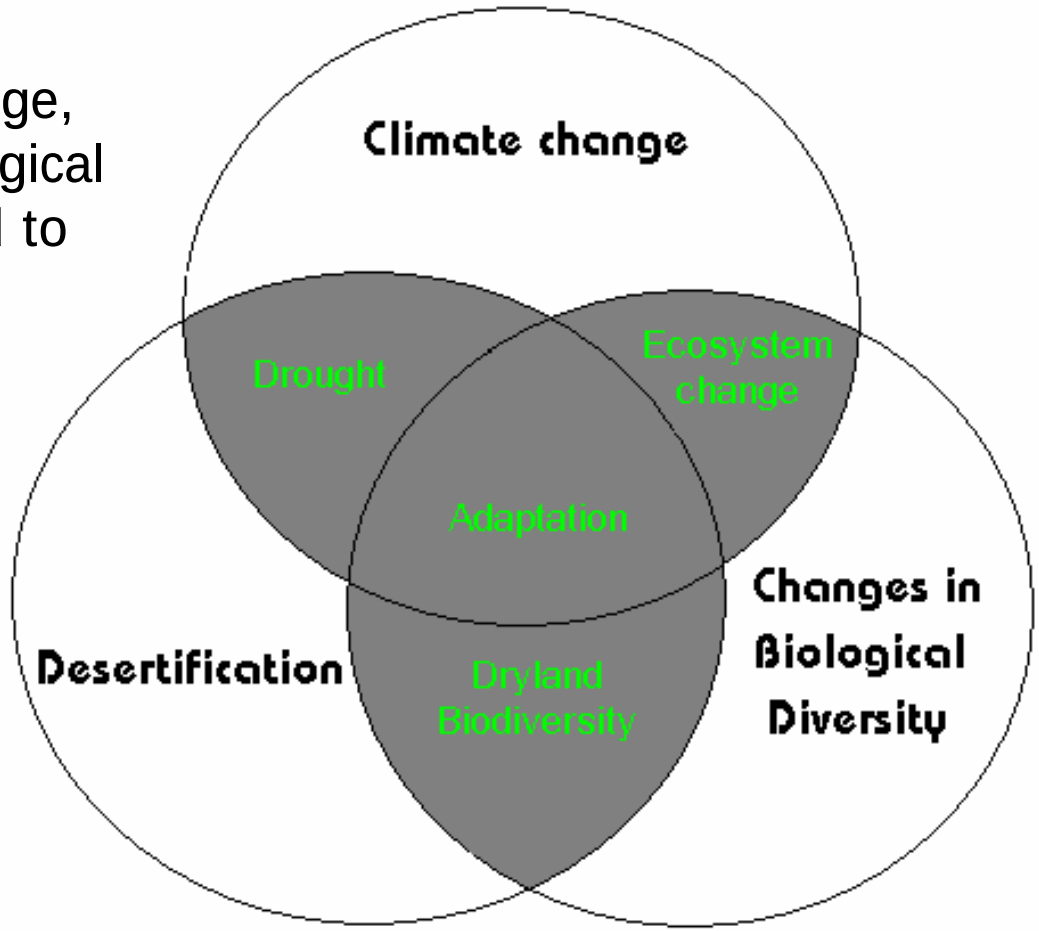
CLIMATE CHANGE AND VARIABILITY IN VIETNAM AND STRATEGIESTO BE ADDAPTED ON AGRICULTURE FOR SUSTAINABLE DEVELOPMENT

By Ass.Prof.Dr. Nguyen Van Viet
Agrometeorologycal research centre

INTRODUCTION

As seen in Figure climate change, desertification and loss of biological diersity are intimately conected to one another- they overlap and affect, and are affectedby, eachother



Studies of climate change and variability in Vietnam and strategies of sustainable development on Agriculture we have analyzed the following fluctuations:

1. Analyzed some mains of climate elements related with agriculture production:
    - ✓ Air temperature;
    - ✓ Precipitation;
    - ✓ Sunshine duration;
    - ✓ Typhoon.
2. Impact of climate change and variability on rice crop yield;
3. Strategies of sustainable development on Agriculture.

METHODOLOGY AND DATA

- Used methods of statistical analyze in climate and Agrometeorology.
- Data have been collected in some main stations in 7 Ago-economic region:
  - + North mountain and midland
  - + Red river delta
  - + North central
  - + South central
  - + Central plateau
  - + North eat south
  - + Mekong river delta

ASSESSMENT CLIMATE CHANGE AND VARIABILITY IN VIETNAM

1. Air average temperature.Long term variation and trend of temperature in January, July and annual over last 35 years are increased about 0.2-1^{o}C.
2. The dates of beginning and ending temperatures through 20^{o}C, 25^{o}C.

The dates of beginning and ending temperatures through 20^{o}C, 25^{o}C are very important for defining the crop calendar and crop rotation , especially for defining the growing period for Agriculture in the North and in the Mountain regions.

Table 1. Variation and trend of average temperature in Vietnam (1960-2000)

Station	in January	in July	Annual
Bac Giang	-0.3	-0.2	0
Ha Noi	+0.4	+0.4	+0.4
Hai duong	0	0	0
Namdinh	0	0	+0.5
Vinh	+0.4	+0.3	+0.3
Danang	+0.8	+0.3	+0.5
Nha Trang	0	0	0
Playku	+1	+0.9	+1
Buonmathuot	+0.9	+0.4	+0.5
Saigon	0	0	+0.2
Can tho	+0.5	+0.5	+0.5
Baclieu	+0.2	-0.2	0

Table 2. Trend change of dates of beginning and ending temperature through 20°C

Station	The dates of beginning	The dates of ending	Duration of winter
Ha noi	early 1 day	later 6 days	shorter
Nam dinh	later 10 days	later 13 days	shorter
Da Nang	early 10 days	later 5 days	shorter
Playku	early 9 days	later 3 days	shorter
Banmethuot	early 10 days	later 5 days	shorter

Table 3. Trend change of dates of beginning and ending temperature through 25°C

Station	The dates of beginning	The dates of ending	Duration of summer
Ha noi	0	later 6 day	no change
Nam dinh	early 3 days	later 2 days	longest
Da Nang	later 2 day	early 1 day	no change
Playku	later 13 days	early 12 days	no change
Banmethuot	early 1 day	later 10 days	longest

3. Absolute minimum temperature

Absolute minimum temperature is very important for distribution of perennial plant such as industrial crop coffee , rubber , tea and fruit trees such as lemon , orange, banana, longan, litchi... .

Table 4. Trend and variation of absolute minimum temperature

Region	Station	Variation (°C)
North wet	Lai Chau	+1.5
	Sapa	+1
	Van Chan	+2
North eat	Cao Bang	+2
	Lang Son	+1.8
Mid land	Phu Tho	+1
	Bac Giang	+1
Red river delta	Ha Noi	+1
	Hai Duong	+0.4
North central	Vinh	+0.4
South central	Nha Trang	+0.5
North eat south	Sai gon	+0.8
Plateau Taynguyen	Playku	+0.2
	Buonmathuot	+1.2
Mekong river delta	Soctrang	+0.5
	Rach Gia	+1.2

4. Sunshine duration

Sunshine duration are decrease excepts the south central region and high mountain in central region (see table 5)

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Table 5. The trend of change of sunshine duration

Station	January (h)	July(h)	Annual(h)	Summer season(h)	Winter-spring season (h)
Bac giang	- 20h	- 10h	- 50h	- 10h	- 40h
Ha Noi	- 20h	- 30h	- 200h	- 100h	- 100h
Nam dinh	- 10h	- 60h	- 250h	- 160h	- 100h
Vinh	- 8h	- 20h	no change	- 5h	- 15h
Banmathuot	+ 15h	+ 10h	no change	- 40h	+ 10h
Bac lieu	- 15h	- 20h	- 140h	- 60h	- 100h

5. Rainfall

The situation of rainfall is some what complex depending on locations and seasons. In annual and summer season (May - October) small decreasing trend is found at station Hai duong, Ha noi (Red river delta region), Vinh (North central region), Can tho and Bac Lieu (Mekong river delta). On the other hand, in winter-spring season rainfall is increasing trend which observed at Bac Giang, Ha noi, Nam dinh, Vinh, Playku, Saigon

Table 6. The trend of change of rainfall

Station	January (mm)	July (mm)	Annual (mm)	Summer season (mm)	Winter-spring season (mm)
Bac giang	0	+60	+150	+110	+15
Ha Noi	+12	+20	0	-10	+60
Hai duong	+12	-20	-180	-180	+10
Nam dinh	+5	+50	-50	0	+50
Vinh	-20	-50	-40	-100	+10
Da nang	0	-10	+200	+180	-20
Playku	-2	-10	0	0	+60
Sai gon	-5	0	0	-50	+50
Can tho	-1	+30	0	-20	0
Bac lieu	-30	+125	-100	-50	-20

6. Typhoon visit in Vietnam

Annual number of typhoon visit in Vietnam the period from 1950-1999 is show in table 7. Number of typhoon visit in Vietnam shown increasing trend from the 1950-1980. While it shows some decreasing trend in the 1990. Also noted is a clear shift of typhoon visit season in Vietnam. The peak month in the 1950 is August while it is in September in both the 1960 and the 1970. It shifts to October in the 1980 and even to November in the 1990. There fore clear delay trend of the typhoon visit season can be found during the latter half of the 20th century ; of which season should be investigated in future.

Table 7. Monthly and annual frequent of typhoon visit in Vietnam for 1950-1999.

Month	1	2	3	4	5	6	7	8	9	10	11	12	Year
1950-1959	0	0	0	1	1	4	5	11	9	9	7	3	50
1960-1969	0	1	0	1	1	5	11	13	19	12	8	1	72
1970-1979	0	0	0	0	2	9	7	13	18	15	10	4	78
1980-1989	0	0	2	0	1	9	10	9	9	24	11	2	77
1990-1999	0	0	0	1	0	6	8	10	12	14	15	5	71
Total frequent per year	0	0.02	0.04	0.06	0.1	0.66	0.82	1.12	1.34	1.48	1.02	0.3	6.96

IMPACT OF CLIMATE CHANGE AND VARIABILITY ON AGRICULTURE

In order to study impacts of climate change and variability or extreme climate event (Elnino, Lanina) on rice yields in different agro-economic regions were under taken analysis data series of rice yield of winter – spring and summer crop season. As well as calculate differences of rice yield and differences of climate element between this year with the year before from 1960-1998. After that calculate correlation coefficient between differences of rice yields with differences of climate elements in growing period (see table 8, 9)

Table 8. Correlation coefficients between winter spring rice yield with climate - element in growing period

Month / region	XI	XII	I	II	III	IV
Temperature						
Platter Bacbo	+0.05	+0.24	-0.16	-0.28	-0.52	+0.04
Red river delta	+0.11	+0.31	-0.23	-0.45	-0.66	-0.24
Mekong river delta	- 0.22	- 0.1	-0.03	+0.36	+0.28	+0.06
Rainfall						
Platter Bacbo	-0.04	-0.09	+0.14	+0.64	+0.13	+0.14
Red river delta	-0.18	+0.14	+0.24	+0.36	+0.34	+0.01
Mekong river delta	-0.09	+0.02	-0.06	-0.25	-0.05	+0.02
Sunshine duration						
Platter Bacbo	+0.08	-0.29	+0.22	-0.15	-0.24	+0.43
Red river delta	+0.24	-0.15	-0.01	-0.31	-0.04	+0.2
Mekong river delta	-0.07	-0.24	-0.15	-0.04	-0.2	+0.19

Table 9. Correlation coefficients between summer rice yield with climate - element

Region \ Month	V	VI	VII	VIII	IX	X
Temperature						
Platter Bacbo	+0.09	+0.14	+0.4	-0.48	-0.33	-0.01
Red river delta	-0.08	+0.32	+0.64	-0.05	+0.22	+0.48
Mekong river delta	+0.12	-0.12	-0.27	-0.03	-0.03	+0.04
Rainfall						
Platter Bacbo	+0.38	+0.1	-0.25	-0.08	+0.10	-0.46
Red river delta	-0.09	+0.03	-0.44	-0.07	-0.08	-0.35
Mekong river delta	-0.27	-0.16	+0.31	+0.1	-0.33	-0.12
Sunshine duration						
Platter Bacbo	+0.21	-0.2	+0.39	-0.24	-0.12	+0.33
Red river delta	-0.1	+0.06	+0.36	+0.07	+0.03	+0.18
Mekong river delta	+0.24	-0.59	-0.42	+0.11	+0.15	+0.01

In order to predict rice yield before harvest time use equal:

$$Y_{t+1} = Y_t + \Delta Y$$

Where are:

Y_{t+1} -Prediction rice yield in this year

Yt -rice yield in the year before

ΔY -difference of winter - spring or summer

Rice yield can find in following equations:

For winter-spring rice

In midland Bacbo:

$$\Delta Y = 0.451 - 1.156\Delta T_3 + 0.095\Delta R_2 + 0.041\Delta S_4$$

In red river delta:

$$\Delta Y = 0.714 - 2.422\Delta T_3 + 0.024\Delta R_2 + 0.02\Delta S_{11}$$

In the Mekong river delta:

$$\Delta Y = 0.708 + 1.095\Delta T_2 + 0.296\Delta R_2 - 0.042\Delta S_{12}$$

Where are: ΔT_2, ΔT_3, ΔR_2, ΔS_4, ΔS_{11}, ΔS_{12} - *differences of temperature, rainfall and sunshine duration in February , March, April, November, December.*

Rice yield can find in following equations:

For summer rice yield

In midland Bacbo:

$$\Delta Y = 0.397 - 2.034\Delta T_8 + 0.01\Delta R_{10} + 0.008\Delta S_7$$

In red river delta:

$$\Delta Y = 0.159 + 3.406\Delta T_7 - 0.002\Delta R_7 + 0.002\Delta S_5$$

In the Mekong river delta:

$$\Delta Y = 0.851 - 0.613\Delta T_7 + 0.011\Delta R_7 - 0.106\Delta S_6$$

Where are $\Delta T_7, \Delta T_8, \Delta R_7, \Delta R_{10}, \Delta S_5, \Delta S_6, \Delta S_7$ *- differences of temperature, rainfall are sunshine duration in May, June, July, August, October.*

STRATEGIES TO BE ADAPTED ON AGRICULTURE FOR SUSTAINABLE DEVELOPMENT

Adaptation isan automatic or planned activity that minimises adverse effects of climate change and maximises advantages. It is one of the two possible means of copping with the impacts of human- induced climate change- the other is emission mitigation, or reduction of the degree of climate change. Adaptation is essential to cope with the climate change we cannot avoid now and in the near future, while mitigation would limit the exten of the climate change over time

STRATEGIES TO BE ADAPTED ON AGRICULTURE FOR SUSTAINABLE DEVELOPMENT

1) Short term adaptation

a) Insurance: in agriculture to cope with weather variation,

b) Crop and livestock diversificationesses. Changing crop types requires sufficient knowledge to grow and cultivate.

c) Changes in intensity of production:.

d) Improved nutrient and pest control management.

e) Changes in tillage practices and farm systems

f) Temperature migration:

STRATEGIES TO BE ADAPTED ON AGRICULTURE FOR SUSTAINABLE DEVELOPMENT

2) Long term adaptation

a) Development of new technologies and modernization

b) Changing crop mix.

c) Improving water management

d) Permanent migration of labor

STRATEGIES TO BE ADAPTED ON AGRICULTURE FOR SUSTAINABLE DEVELOPMENT

3) Both short and long-term strategies

a) Investment and accumulation of capital

b) Reform of pricing schemes development of open markets and other reforms.

c) Adaptation of new technologies

d) Promotion of trade This is likely to enhance economic adaptations under climate

e) Extension services

f) Diversification if income earning and employment opportunities

g) Dissemination of climate data

h) Institutional planning and implementation

CONCLUSION

- ✓ Vietnam climate change and variability are a part of global climate change, if it occurs will definitely effect agriculture.
- ✓ In Vietnam the change and variability of climate elements in every Agro-ecological regions are difference. In general temperature is increasing sunshine duration is decreasing typhoon is moving in the South, the change of rainfall is not clear for every regions.
- ✓ The effect of climate change and variability on agriculture are not similar in difference agro-ecological region of Vietnam.
- ✓ For sustainable development on agriculture to cope with climate change will have to change the cropping calendar , cropping pattern, cropping rotation for every agro-ecological regions.
- ✓ To select adaptation crop, varieties for every agro-ecological regions and for every crop season.

RECOMMENDATION

1. In order to establish above mentioned strategies and tactics as well as to improve the application of those results in agricultural practices should be continued research project on impact of climate change;
2. The impact of climate change and variability on agriculture, forestry and food security inVietnam and strategies to be adapted on agriculture;
3. Preparation the Vietnam- National Adaptation Programmes of Action (NAPA) to adapt to the present threats from climate change. In this preparing a"handbook for Central and local Gevernments"

Fig1. Trend and variation of annual average temperature (station Ha Noi)

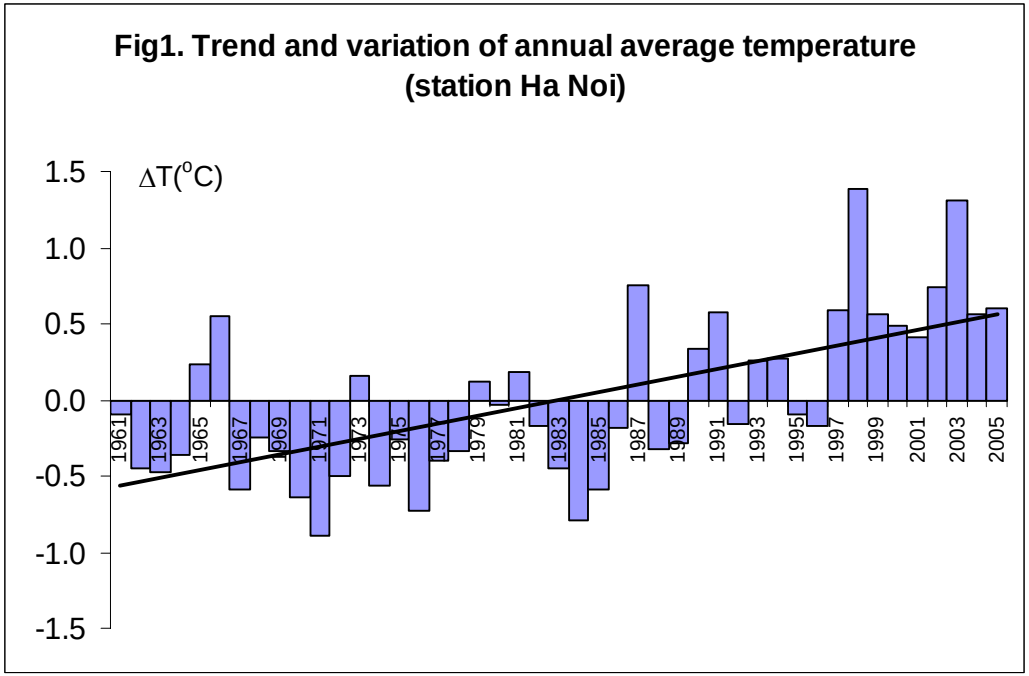

Fig2. Trend and variation of annual average temperature (station Da Nang)

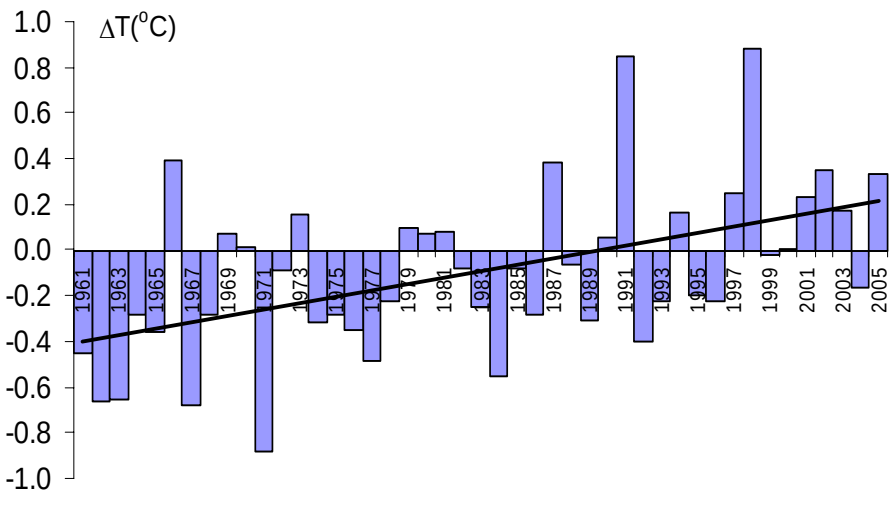

Fig3. Trend and variation of annual average temperature (station Ho Chi Minh)

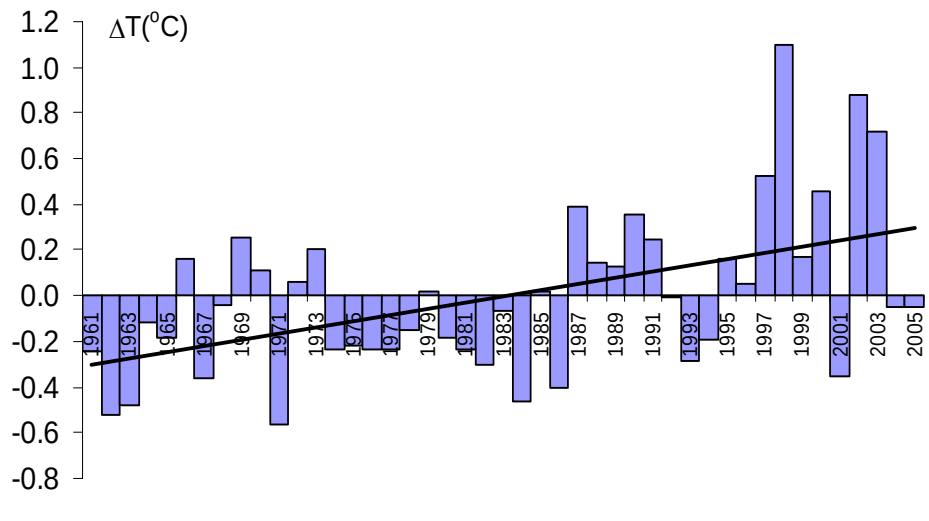

Fig4. Trend and variation of absolute minimum temperature (station Ha Noi)

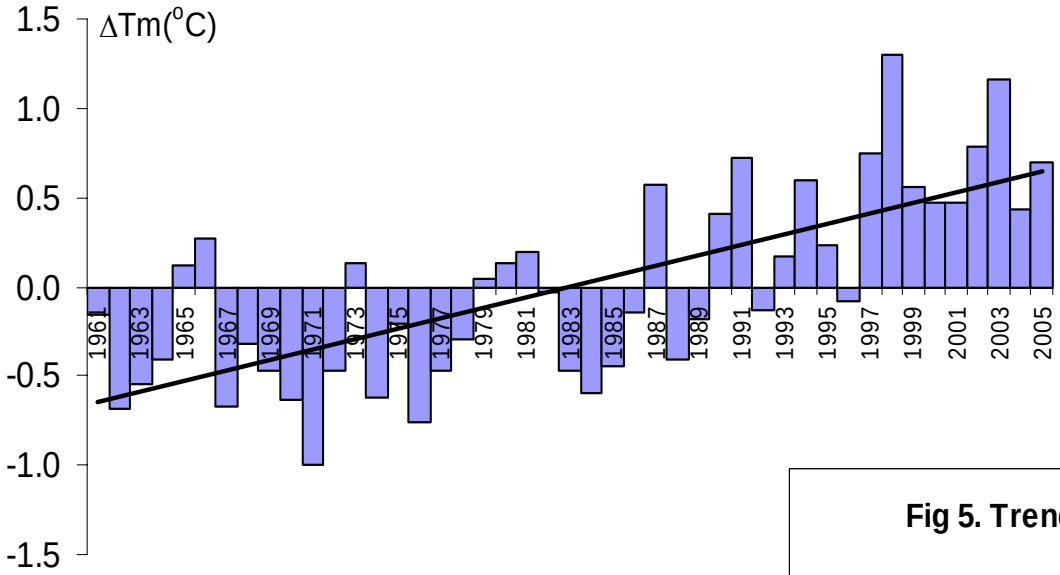

Fig 5. Trend and variation of absolute minimum temperature (station Da Nang)

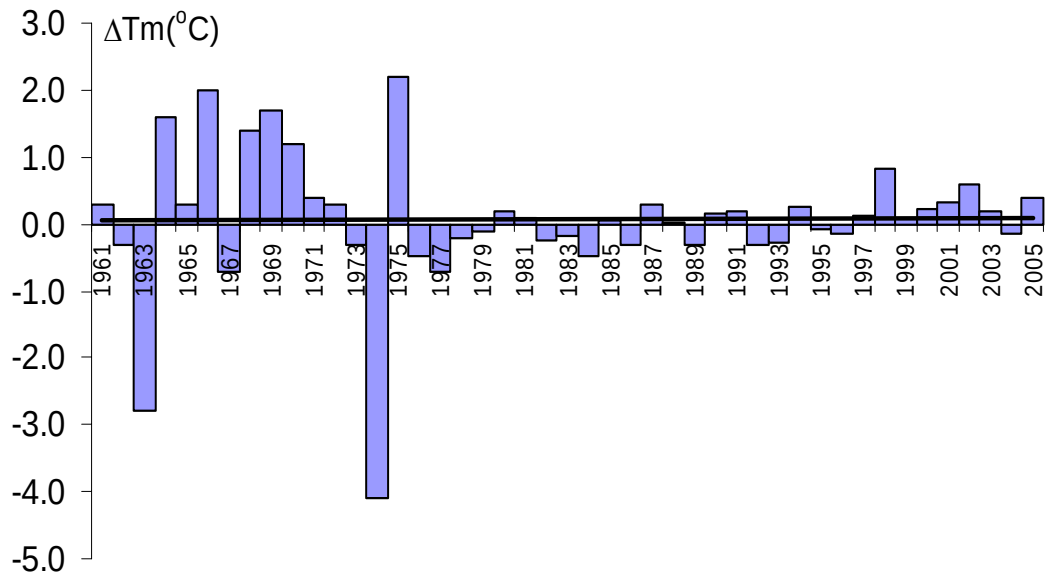

Fig6. Trend and variation of annual total rainfall (station Ha Noi)

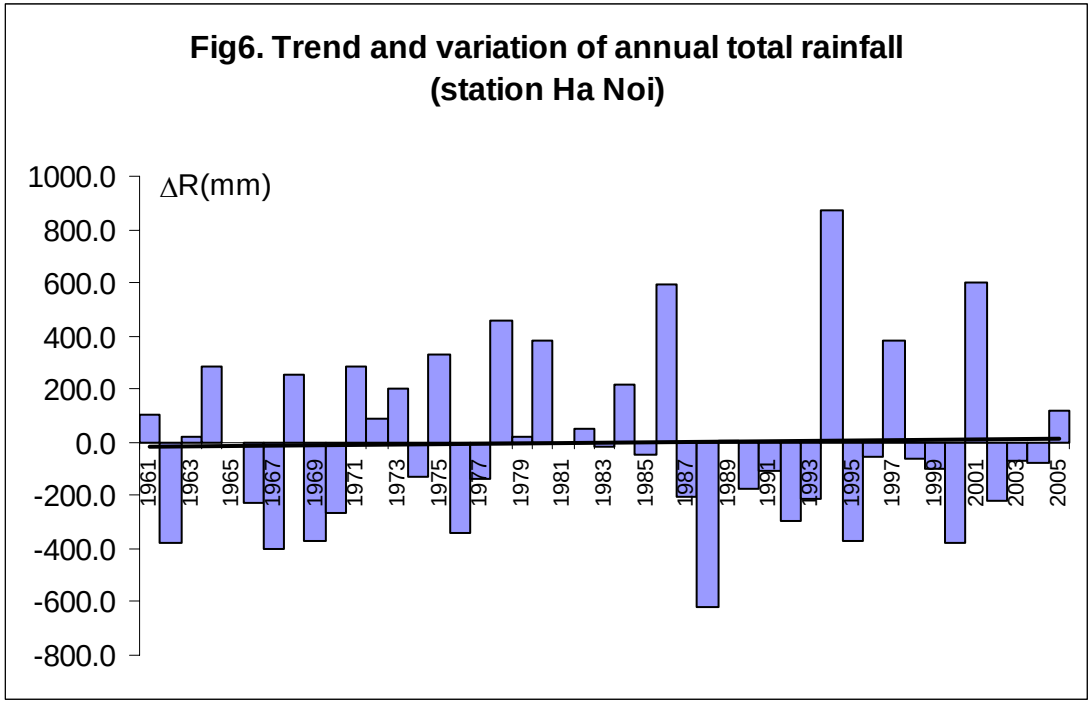

Fig7. Trend and variation of annual total rainfall (station Da Nang)

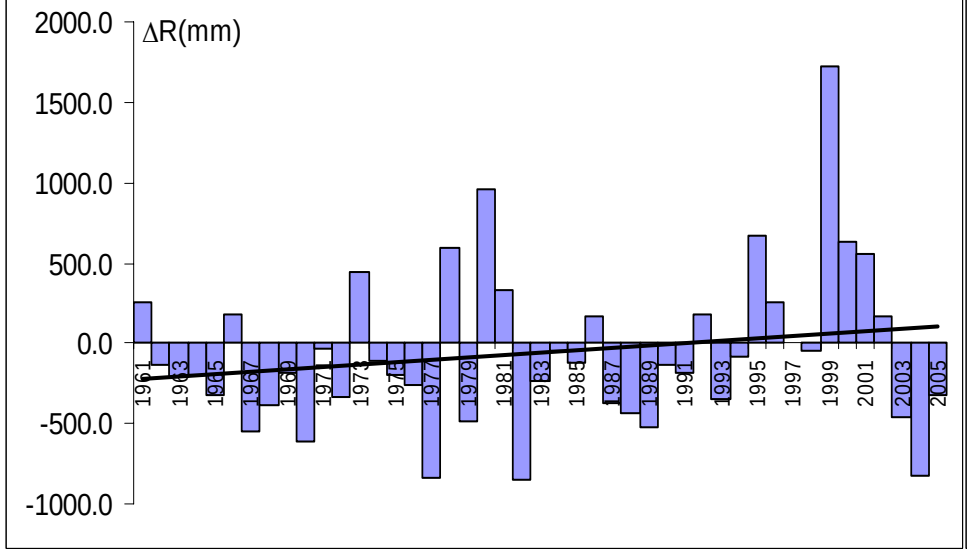

Fig 8. Trend and variation of annual total rainfall (station Ho Chi Minh)