Commodity Derivatives and Risk Management
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Lecture 34
Weather Derivatives (Part 2)

Hi all welcome to this session on Commodity Derivatives and Risk Management and we will continue with the discussion on Weather derivatives. And if you recall we had started discussing about HDD contract and CDD contract which are listed at Chicago Mercantile Exchange, and this is the only exchange in the world which have derivative contracts and also another important point which I must mention at this point of time that couple of years back CME had many other types of weather derivative contracts like hurricane, contracts and hurricane contracts on rainfall, snowfall etc. But because of lack of interest this CME has discontinued with these weather derivatives, however very briefly we will be discussing different aspects of this rainfall and snowfall and hurricane derivative contracts just for sake of our knowledge and we will also be discussing little more on this HDD and CDD contracts which are continue to be offered at CME exchange.

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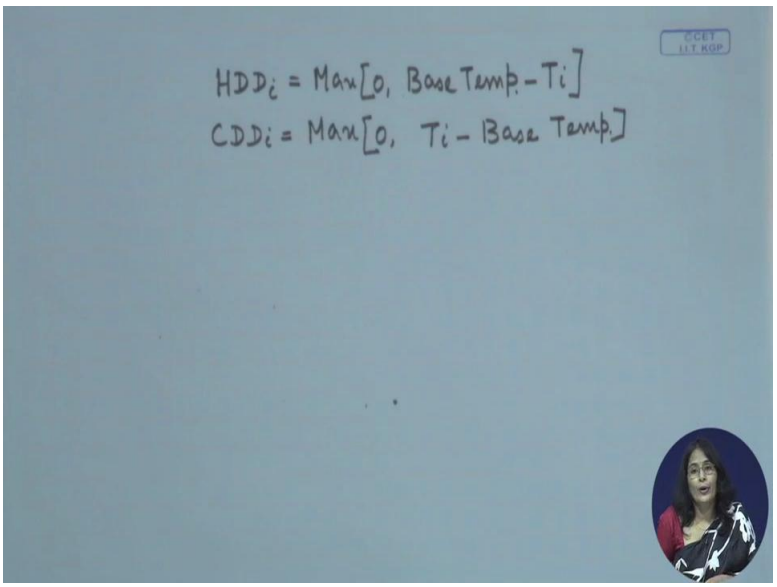

So let us go to our discussion on HDD and CDD if you recall a day will be treated as a heating degree day a day requiring heating degree day will be Max [0, base temperature - T i, similarly a day which will be treated as a cooling degree day you will have a Max [0 comma T i - base temperature] and this base temperature values are given by the exchange and also another important point about this heating degree day or cooling degree day contract is

always with respect to a specific location. USA is a very big country so temperature varies from location to location on a given day.

So if a wheat farmer from Minneapolis is interested to take wheat futures is interested to take futures contract on temperature it must be interested or it would be keen on taking the temperature contract related to Minneapolis, so it will not be interested to take temperature related derivative contracts with respect to other location of USA.

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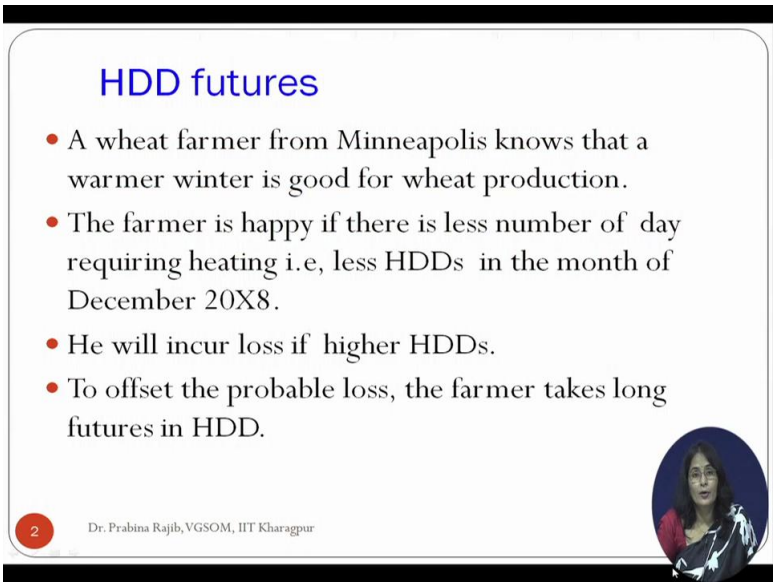

And let us quickly discuss about what we from where we stopped last session, so wheat farmer has a fear of colder winter, so if winter is going to be very cold the quality of wheat is not going to be good, so it is interested in mitigating this risk by entering into weather derivative, so what is the farmers fear? Farmer fears that if there are more number of days requiring HDD heating degree days the farmer is going to incur loss, so if HDDs are more it should get benefit from the futures contract. So it enters into a long futures contract and depending upon the actual value of HDD the farmer may get money or pay money.

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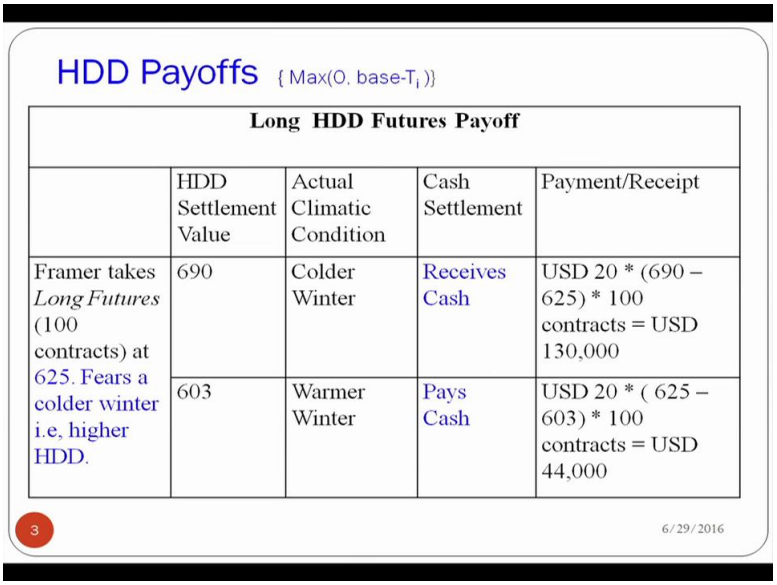

So if total HDD value for that given month closes at 690 and the farmer had taken the long futures as 625 and in that case the counter party to the farmer will be 130000 to the farmer and in the other case when the HDD closed at 603 the farmer is going to pay 44000 to the counter party. Now let us take another example of how if this weather contract can be used by eh another business.

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Let us say a hot coffee chain sells in summer month suppose the chain fears a hotter summer in coming July and decline in sales this company is expecting that sales is going to decline and every year sales declines in the month of July because it is a summer month and but this year it is expecting that the summer is going to be unusually hotter and the sales is going to

be even going down even more than the other years. So how this particular coffee chain will be able to utilise the derivative contract weather derivative contract to mitigate the risk.

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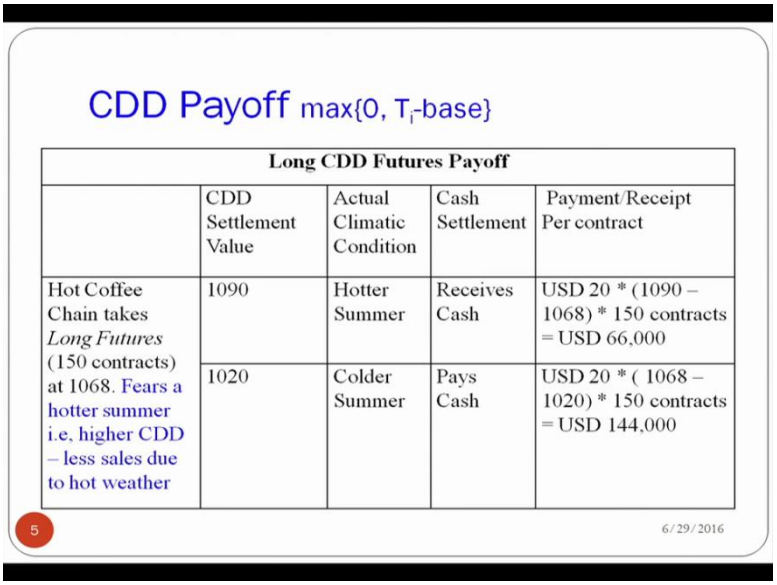

So my question to you is that whether it will take HDD contract or CDD contract and whether it will take long futures or short futures? Ok, the answer to my question is, this company will take CDD and it will take again long futures position that is if there more number of cooling degree days, so if the summer is hot enough than you will have more number of cooling degree days. So if there are more number of cooling degree days this company is going to incur loss because many people will not be interested to to drink hot coffee.

So if there are more number of cooling days it would be incurring loss from its revenue and it would be incurring loss from the coffee sales so it should be compensated from the from the futures contract. So it will be entering into a long futures contract so let us take the CDD value to be the price at which it entered into long futures or the value at which it enters entered into long futures position is 1068 and his fear comes to comes true and the or the companies fear comes true and it is unusually hotter and requiring people to requiring people to switch on their ACs and many people did not venture into venture to drink hot coffee.

So in that case CDD value closed at 1090, so this company will receive cash from the counter party which is to the tune of 66000. Similarly let us say companies is not right in its expectation regarding more number of cooling degree days so this July month the number of cooling day days was little lesser so the company this CDD closed at a value of 1020 and so

it is a colder summer month and it will be paying cash to the counter party to the tune of 144000.

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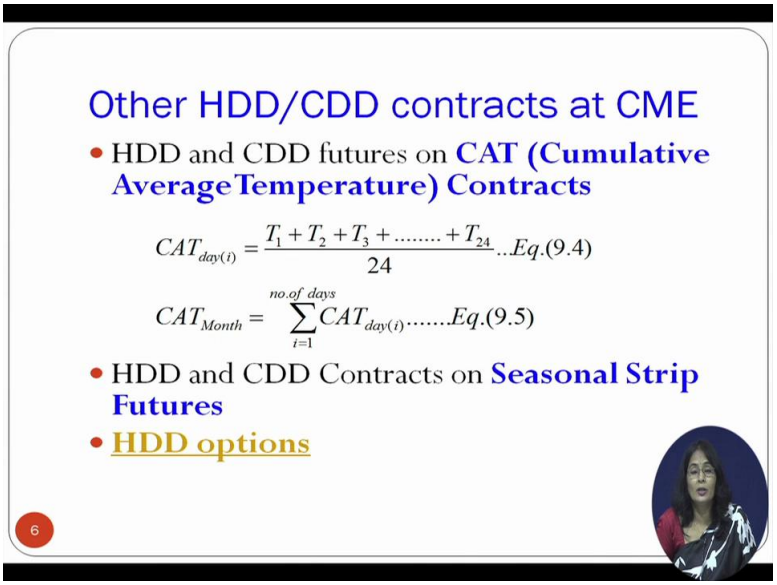

Now besides this HDD and CDD contracts CME also offers contracts called CAT that is Cumulative Average Temperature Contract, if you recall the T i is calculated by the by taking average of dailies 1 days maximum temperature and the minimum temperature, so in case of a CAT contract that is Cumulative Average Temperature contract the T i is sum is the average of the every hourly temperature.

So independent party has to take record the hourly temperature and that hourly temperature divided by sum total of 24 hours temperature divide by divided by 24 keeps the CAT for that day and CAT for the month will be obviously sum total of the CAT of the day and accordingly this buyer and seller will be able to take call on this CAT values and depending upon the final settlement CAT values the either long futures will pay money to the short future or vice versa.

Exchange also offer contracts on HDD option, so you can have traders take into long call, short call, long put or short put options and exactly the same way in case of a call the exercise value of the HDD or CDD is already pre-decided and if it is a long call option if actual HDD is more than the exercise HDD value the long call option position holder gets money from short call option position holder. So it is exactly like any other option contract only the underlying gets decided from the value of the CDD or HDD.

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Uh CME at one point of time as I mentioned it had frost, snowfall and rainfall index futures contract on frost, snowfall and rainfall index shows at a some specific location let us say Amsterdam airport USA also had contracts which is derivatives contract for some specific locations in Europe. So let us say at Amsterdam airport if the snowfall is beyond certain value the buyers and sellers will be able will be paying money to each other depending upon the snowfall recorded at specific location, as I mentioned it could be Amsterdam airport.

The specific locations are very clearly mentioned so if I am entering into a futures contracts or futures contract or option contract, I know this particular weather contract is respect to which location and which weather parameter. So if it is snowfall then if it is a snowfall contract but for which location, is it New York, is it eh any other city in USA or it could be any city in Europe, so depending upon the city or location as a buyer or seller I will be taking position for that particular contract for that city. As also as you must by this time maybe understanding that this some independent party has to be interested with calculation of this index, so what is going to be the snowfall index.

How do you measure the snowfall because as soon as the snowfalls it melts, so how do how there has to be some scientific way of recording snowfall, so how do you measure also the frost, so if the revert is a how do you what is the difference between frost and snowfall. So all these factors were incorporated into the contract specification and let us say for a snowfall index there is a way independent party will measure the snowfall at a specific location and depending upon that value either long futures party will pay to the short futures positions holder or vice versa.

And I am not going into this detail because this contracts are not no more available for trading, so however the contract specifications are it is available just for the sake of information, if you are more interested you can download this contract information and try to understand more about this. in Indian context we have multi commodity exchange preparing and reporting rainfall index for 3 places, I will just take you through this detail but there is no derivative contract available for trading on this rainfall indices, so only the index values are reported as of now, maybe as the time goes by and there are enough trader who are interested to trade in this rainfall contracts this futures contracts on rainfall can be made available by these Indian exchanges.

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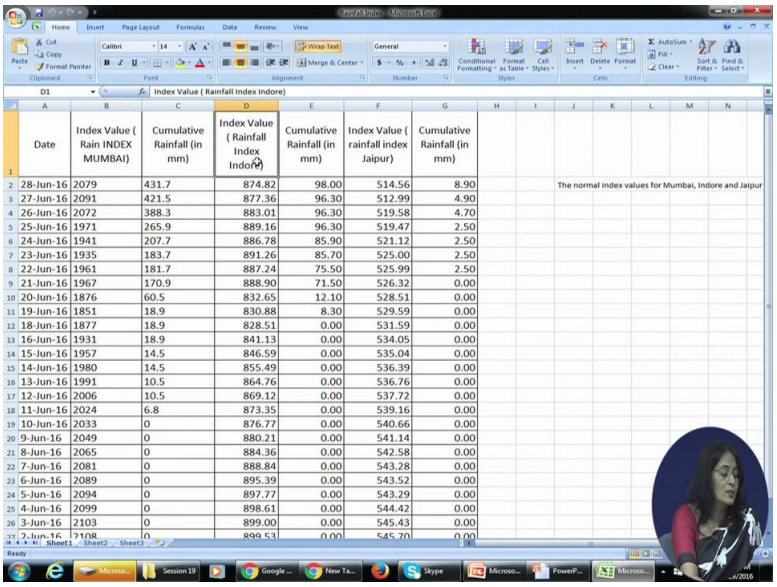

Date	Index Value (Rain INDEX MUMBAI)	Cumulative Rainfall (in mm)	Index Value (Rainfall Index Indore)	Cumulative Rainfall (in mm)	Index Value (rainfall index Jaipur)	Cumulative Rainfall (in mm)
28-Jun-16	2079	431.7	874.82	98.00	514.56	8.90
27-Jun-16	2091	421.5	877.36	96.30	512.99	4.90
26-Jun-16	2072	388.3	883.01	96.30	519.58	4.70
25-Jun-16	1971	265.9	889.16	96.30	519.47	2.50
24-Jun-16	1941	207.7	886.78	85.90	521.12	2.50
23-Jun-16	1935	183.7	891.26	85.70	525.00	2.50
22-Jun-16	1961	181.7	887.24	75.50	525.99	2.50
21-Jun-16	1967	170.9	888.90	71.50	526.32	0.00
20-Jun-16	1876	60.5	832.65	12.10	528.51	0.00
19-Jun-16	1851	18.9	830.88	8.30	529.59	0.00
18-Jun-16	1877	18.9	828.51	0.00	531.59	0.00
16-Jun-16	1931	18.9	841.13	0.00	534.05	0.00
15-Jun-16	1957	14.5	846.59	0.00	535.04	0.00
14-Jun-16	1980	14.5	855.49	0.00	536.39	0.00
13-Jun-16	1991	10.5	864.76	0.00	536.76	0.00
12-Jun-16	2006	10.5	869.12	0.00	537.72	0.00
11-Jun-16	2024	6.8	873.35	0.00	539.16	0.00
10-Jun-16	2033	0	876.77	0.00	540.66	0.00
9-Jun-16	2049	0	880.21	0.00	541.14	0.00
8-Jun-16	2065	0	884.36	0.00	542.58	0.00
7-Jun-16	2081	0	888.84	0.00	543.28	0.00
6-Jun-16	2089	0	895.39	0.00	543.52	0.00
5-Jun-16	2094	0	897.77	0.00	543.29	0.00
4-Jun-16	2099	0	898.61	0.00	544.42	0.00
3-Jun-16	2103	0	899.00	0.00	545.43	0.00
2-Jun-16	2108	0	899.53	0.00	545.70	0.00

The normal index values for Mumbai, Indore and Jaipur

So you have this is the index value for Mumbai, this is the index value for Indore and this is the index value for Jaipur. So these are the different values given so what are the normal values index normal values, normal value for Mumbai is 1950 and please note that this index gets calculated only for rainy months, so rainy season it is never get calculated for other non-rainy season. So in the month of June so let us see for Bombay so 28 June what is the value of this rainfall index, rainfall index value for Mumbai is 2079 and it can be interpreted that it is more than the normal value of 1950. So this is just for sake of information, so if you want to again learn more about how these indices are calculated and all you can visit the MCX website.

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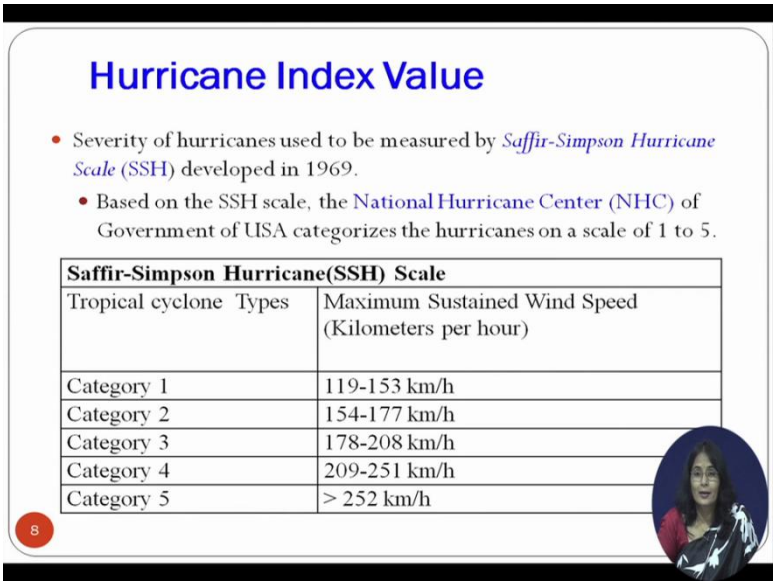

I would like to also take you through the hurricane index at one point of time there is a futures contract on hurricane and hurricane was available for trading at Chicago Mercantile Exchange it was very interesting contract because the moment you say that somebody can buy and sell hurricane trough a exchange derivative contract, people give you this incredulous look that is something wrong with this particular person, how can somebody buy and sell contracts on hurricane, how do you measure hurricane?

There has to be some rational and very logical way of measuring a hurricane when a derivative contracts will be traded, the underlying value has to be quantified properly because the best the best on this quantification payment and receipt by long futures and short futures holders are made. So how exactly hurricane the value of a hurricane was measured, so there were two indices in the first initial indices to measure the value of a hurricane or measure the impact of a hurricane was known as a Saffir-Simpson index. Saffir-Simpson hurricane scale which was developed in 1969 and this based on this assisted scale National hurricane canter of government of USA categorises hurricane on a scale of 1 to 5. So it will be one category one if it has a wind speed from 119 to 153 and category 5 will be any hurricane which has a wind speed more than 252 kilometres per hour will be categorised as a hurricane category 5.

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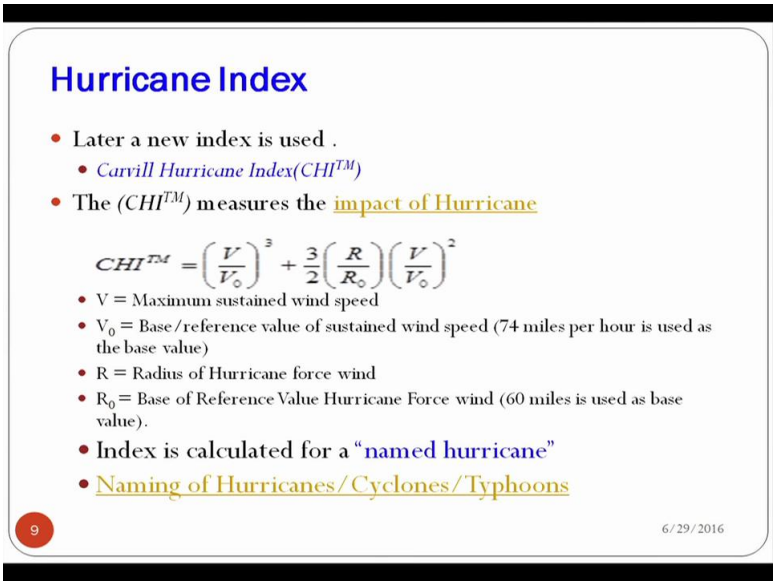

Now based on this Saffir-Simpson hurricane index subsequently a new index came into you now into existence that is known as Cartwheel hurricane index or CHI, the CHI not only took into consideration the wind speed it also took into consideration the radius of hurricane force wind. So the wind speed as well the area on which it is covering or it impact of hurricane is applicable for a what is the radius of the area on which the impact of hurricane is felt, so taking into this these 2 data, so CHI that is Cartwheel Hurricane Index was calculated, so this detail is mentioned here, V is your maximum sustained wind speed and V 0 is some based value, similarly you have R 0, R is your radius of hurricane force wind and R 0 is the base value for R.

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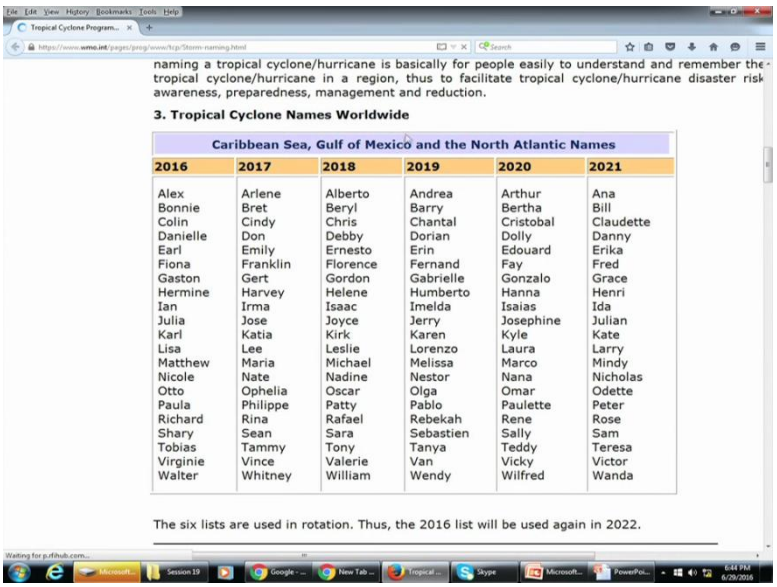

naming a tropical cyclone/hurricane is basically for people easily to understand and remember the tropical cyclone/hurricane in a region, thus to facilitate tropical cyclone/hurricane disaster risk awareness, preparedness, management and reduction.

3. Tropical Cyclone Names Worldwide

Caribbean Sea, Gulf of Mexico and the North Atlantic Names

2016	2017	2018	2019	2020	2021
Alex	Arlene	Alberto	Andrea	Arthur	Ana
Bonnie	Bret	Beryl	Barry	Bertha	Bill
Colin	Cindy	Chris	Chantal	Cristobal	Claudette
Danielle	Don	Debby	Dorian	Dolly	Danny
Earl	Emily	Ernesto	Erin	Edouard	Erika
Fiona	Franklin	Florence	Fernand	Fay	Fred
Gaston	Gert	Gordon	Gabrielle	Gonzalo	Grace
Hermine	Harvey	Helene	Humberto	Hanna	Henri
Ian	Irma	Isaac	Imelda	Isaias	Ida
Julia	Jose	Joyce	Jerry	Josephine	Julian
Karl	Katia	Kirk	Karen	Kyle	Kate
Lisa	Lee	Leslie	Lorenzo	Laura	Larry
Matthew	Maria	Michael	Melissa	Marco	Mindy
Nicole	Nate	Nadine	Nestor	Nana	Nicholas
Otto	Ophelia	Oscar	Olga	Omar	Odette
Paula	Philippe	Patty	Pablo	Paulette	Peter
Richard	Rina	Rafael	Rebekah	Rene	Rose
Shary	Sean	Sara	Sebastien	Sally	Sam
Tobias	Tammy	Tony	Tanya	Teddy	Teresa
Virginie	Vince	Valerie	Van	Vicky	Victor
Walter	Whitney	William	Wendy	Wilfred	Wanda

The six lists are used in rotation. Thus, the 2016 list will be used again in 2022.

So this is how he index values were calculated but hurricanes are I mean how do which which hurricane for which hurricane we are calculating these values. So hurricane started getting their names. So if you see this one and this particular website that is World Metrological Organisation has listed out the name of the different hurricane, so let me just increase the size. So the tropical cyclone names worldwide, so Caribbean Sea, all tropical cyclone which are emanating from Caribbean Sea, Gulf of Mexico, North Atlantic sea, so you will have this will be in 2016 the first hurricane to come will be named as Alex, the second will be Bonny, third one will be Collin, fourth one will be Daniel, so and so forth, 2007, 18, 19, 20, 21.

So all these years sequentially as by as and when the names the hurricanes will be coming these will be named and based on this names or once a hurricane is named, the exchange used to calculate the value of the hurricane or then exchange used to inform the status of the hurricane whether it is a category 1, category 2 and so on so forth and depending upon when the hurricane becomes little the impact of hurricane was considered to be more or the likelihood of the impact of impact of hurricane is going to be more in terms of its destructive capability only then the exchange used to list it for trading.

Suppose there is a category 1 hurricane eh if Alex starts and in the metrological the metrological unit of US government says that eh the Alex hurricane Alex is a category 1 hurricane, then probably not many people will be interested to buy and sell the derivative contracts. So after the sometime maybe 2-3 days and the hurricane gathers its momentum and it becomes it shifts from being hurricane category 1 to category 2 or 3 then only the exchange makes this contract available for trading, and only that point of time the exchange informs what is going to be the cartwheel index and that information is given to the people and then buyers and sellers whoever is going to be list more affected.

And who fear that if the impact of this hurricane is going to be more and this company is going to incur loss because of the negative impact of the hurricane thus company will enter into a long futures contract. And if actually the hurricane risk has a company incurs loss or let me put it other way round, if let us say a particular hurricane took index value of 2 or 2.5 when the contract got listed in by the CME and a particular company entered into a futures contract on other value of 2.7. Now when the hurricane has made a landfall and on the day of the landfall let us say the CHI index for that hurricane was 2.9 so that means this companies

fear has come to true and the hurricane impact is more than the agreed upon value of 2.7, so this company is going to get money from the counter party.

Let us say the other way round this company which has entered into long futures contract o hurricane Alex at a value of 2.7 and as the day went by maybe within 3-4 days the day the landfall happened that day Alex the intensity of Alex had gone down and other CHI index came to let us say 1.9, so in that case this company is going to give payment to the counter party. Of course this particular website not only mentions the hurricanes which are going to emanate from Gulf of Mexico and Caribbean Sea it also lists the hurricanes name to be emanating from other places of the earth.

So you have this is for eh Eastern North Pacific names you have, Central North Pacific names, you have Western North Pacific and South China names, you have Australian names you have substantial number of North Indian Ocean names, please see this one, this is if you recall couple of years back they people used to only say that this is the a hurricane is going to come but nowadays people are talking about hurricane that is a typhoon or a cyclone, hood-hood last to last year there was lot of discussion on cyclone hood-hood, so there was earlier a cyclone is going to come a cyclone is going to come.

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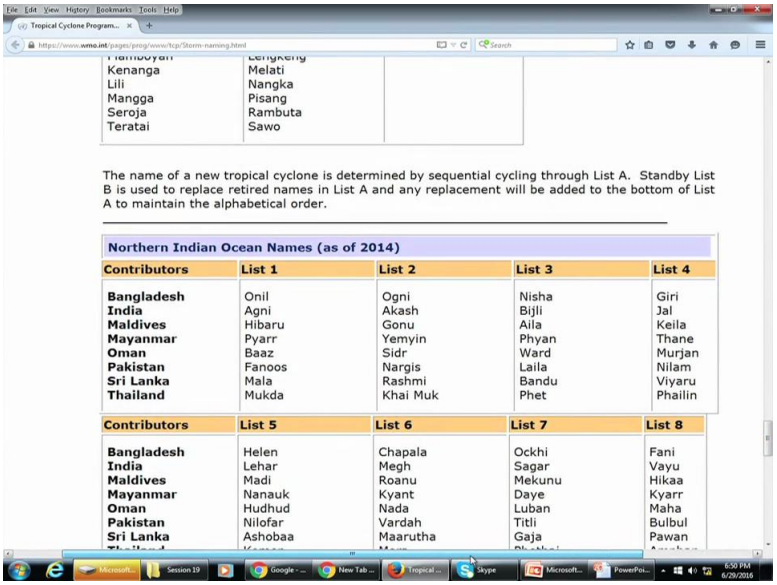

So all this cyclones were never getting named but nowadays all cyclones are named because already World Metrological Organisation has already finalised the names. So just for a trivia, so if you see what are the names from Northern Indian Ocean names, so Bangladesh has contributed this, Bangladesh has contributed Onil, Ogni, Nisha, Giri, India has contributed

Agni, Akash, Bijli, Jal, so on and so forth Maldives has given Hibaru, Gonu, Aila and Keila. If you remember this Aila was also cyclone Aila or typhoon Aila we couple of years back we were hearing about this particular name.

So just to summarise with respect to the hurricane index that the CHI value is always calculated for a particular hurricane or particular cyclone and CME when this contracts were available for trading CME used to list these contracts some time just before the this cyclone is about to landfall maybe 6-7 days before the cyclone is about to make a landfall and whatever trading was happening, trading was happening during this 6-7 days and the day the the hurricane made a landfall on made a landfall that come that day the exchange was coming to an end.

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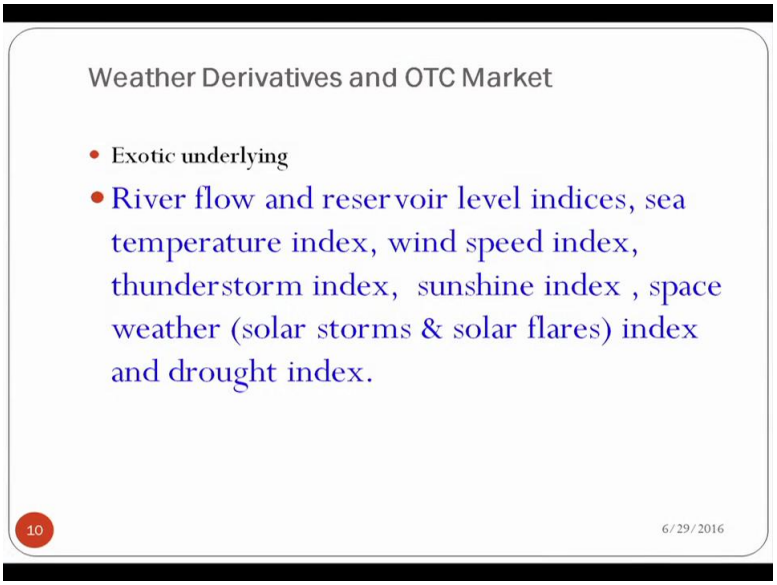

So the maturity period of the contract was very short and it was not predefined, it could be 4 days, 5 days or 6 days as long as the hurricane makes a landfall. Also there are lot of other weather derivatives on OTC market river flow reservoir, label index, sea temperature index, wind speed index, so based on many parameters you had weather derivatives contracts signed by companies in the OTC market by companies and counter parties.

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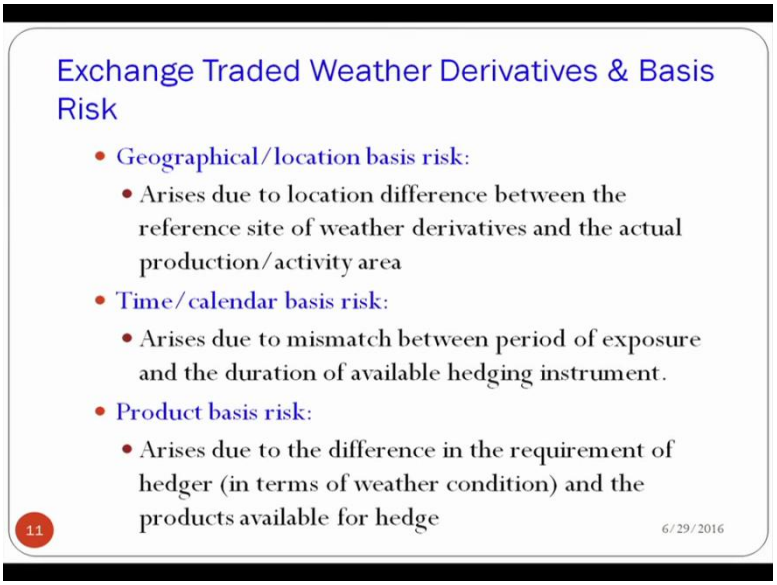

So here this exchange traded weather derivatives contracts have significant amount of basis risk because geographical and location basis risk is one of the very important risk, it arises due to locational difference between the reference site of weather derivative and the actual production or activity area. As I eh mentioned let us say this Nasik farmer from sorry grape farmers from Nasik, let us say temperature contract is available at for Nasik region but let us say grape farmer from Bangalore would like to enter into that temperature contract, so in that case that that kind of a, if Bangalore grape farmers enter into derivative contracts, temperature related derivative contracts which are based on Nasik's temperature than this will be an example of a geographical or locational basis risk.

Also time and calendar basis risk, the duration of the weather contract or the maturity period of the winter weather contract may not be coinciding with the actual requirement of the company who is interested to buy or sell those weather contracts. So that is gives rise to your time and calendar basis risk and also product basis risk, what is a product basis risk? Let us say a Bangalore farmer grape farmer is interested not only to buy a contract on weather, also he is interested to buy contract on frost because frost also affects the grape output significantly quality of grade out grape output significantly. So you may have so no exchange traded contract will be able to combine the combine the risk associated to with weather and the frost.

So the exchange or this company may have to go for a temperature related contract and a frost related contract if these are available, of course in India as I mentioned none of the weather related contracts are yet to make their debut and however in this last 2 this 2 sessions

I thought of discussing because this is a very important part of mitigating weather related risk.

So with this I will be ending this session and let just to summarise weather contracts are not weather derivative contracts are not weather derivative contracts are not to mitigate the catastrophic loss and popular weather derivative contracts which are trading currently at CME is your contracts pertaining to temperature and you can have contracts on snowfall, rainfall, frost or any weather parameter and at one point of time hurricane related contracts were traded and it was a very interesting contract. Of course most of this contracts are not trading at CME because lack of participation by traders. So with this I will be ending up this discussion and thanking all of you, looking forward to again meeting you all in the next session, thank you, thank you all of you.