CLIMATE CHANGE AND VARIABILITY ASSESSMENT: AGRICULTURAL IMPLICATION IN VIETNAM

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ABSTRACT

Mankind has been suffering the abnormal changes of the earth's climate, the earth warming, the average sea level raising along with the tend changing, activities' behaviors in space and time about natural calamities like typhoons, floods, heavy rain*s, droughts… Besides, there are noises of climate, weather, including El Nino and La Nina. The infiltration of exotic animal and botanical species is increasing day by day, Bio-environments are being minimized and separated from each other. Population is growing fast, the pressure upon industrialization and trade globalization is increasing, information exchange is spreading, international terrorism… All of these changes has been creating a great influence to the development of the countries all over the world in general, and to Vietnam's agriculture and rural development in particular. This report presents some proofs about global climate fluctuations, disturbs, and changes, the phenomenon of "light pollution", contributions of "global cooling phenomenon" and assessments and considerations about Vietnam's agriculture and rural development.*

1. GLOBAL CLIMATE CHANGE AND IT'S IMPACTS IN THE WORLD

The climate change's reason now is the multi-dimensional interactive system of Atmosphere, Hydrosphere, Biosphere, and Human dimension, within which about 90% is caused by human activities (IPCC-2007). The manifestation of the climate change includes: (1) The earth's surface warming: changes of atmosphere's components and quality is harmful for human's living environment and Earth's ecosystems, the increasing of the ratio of some gases cause greenhouse effect; (2) The sea level increasing caused by the glacial melting leads to the floods in hollow areas, threaten many islands in the sea; (3) The moving and changing of climatic belts existed for thousands of years on various zones on the Earth leads to the threat of living species' lives, losing balances of ecosystem and human activities; (4) Changes of activities intensity and the circulation of atmosphere's space and time characteristics, the cycle of circulation of water in natural, and other cycles of biology and geochemistry; Changes of the ecosystems' biology productivity, quality and components of hydrosphere, biosphere, and geosphere; and (6) changes of space and time activity behaviors of fluctuation and climate change phenomena, natural calamities such as typhoons, floods, droughts… and other dangerous climate and weather interruption phenomena, including unusual activities of ENSO climate and weather interruption phenomenon

1.1. Climate change evident

1.1.1. Greenhouse gas effect: The earth warming more or less depends on the content of the gases causing greenhouse effect in the atmosphere. During the last 200 years, the concentration of CO_2 generated by emissions into the atmosphere has increased almost 1/3 compare to the pre-

industrial period, about 372ppm (280ppm at the pre-industrial period). The concentration of other gases causing greenhouse effect has also increased because of human activities and production, 200 years ago the concentration of CH_4 is 800ppb and now is 1750ppb (119% increased). Group of NO_x has also increased to 310ppb from 270ppb (15% increased). Gases that cause greenhouse effect, including CO_2 is the main reason that causes the global warming (Picture 1. IPCC-2007)

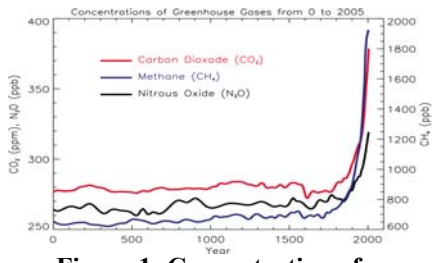

Figure 1: Concentration of Greenhouse Gases FAQ 2.1, Figure 1

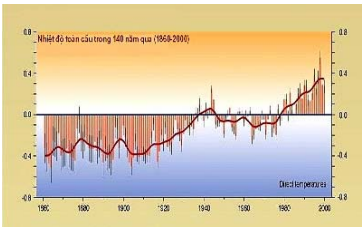

Figure 2: Global average temperatures

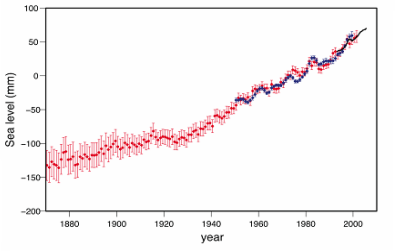

Figure 3: Sea level on average annually

1.1.2. Global warming phenomenon: According to IPCC fourth report (2007), the mean temperature on the earth's surface has increased 1^0C in the last 80 years (from 1920 to 2005). If we linear calculate the temperature, during the last century from 1906 to 2005 the temperature on the earth's surface has increased $0,74^0$C. The earth's temperature can increase 1,1-$6,4^0$C until 2100. At present, the earth is warming within hours with the speed and tend that can be even faster (Picture 2. IPCC-2007)

1.1.3. Sea level rise: Glacial melting causes the sea level to rise continuously during the last several years. In the 20th century, in average, the sea level in Asia rose 2,4mm/year, within the last decade only, it rose 3,1mm/year, and is forecasted to be continue to rise higher in 21st century at least 2,8-4,3mm/year (Picture 3. IPCC-2007). Water level monitoring data shows that during 20th century, the oceans' water level has risen 10-20cm and the water surface's temperature has also risen significantly

1.1.4. Global dimming: Fossil fuel use has eliminated to the atmosphere the gases that cause greenhouse effect. The studies of cloud physicians, astronomers show the matters such as sulphur dioxide, soot, ash, dust, smoke and some other gases causing the pollution to the clouds, changes their chemical-physical characteristics in the tend of increasing albedo, reflect the Sunlight back to the universe's space, and contribute to cool the Earth. Simultaneously, the polluted clouds, especially above the developed industrial zones has blocked the Sun array to shine the Earth, causing the "phenomenon of dimming", decrease the lighting of the Sun. The result of the illumination measurement on Earth shows that human receive less and less Sunlight compare to several decades ago. The amount of Sun light is decreasing while the phenomenon of atmosphere warming is increasing. The discovery of the English scientist Gerry Stanhill in 1980 shows that compare to about 50 years ago, the phenomenon of dimming occurs widely in many places. And the short of Sunlight can make the phenomenon of the atmosphere temperature increasing gets worse. Compare the sunlight index in Israel in the 50s and at present, the sunlight now decreased 22%, in America, it's 10%, in some areas from the old Soviet Union is 30%, and in English Islands is 16%.

Some main characteristics of the global warming and dimming: global warming and dimming is the opposite of each other on the Earth's surface; Less CO_2 emission: less warming; Pure air:

increase the brightness of Sunlight; If the CO_2 and other greenhouse gases emission is not lessened and the air is not pure will lead to the phenomenon of warming and increasing warming speed; Dimming will change depend on seasons and zones; The warming occurs in long-term and globally; and many parts on the Earth is influenced from both the warming and dimming.

The emission of many greenhouse gases into the Earth atmosphere along with human productive and develop activities cause the dimming along with the decline of the ozon at low-level of the atmosphere, global environmental change and we may have to face the new pollution calamity – "light pollution" with the complicated consequences of health, eye diseases, myopia, astigmatism, skin diseases... and new diseases, and human haven't been paying any attention.

1.1.5. Global cooling: Scientists showed many proofs about climate change and the phenomenon of global warming that have been occurred over the decades but haven't been able to explain the tend of lighten the global temperature from the beginning of the 40s to the beginning of the 70s in 20^{th} century. There are many other instances about "global cooling" with the contribution of various elements. According to the data of the scientists from England Oceanography Center, the branches of the hot sea current Golfstream is weakening, therefore the calorie source moves to the North is lessened. The English scientists believe that Europe is not warming but cooling. At the same time the glacial melting at the poles has flattened the sea water and increase the water poured into Northern rivers. People also doubts that, the lessen of the cool water source may be caused by the natural changes during the processes occur in the ocean's heart. However, all scientists agree that it is necessary to continue tracking on the system development that influences the European climate. In one hover cycle, the gases and dust in the atmosphere agglomerate and drop to the sea stimulate the development of the ephemera creatures. These creatures absorb CO_2 greenhouse gas and cool the ocean surface. This causes less clouds and rains – the ideal condition to create more dust storms. The La Nina, although occur less than El Nino, but also decreases the global temperature. Russian astronomers calculated that the Sun's positive operation frequency has passed the peak and lessening. In the middle of the 21^{st} century, the world will expect the global cooling. No greenhouse gases can stop this process. Until the middle of the 21^{st} century, the Earth can be threatened not by the global warming like the scientists all over the world are thinking, but the global cooling. Now the Earth continues warming. The year 2005 is considered to be the warmest year of the observation history (from 1890) by NASA. Some meteorological and weather researchers claim that the phenomenon of global warming will continue, even if we stop the greenhouse gases emission into the atmosphere then during the next 100 years, the annual mean temperature of the Earth will still increase $1,4^0C$, and the sea level will rise about 20cm. However, if the factories and enterprises all over the world continue their work as usual, the annual mean temperature will increase $5,8^0C$ and the sea level will rise 80cm.

In general, climate change, Earth's temperature and average sea level is increasing globally, but we need to consider all aspects, including the causes of the Earth's warming and cooling in order to have a comprehensive look about the global climate and environmental change to be able to have more accurate assesses about the influences at specific areas and at specific period.

1.1.6. Variation and disorder of climate, weather: Climate variation is the variation around the climate mean value at the long enough time scale, wide enough space scale compare to the individual weather phenomenon. Examples of climate variation are droughts, long floods, water level increase because of typhoons... and other conditions because of the climate and weather

variation and disorder ENSO (El-Nino and La-Nina) period and operation characteristic change is also the reason of many natural calamities all over the world such as: heavy rains, typhoons, floods in one region, drought, forest fire in another, cause the big damage of people and property. We haven't been able to be sure about the climate forecast for the next 30, 50, 70, 100 or thousands of years later and we will focus forces, money, time to deal with the sea level that may rise a few centimetres a year or in the short term we need to determine and priority other existed reality natural calamities problems and the phenomena of water level can suddenly rise 5-10m in a short period of time such as water level rise caused by the typhoon combine with the landfalls, Tsunami or the acts of the climate and weather disorder like El-Nino and La-Nina

1.2. Climate change Scenario

- **IPCC:** bring out the scenario considered to be the standard and most popular one in the fourth report of the Committee in 2007. According to the report, until 2100, the Earth mean temperature can increase 1,1-6,4^{0}C (0,11 – 0,64^{0}C/10 years). If it increases 1^{0}C, the corn productivity at tropical and subtropical regions will decrease by 5-20% and may reach the rate of 60% if it increases 4^{0}C. Glacial melting causes the sea level rising continuously in many years and forecasted to be continue rising higher in 21st century at least 28-43cm/tear (IPCC-2007). In 2100, the sea level will rise 18-59cm
- **UNDP:** "Human development report 2007/2008" forecasts that if the temperature increases by 3^{0}C then about 20-30% of the continental creatures will face the risk of extinction, makes 330 million people to move temporarily or permanently because of floods. Over 70 million Bangladesh, 6 million in Egypt low delta and 22 million Vietnamese can be influenced, lose the residential place. In 21st century, the concentration of greenhouse gases may reach 750ppm CO_2. Climate change can increase the number of people that face the risk of petechial fever from 1,5 to 3,5 billion people/year at 2080
- **SRES:** (Special report in emission scenario, developed by Nakicenovic in 2000): forecast that the global average sea level will increase 9-88cm in 21st century. The main manifestations of climate change in the important time landmark in 21st century includes CO_2 concentration increasing, temperature increasing, and sea level rising on the Earth's surface

Table 1: The scenario on emissions of greenhouse gases, socio-economic, climate and sea level rise

Year	*World's population (billion people)*	*GDP in the world (10^{12} $/year)*	*The rate of income per capita (developed countries/developing countries)*	*Content ozon low-level (ppm)*	*Content CO_2 (ppm)*	*Changes of global temperature (^{0}C)*	*Sea level rise (cm)*
1990	5.3	21	16.1	-	354	0	0
2000	6.1-6.2	25-28	12.3-14.2	40	367	0.2	2
2050	8.4-11.3	59-187	2.4-8.2	~60	463-623	0.8-2.6	5-32
2100	7.0-15.1	197-550	1.4-6.3	>70	478-1099	1.4-5.8	9-88

1.3. Impact of Climate change: With the result gained from economic models, Nicholas Stern's calculation shows that if we don't take actions, the total cost and risk caused by climate change equivalent to global 5% GDP from now on. If consider the risk and impact in wider amplitude, the loss (annually) is estimated to be 20% GDP or more. Otherwise, the cost for the greenhouse gases emission lessen actions, in order to avoid worst impact of climate change, can only limited in the range of 1% GDP annually. The main impacts include: Production agriculture and food security; Biodiversity and ecology systems; Rural development; Water resources; Energy and production industry; and Settle down and Health.

2. CLIMATE CHANGE AND AGRICULTURE IN VIETNAM

2.1. Climate change evident in Vietnam

- Temperature: annual average temperature in Vietnam increased by 0.7^{o}C (1951-2000)
- Sea level: According to the observation in the last 50 years at Cua Ong and Hon Dau stations the average sea level raised by about 20cm.
- Number of cold fronts: In the last two decades, (1994 - 2007) number of cold fronts affecting Vietnam was reduced significantly. Annually there were only 15 - 16 cold fronts equalling 56% of multi-year average.
- Number of Typhoon: in the recent years, there were more typhoons with higher intensity affecting Vietnam, typhoon track has moved towards Southern latitude and typhoon season ends later. Many typhoons moved more abnormally.
- ENSO, El-Nino and La-Nina: with opposite consequences of El-Nino phenomenon with un-regular warming of central Pacific sea surface water, causing heavy rainfall and flooding in South American continent, droughts in Asia etc. La Nina is the phenomenon with un-regular cooling of sea surface water. This phenomenon appears to cause rain and more humid regions in mainland. ENSO is increasingly strong impact to the weather and climate features in regions of Vietnam. ENSO activity more powerful cause of many disasters unusual, typhoons trend to increase the intensity, unusual about the timing and move towards (Figure 4).

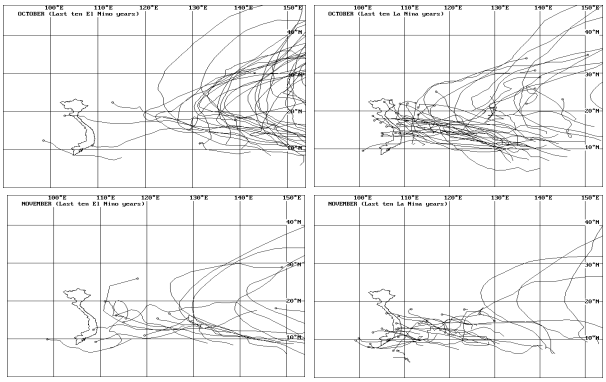

Figure 4: The track of typhoons in 10 years in El Nino-final (left column) and 10-year La Nina final (right column) on May 10 (row on) and May 11 (row under) in the period From 1951 to 1999 affecting Viet Nam (H. M. Hiền, 2000)

2.2. Climate change Scenario in Vietnam

a) If the temperature increases 10C then the needs of watering will increase by 10%. In Vietnam, the sea level rise with the speed of 2,5-3cm/ decade. If sea water rises by 1m, the Red river Delta will have 5000km2 flooded and Mekong river Delta will have 15.000-20.000km2. Land loss will cause the food volume of Vietnam to be decreased by 12%

b) Climate change in Vietnam will make the temperature increase by 0,3-0,50C from now to 2010 and 1-20C in 2020 and may increase 50 more. If the temperature increases 30C then 22 million people in Vietnam may be influenced. If the sea level rises by 1m, Vietnam will lose 12,2% land and 1/5 population (about 16 million people) will lose their houses in the end of the 21st century.

c) World Bank (WB) conclude: If the sea level rises by 1m, Vietnam will have 10% of the population directly impacted, the loss will be 10% GDP, about 40.000km2 of the coastal deltas is flooded, 90% of the Mekong Delta is almost total flooded. If the sea level rises by

3m, there will be 25% of the population directly impacted and 25% GDP lost, 90% of the Mekong Delta is almost total flooded, and the property loss will be 17 billion USD.

d) The Climate change scenario in Vietnam was built for 1999-2020 period in the scope of "Report country's first Vietnam to the UN Framework Convention on climate change" (UNFCCC). This scenario forecasts the temperature of coastal areas will increase 0,30C in 2010 (0,30C/10 years), increase 1,10C (2050) (0,220C/10 years) and 1,50C (2070) (0,2140C/10 years). In the regional rainy South West monsoon, the rainfall change is not obvious, and in regional rainy North East monsoon, the rainfall increases about 0-5% in the dry season and 0-10% in rainy season. It is forecasted that in 2010 the sea level will rise 9cm (90mm/10years), 33cm in 2050 (66mm/10 years) and 45cm in 2070 (64mm/10 years). The frequency and intensity of El-Nino will increase, strongly influence the weather system and climate characteristics on many areas of Vietnam. The number of typhoons that impact our country and its range of impact has the trend of increasing, typhoons occur later and move to lower latitude. Floods, droughts will occur stronger and more complicated.

2.3. Research on Climate change and national disaster in Vietnam

Vietnam has the tropical monsoon climate. Locations in many latitudes and diversity terrain makes Vietnam becoming one of the most threatened countries by the natural calamities in the world such as typhoons, floods, droughts, salt intrusion, landslide and forest fire… Among these calamities, the ones that cause the most damage and occur the most often are typhoons, tropical low pressure and floods. According to the General Department of Statistics, the total damage caused by natural calamities, mainly typhoons, floods, landslides in 50 provinces and cities all over the country in 2007 is estimated to be 11.600 billion VND, equal to about 1% GDP

2.3.1. Typhoons and tropical storm: Vietnam and the East sea coastal is influenced by the two typhoon sources, typhoons from the North West Pacific Ocean and typhoons from the East sea. Typhoon is one of the main and dangerous natural calamities in Vietnam, in the last 50 years (1964-2006), there were 380 typhoons and tropical storm in Vietnam, within which 31% in Tonkin, 36% in North and Central of the central part, 33% in South of central part and the south of Vietnam. Typhoons meet the landfalls when sea level rises, along with long-term heavy rains, will cause floods. There are 80-90% of Vietnam population is influenced by typhoons. During the recent several decades (Fan et al., 2006), the pattern of typhoons is to the South and happen later in the year. The appearance of typhoons and tropical storm will change follow the scenarios about climate change, by then typhoons can occur more often, stronger or change paths (IPCC-2001), and the typhoon season may last longer.

2.3.2. Floods: During flood season, the big rainfall at upper reaches creates the big amount of flood let-out and causes floods on a large scale every year during September-October. The flooded time can even last longer, up to 6 months depend on the weather change and terrain (Wassman et al., 2004). These floods will get worse because of the landfalls.

.***2.3.3. Flash flood:*** Flash floods occurred and face the risk to occur in almost 33 mountainous provinces all over the country in 4 regions: Northern mountainous, Central part, Tay Nguyen, and South East part. Because of climate change, in the last few years, flash floods occur more and more in our country, there is 2-4 flash floods occurred in the flood season yearly in average. There are places that it occurs many times. Flash floods usually occur unexpected, in a narrow scale but very violent and usually cause serious loss of people and property.

2.3.4. Inundations: Inundations usually caused by heavy rains, in some areas, the inundation time can last very long. Floods although cause less loss of people but have great influence to the agriculture production and ecological environment.

2.3.5. Droughts: Drought is the kind of natural calamity that usually occurs in Vietnam and is at the third rank in causing the loss after typhoons and floods. In the last few years, droughts consecutively occur all over the country. Droughts can reduce the plants productivity by 20-30% some year, reduce the food production causing the great influence to animal livestock and citizen lives. Drought fighting usually meets many difficulties because of the water source short. Droughts not only reduce the harvest productivity, but also is the threat to the forest fires that cause big damage in many range.

2.4. Impacts of Climate Change on Agriculture in Vietnam

2.4.1. Cultivation: Production agriculture in our country now still depends a lot in weather. When temperature, weather and climate variation and abnormal properties increase, the influent to agriculture will be big, especially planting.

a) Climate change leads to the risk of losing food security: climate change has a great impact to cultivation growth, development, and season, increase pestilent insects, decrease planting productivity, production. Besides, climate change can increase the frequency, intensity, oscillation and extreme levels of dangerous weather phenomena such as typhoons, floods, droughts, damaging cold… decrease planting and domestic animal productivity and production, increase the risk and danger to production agriculture and food security. In the last 3 years, the number of typhoons that impact directly to agriculture production is increasing. 2005 harvest season, typhoons seriously influenced 150.000ha of rice; 2006, there were 200.000ha of rice needed to be re-planted. In 2007, there were 5 floods occurred consecutively in the Central part made the remarkable damages to agriculture production. Especially the historical cold wave lasted 38 days in the Winter-Spring season 2007-2008 killed 200.000ha of newly planted rice, around 20.000ha of rise seeding died, killed 137.000 buffalos and cows, and made bad influent to the growth and development of thousands of ha of plants and millions of domestic animals.
b) Climate change causes the risk of narrowing agriculture land area: sea level rises will cause many coastal areas, delta areas to be salt-infiltrated, planting area will be narrowed causing the short of farming land. Natural calamities, typhoons, floods will increase causing erosion, sweeping away, landslide, sedimentation … influence greatly to land sources. Water short phenomenon and droughts will lead to the phenomenon of mankind desertification occur in many provinces in the Central part.
c) Climate change leads to the short of planting water: climate change changes the hydrology rules of rivers, cause the droughts. Typical example is the Red River Delta provinces has suffered from the serious short of water in the Winter-Spring season during the last 5 years because the Red river water level is lower than the historical lowest level in the last 100 years. The second instance is the phenomenon of warm winter in the North in recent 3-4 years.
d) Climate change leads to the droughts and increases the risk of epidemic diseases: climate change changes the living conditions of creatures, loses or changes the links of the food chain and food net causes the disappearance of some creatures and increase the number of natural enemy. Climate change can generate some new worm species, danger not only production but also in preserving agriculture production, food. In the last 2 years, Nilaparvata lugens,

Tungro, Rice Grassy Stunt Virus, in Mekong delta is complicatedly developing, influences the capability of intensive cultivation, increasing number of seasons and seriously decreases the production in some areas. In the North during the last Winter-Spring season, leaf roller was arising pestilent, in the high period, the damaged rice area was 400.000ha, created the remarkable damages to rice productivity and raised the production cost.

2.4.2. Animal livestock: Climate change influences the animal husbandry in two main impacts: 1) Domestic animal productivity and production: some animals can be lessened because of the variation amplitude of temperature, humidity and other outcome elements increasing. Food production decreasing causing the breeding food source decreasing, influence the animal livestock development; 2) Temperature increasing along with the changes of other climate and weather elements is the reason causing diseases on livestock's, poultries, and make the disease prevention harder to proceed. Specific expressions are the appearance of many dangerous diseases, more complicatedly developing, causing the huge impact to breeding such as Bird flu, Blue Ears disease, Foot and Mouth diseases (FMD), …

2.4.3. To the biodiversity and forestry: Vietnam has the high biodiversity (rank 16 in the world, WCMC, 1992), has diversity ecosystems. However, under the impact of climate change, the natural conditions in dry areas and semi-dry areas will be more harsh. Almost of the desert sand lands in our country will be hotter and terminate some species, the phenomenon of deserting will develop more seriously. Change cycle of rainfall and evaporation will influence the plants living organism productivity. Sea level rising will decrease the mangrove area; precious ecosystems at coastal areas (mangrove, coral reef, sea grass…) will face the big risk because of the sea level rising and ocean water temperature increasing.

2.4.4. Fishery and economic marine: Climate change is influencing our sea area. Sea level rising make the hydro-physical, hydro-chemical, water living get worse. The result is that the biological population appear in the sea area changes the structure, component, additional reserves decreasing. Fish in coral dust is terminated and move to other sea region influences the productivity and quality of the caught products. Climate change will impact the Vietnam coastal regions where lived about 18 million people, ¼ of the population of Vietnam. 58% of the coastal citizen livings are based on agriculture and water products, about 480.000 people are fishermen, 10.000 people are at sea products processing industry and 2.140.000 people provide services related to fish industry will be influenced. Sea level rising make the salt intrusion at coastal regions gets worse, the salt intrusion at dry season increases causing the direct impact to the aquaculture industry.

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