAI Journal of Derivatives Markets, 2006*, July, vol 3, no 3, pp 76-83

Kotreshwar, G., (2015). Securitization of Rainfall Risk in India: Designing Rainfall Derivative Contracts Based on Standard Metrics. *Paper presented in International Conference on Emerging Trends in Finance Accounting*, SDM-IMD, Mysuru.

Palak Shah (2015, June 5) Bookies ignore IMD forecasts, bet in 92-95% range on normal monsoon. *The Economic Times.* Retrived from https://economictimes.indiatimes.com/news/economy/agriculture/bookies-ignore-imd-forecasts-bet-in-92-95-range-on-normal-monsoon/article show/47548719.cms?from=mdr

Panagariya, A. (2009, July). Climate change and India: Implications and policy options. In *India policy forum* (Vol. 6, No. y: 2010: i: 1: p: 73-151, pp. 73-151). National Council of Applied Economic Research.

Parchure, R. (2002). Varsha bonds and options: Capital market solutions for crop insurance problems. *UTI Institute of Capital Markets*, Mumbai. http://www. utiicm. com/rkparchure, 36.

Parthasarathy, B., Kumar, K. R., & Kothawale, D. R. (1992). Indian summer monsoon rainfall indices: 1871-1990. *Meteorological Magazine*, *121*(1441), 174-186.

Radheshyam Jadhav (2021, March 24) States drag their feet on farm-loan waivers. *The Hindu Busniess Line.* Retrived from https://www.thehindubusiness line.com/data-stories/data-focus/states-drag-their-feet-on-farm-loan-waivers/article34153614.ece

Shivkumar, D., & Kotrshwar, G. (2013). Trading in weather risk transfer products–Reengineering rainfall indexation. *International Journal of Business and Management Invention*, *2*(11), 33-41.

Shivkumar, D.P (2014). *Weather risk management in India- Feasibility of monsoon (rainfall) derivatives as an ART (Alternative Risk Transfer) instrument* (Doctoral dissertation, University of Mysore). Retrieved from http://shodhganga.inflibnet.ac.in:8080 /jspui/handle/10603/72545#

Vishwa Mohan, (2017, August 18), Climate change costs India $10 billion every year: Government. *The Economic Times.* Retrieved from https://economictimes.indiatimes. com/news/economy/finance/climate-change-costs-india-10-billion-every-year-government/printarticle/60113030.%E2%80%A6