Measurement of Disease Frequency

Occurrence and Trends

Module 1

Measurement of Disease for Outbreaks and Trends

- Measurement of disease burden
  - Prevalence, Proportion, % etc
- Measurement of disease occurrence
  - Incidence, death rate,
- Measurement of association (risk vs outcome)
  - Odds Ratio, RR
- Measurement of Trends and Distributions**
  - Dose – response, Trends over time cohort (APC)
  - Time Series etc.

Measurement of disease burden

- Count (number) and unit of count (such as aggregate number – group, cluster, flock etc)
- Count and proportion (number of case per survey population, %, ratio – m:f)
- **Prevalence** (magnitude)

Prevalence

$$\text{Prevalence}_{\text{(point)}} = \frac{\text{Number of existing cases at a point of time}}{\text{Size of the population at a point of time}}$$

$$\text{Prevalence}_{\text{period}} = \frac{\text{No. of existing cases + new cases during a period of time}}{\text{Average size of the population at the period of time}}$$

Prevalence (point)

$$\text{Prevalence}_{(\text{point})} = \frac{\text{Number of DM cases in the survey of a village}}{\text{Size of the population of the village}}$$

$$= \frac{36}{3200 \text{ villager}}$$

$$= 0.01125 \quad \text{Or} \quad 1.12 \text{ person in } 100 \text{ people}$$

Prevalence

$$\text{Prevalence}_{\text{period}} = \frac{\text{No. of existing cases + new cases during a period of time}}{\text{Average size of the population at the period of time}}$$

$$= \frac{36 + \mathbf{12} \quad \text{In 6 months period}}{3200 \text{ villager} + 200 \text{ (birth and move in, minus died)}}$$

$$= \frac{48}{3400}$$

$$= 0.0141 \qquad \textbf{Or 1.4 in 100 villager}$$

Measurement of disease occurrence

(incidence rate, death rate etc.

$$\text{Incidence (rate)} = \frac{\textbf{New cases occur} \text{ in an observed period (1 year)}}{\textbf{Size of population at risk} \text{ who stay in the area in 1 year}}$$

$$= \frac{\text{No. of FMD in cows in 1 year}}{\text{Population of cows in the province in 1 year}} \text{ X 1000 or 100000}$$

$$= \frac{500}{2500} \text{ X 10000} = \textbf{200 FMD per 1000 Cows per year}$$

Incidence is rate of change : unit of calculation is per time (t minus 1)

Common measurement in descriptive epidemiology

- Count
- Ratio (A:B) such as M:F
- Proportion (of Total, of school attendant)
- Percentage %
- Prevalence
- Rate (of change) – incidence
- Case Fatality Rate : CFR) - proportion
- Summary of data variable (Mean, Median, Mode)

Number of patients with "D" disease reported from all hospitals in Province/Division 'M' by week, in 201X

Hospital Area	Total	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Provincial H	1778	11	12	12	101	11	12	16	100	121	127	83	89	85	107	63	83	675	6	87	
Hosp A	163					28	31	2	628	13	12	9	5	1	1						
Hosp B	5	1	1	1		1							1								
Hosp C	169	24	1	16	422	25	23	2	04	1		2			16						
Hosp D	656	44	3	47	844	27	21	4	324	24	19	1	34	29	843	4	41	534	3	29	8
Hosp E	466	19	3	33	638	28	20	4	023	16	21	2	17	26	121	1	24	718	2	24	2
Hosp F	226	17	1	27	623	47	26	4	122	2											
Hosp G	242	27	1	28	533	21	20	3	318	28	17	1									

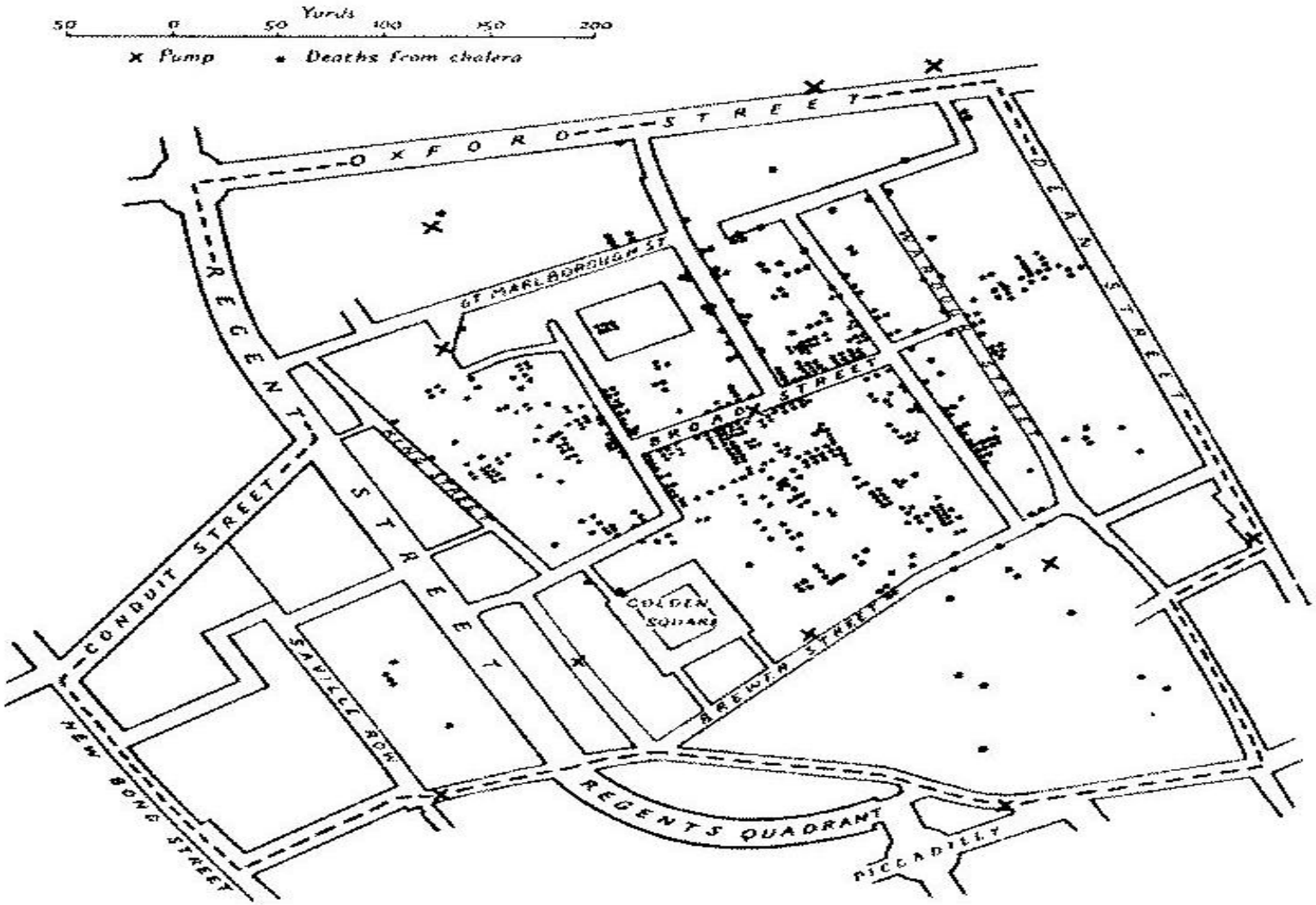
Understand sources of data and how data collected

- Definition of case required for notification
- Surveillance and reporting system (and requirement – such as priority/urgent etc)
- Reporting Persons, organization
- Timeliness
- Completion
- Evaluation and supervision
- Technology

Previous slide content show

- Count per week
- Count of cases among different hospital/area
- No report and missing data
- Incomplete information in some data
- No information, no data – difficult to analyze or interpretation
- No population in each area make it hard to compare the problem
- Can we say something about the trends of disease?

John Snow : Observation and study of Cholera Outbreak, London 1854



Cholera cases, rate per HH
By water supplied company, London 1854.

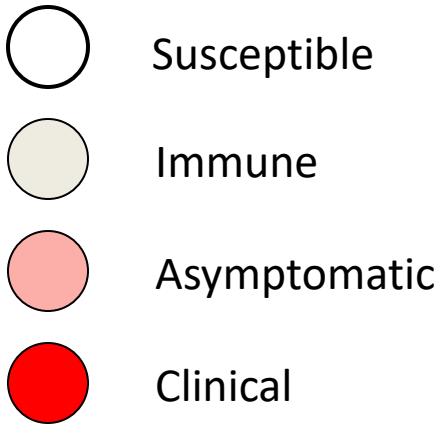
Tap water Supplied company	No. HH	cases	Case per 10000 HH
Southwark & Vauxhall Company	40,046	1,263	315
Lamberth Company	26,107	98	37
Rest of London	256,423	1,422	59

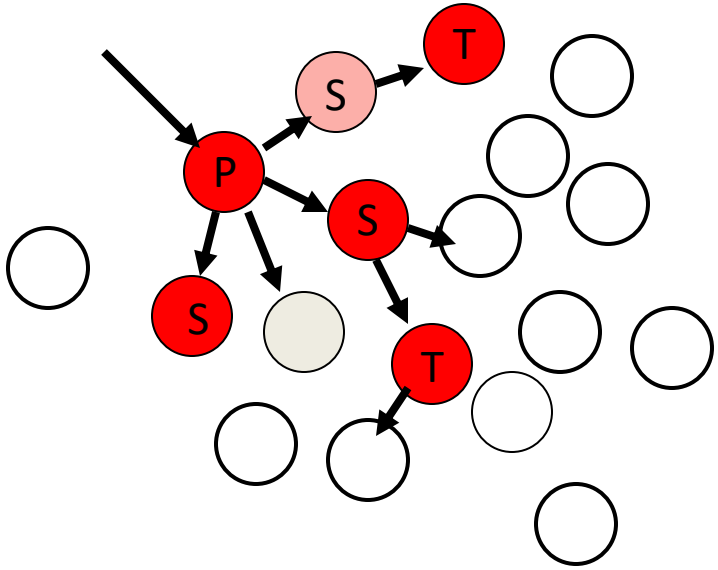
Measure of disease transmission

การถ่ายทอดโรค (Disease Transmission)

Index – first case identified

- Primary – case that brings the infection into a population
- Secondary – infected by a primary case
- Tertiary – infected by a secondary case





Transmission: Reproductive Number

Basic Reproductive Number (R zero)

Secondary cases occurred as a result of exposure (contact) to indexed cases or previous case

Ro = between 1-2 from this example

After an ILI index case ill in families no. of new cases sick in 1 incubation period

Size of families	New case occur	Index to new case ratio
5	2	1:2
4	2	1:2
3	1	1:1
6	3	1:3

Estimated Ro

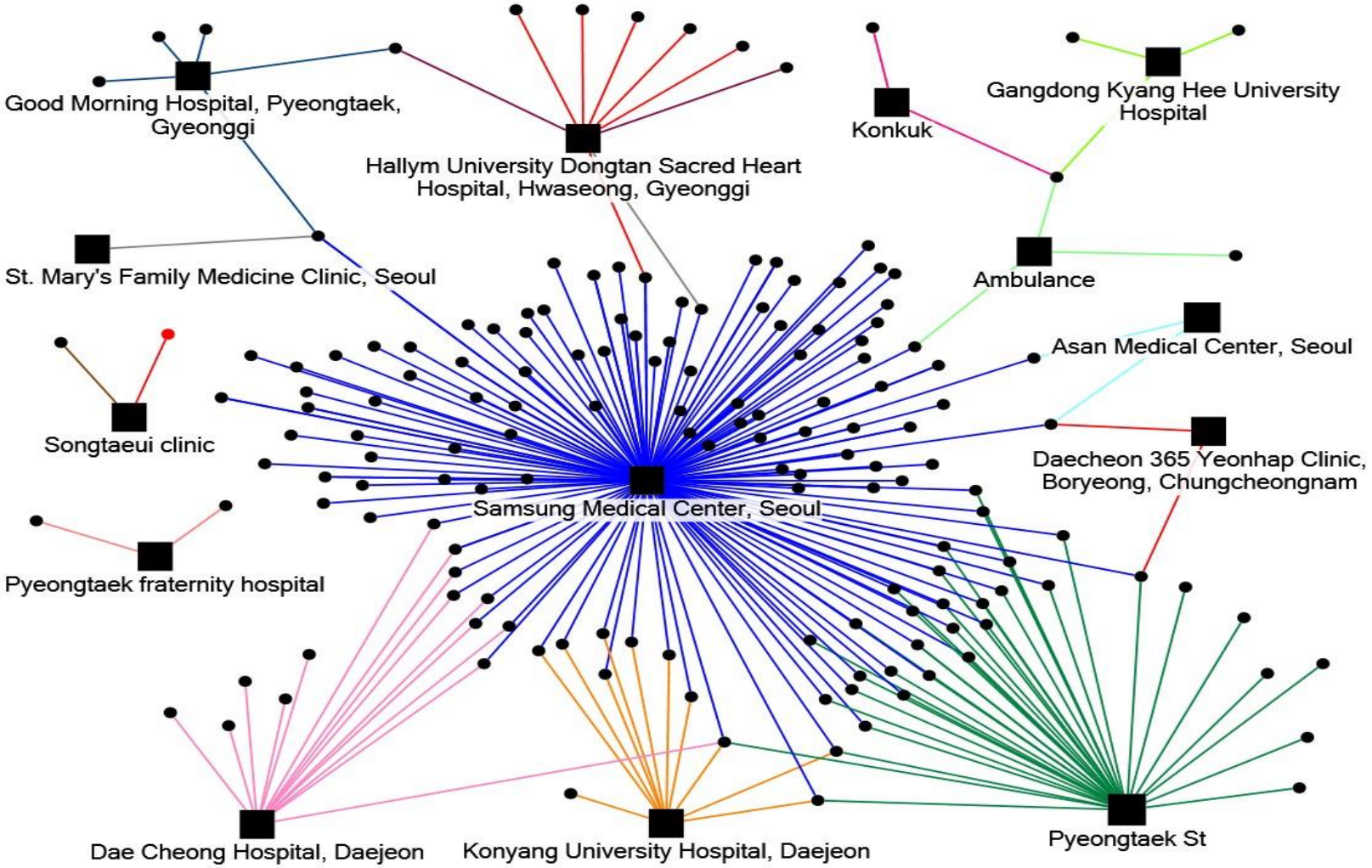
in selected infectious disease

- Seasonal Influenza (2-4)
- Pandemic A/H1N1 (2-5)
- H5N1 (0.5-2)
- SARs (3-7****)
- Tuberculosis (1-2)***
- MERS (0.7-4**)
- Ebola (1-5**)
- HFMD (1-6**)

** depend on settings, family size, contact methods, procedure

First MERS in Korea and transmission

Transmission Relationships



Measurement of association (risk vs outcome)

Odds Ratio, RR

Terminology

- Variable (things with information of interest : Sex, age, Blood sugar, Infection (Y/N), eat food A, bite by rabid dog, vaccination) (y/n)……etc)
- Association (possible relationship of x and y)
- Correlation (how x and y go together) (+/-)
- Some association can be cause-effect relationship

Measurement of association (risk vs outcome)

Odds Ratio, RR

Association

- What is Odd and Odds Ration

  a:b is Odd of X (c:d is another odd of Y)

  X:Y is Odds Ratio

- What is Relative Risk (similar concept

"Studies showed "Drink alcohol" associated with increase in road accident by 3 times"

Calculation format Odd, Odds Ratio

	Accident	No accident	
Drinking “alcohol” Over 75 mg%	a	b	a+b
No alcohol	c	d	c+d
	a+c	b+d	N = a+b+c+d

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Drinking “alcohol” Over 75 mg%	a	b	a+b
No alcohol	c	d	c+d
	a+c	b+d	N = a+b+c+d

Odd of accident in drinking = a/b

Odd of accident in No drinking = c/d

Odd Ratio of Alcohol in accident = (a/b) /(c/d) = a*d /b*c

+ Calculate 95% Confident Intervals

ORs = number

	Accident	No accident	
Drinking “alcohol” Over 75 mg%	50	500	550
No alcohol	5	1200	1205
	55	1700	1755

Odd of accident in drinking = a/b = 50/500 = 0.1

Odd of accident in No drinking = c/d = 5/1200 = 0.00416

Odd Ratio of Alcohol in accident = (0.1) /(0.00416) = 24.04 times

+ Calculate 95% Confident Intervals

ORs = number

Calculation format RR, RRs Ratio

	Case Measles	Normal (child) no illness	
MMR vaccination	a	b	a+b
No MMR vaccination	c	d	c+d
	a+c	b+d	N = a+b+c+d

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	a+c	b+d	N = a+b+c+d

RR of disease in vaccination = a/a+b

RR of disease in non-vaccination = c/c+d

RRs Ratio is = a(a+b)/(c /(c+d))

	Case Measles	Normal (child) no illness	
MMR vaccination	5	400	405
No MMR vaccination	28	300	328
	33	730	763

RR of disease in vaccination = a/a+b = 5/405 = 0.012

RR of disease in non-vaccination = c/c+d = 28/328 = 0.0853

RRs Ratio is = a(a+b)/(c /(c+d))

= 0.012/0.0853 = 0.14

MMR vaccination has 7.1 time protective effect or approximately 76 % efficacy

Cause-effect Association

- Strength of association (high RRs, Ors)
- Consistency
- Specificity
- Temporal relation (A happened before disease)
- Biological Plausibility
- Dose-response relationship
- Coherence
- Experiment support
- Analogy **

** too weak , may not be necessary

Q/A

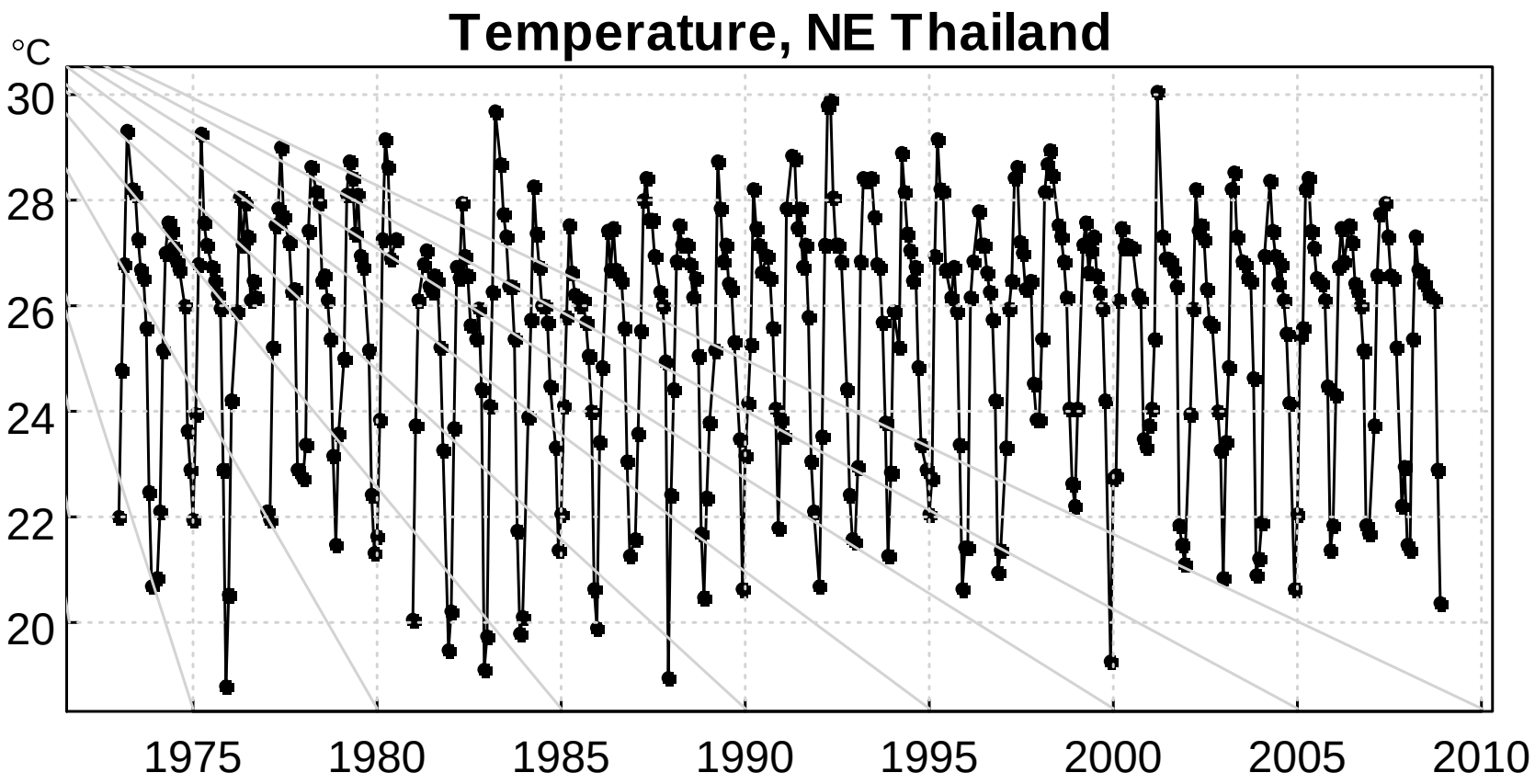
Thank you

For use in future

Trends Analysis (advance)

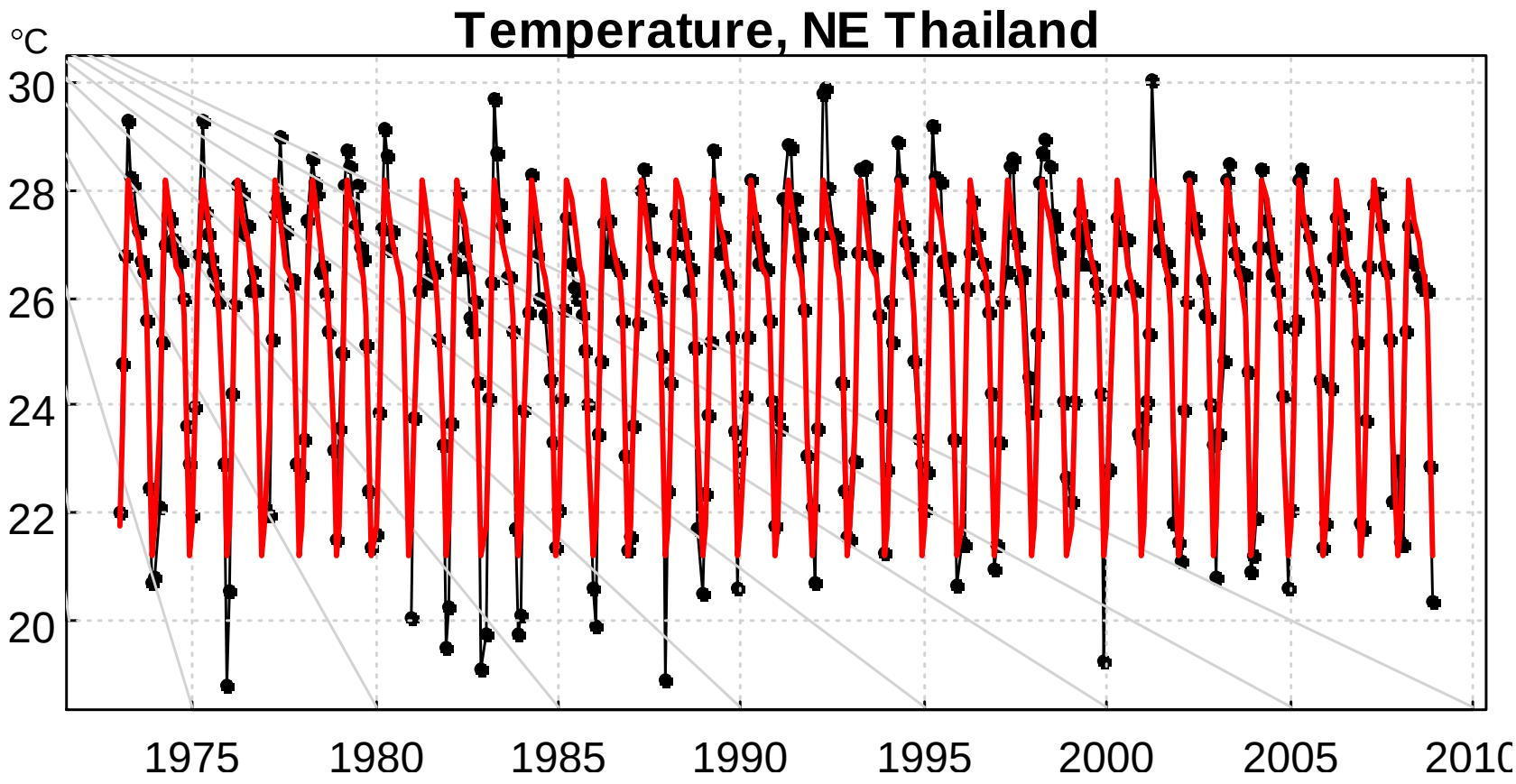
For your interest only

Time series analysis

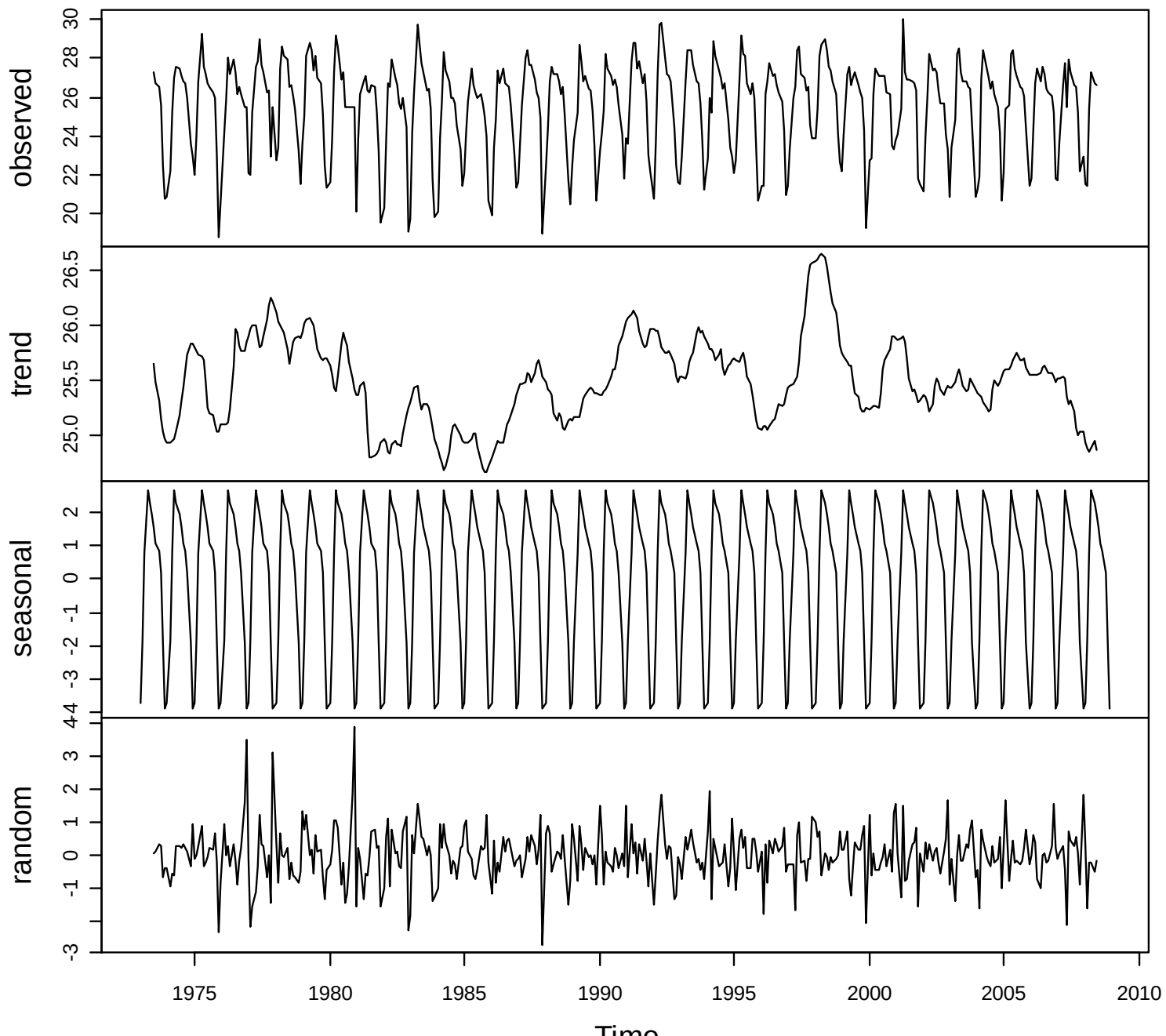

Temperature, NE Thailand
°C
30
28
26
24
22
20
1975
1980
1985
1990
1995
2000
2005
2010

Main composition of determinants of a Time Series

- **Trend:** linear, curvinear, moving average
- **Oscillation** (cosine function)
  - Harmonic terms e.g. cos(a), cos(2a)
  - Starting points e.g. cos(m+a), cos(n+2a)
- *Autoregressive effect*
  - Preceding status has effects on the current one.
- Optionally other explanatory independent terms e.g. temperature, rainfalls, which are beyond the trend and cyclical effects
- Random errors

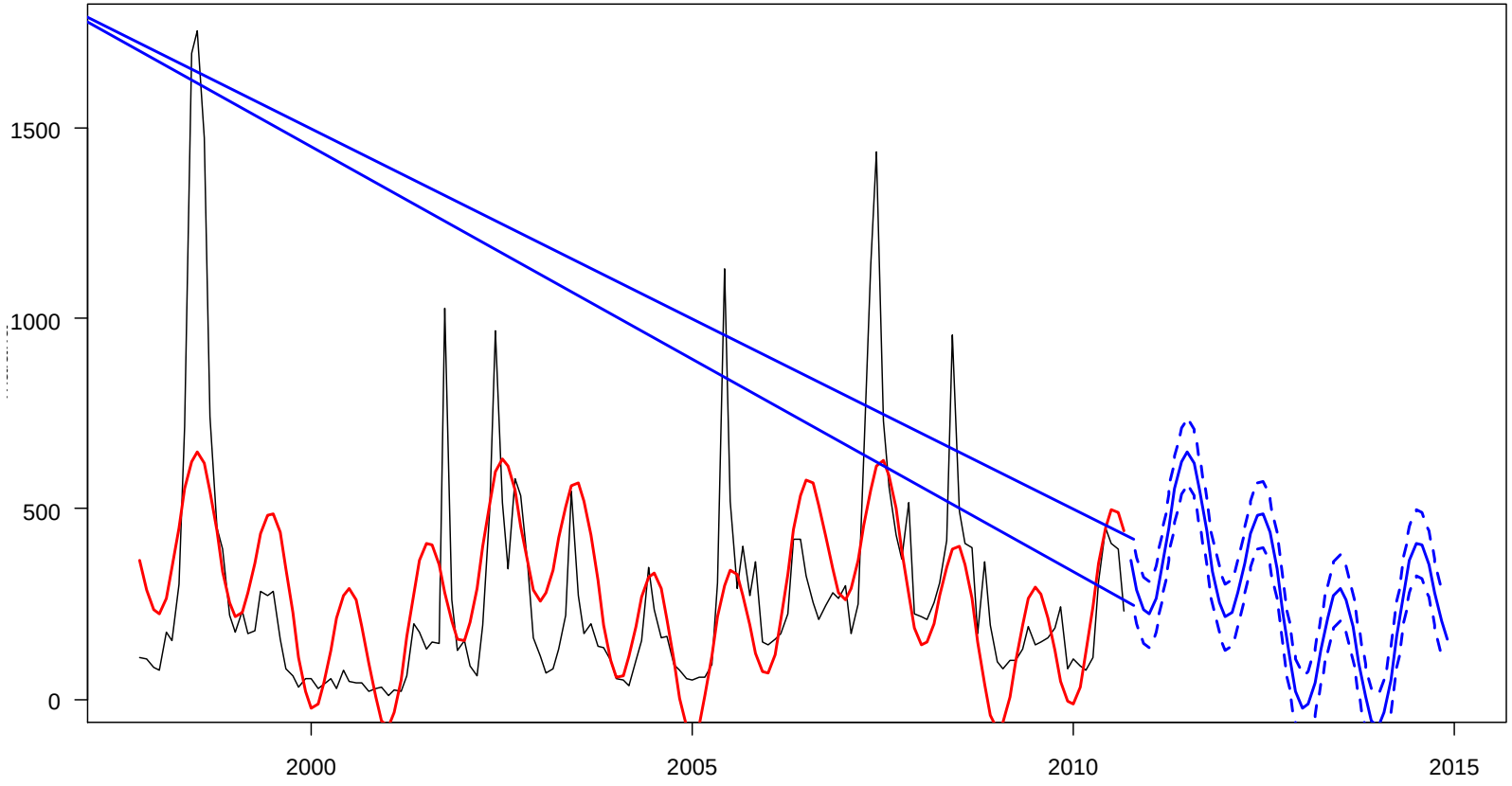


Analysis : Output from R program - red line show trend of temperature with seasonal (time) variation

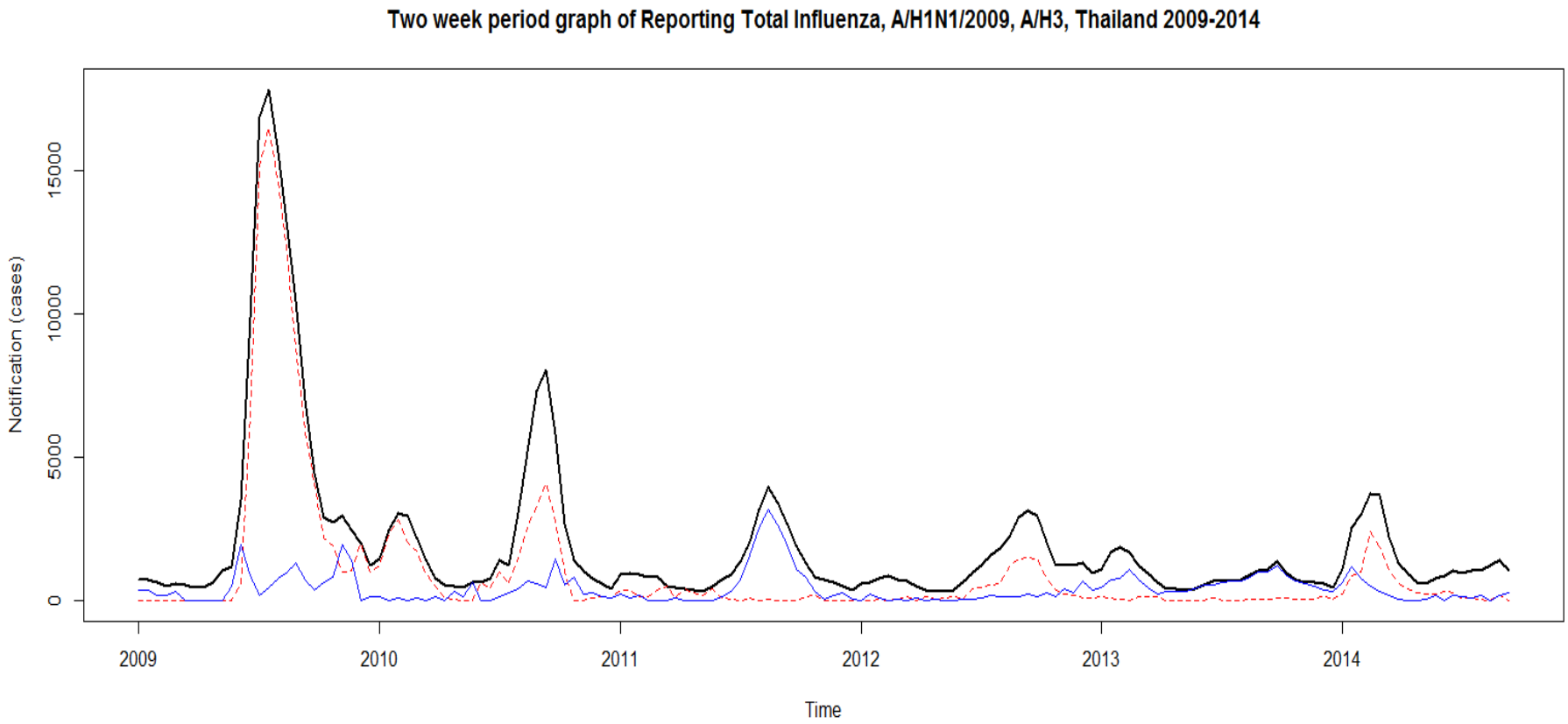

Decomposition of additive time series
observed
trend
seasonal
random
Time
1975
1980
1985
1990
1995
2000
2005
2010

Forecasting malaria in Yala

$$x_t = 277.21 + 94.42\cos(2\pi t \times 0.08) - 167.64\sin(2\pi t \times 0.08) + 69.52\cos(2\pi t \times 0.02) + 167.04\sin(2\pi t \times 0.02)$$



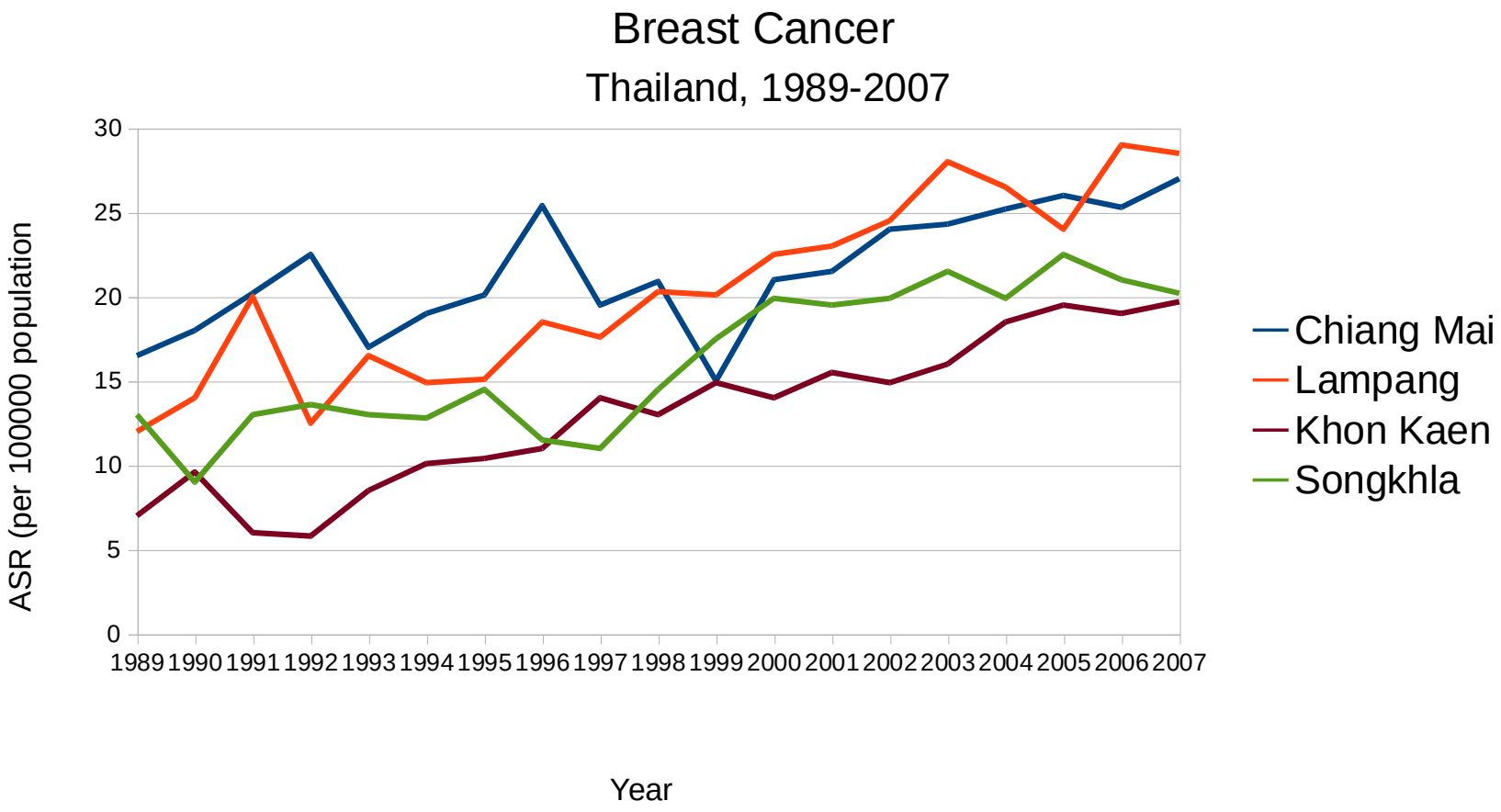
การเปลี่ยนแปลงหลังการระบาดใหญ่ ๕ ปี ของไข้หวัดใหญ่สายพันธ์ใหม่ 20



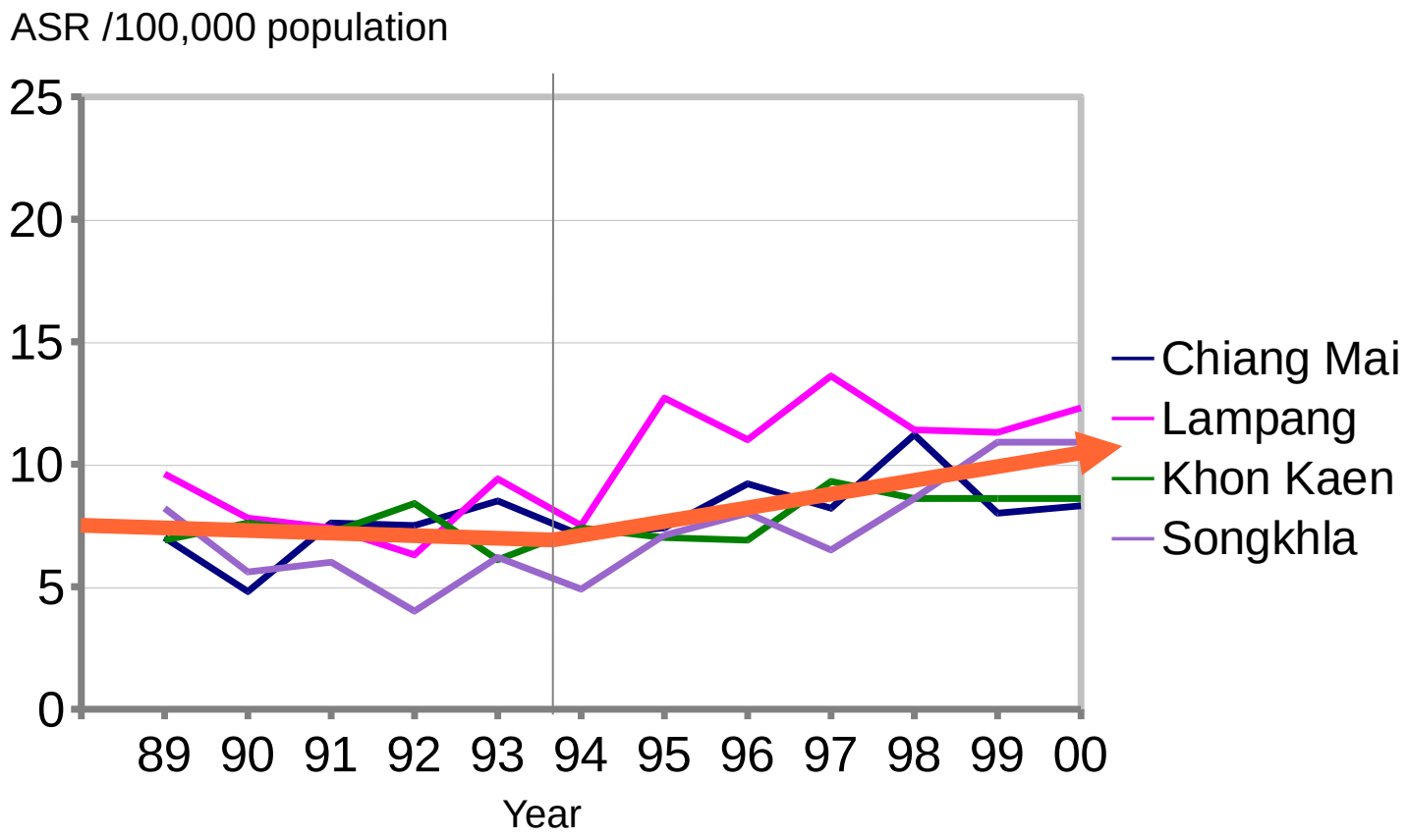
Age-Period-Cohort (APC)

- **Age** – risk of disease depend on age such as
  - Low immunity in children
  - Exposure to chemical, hormone change
  - Age related disease, elderly less immunity etc
- **Period** : certain period living aspect change (60s, 80s, 90s, 2000s, 2010….)
- **Cohort** : Birth cohort experienced different era/period
- Interaction for risk factors

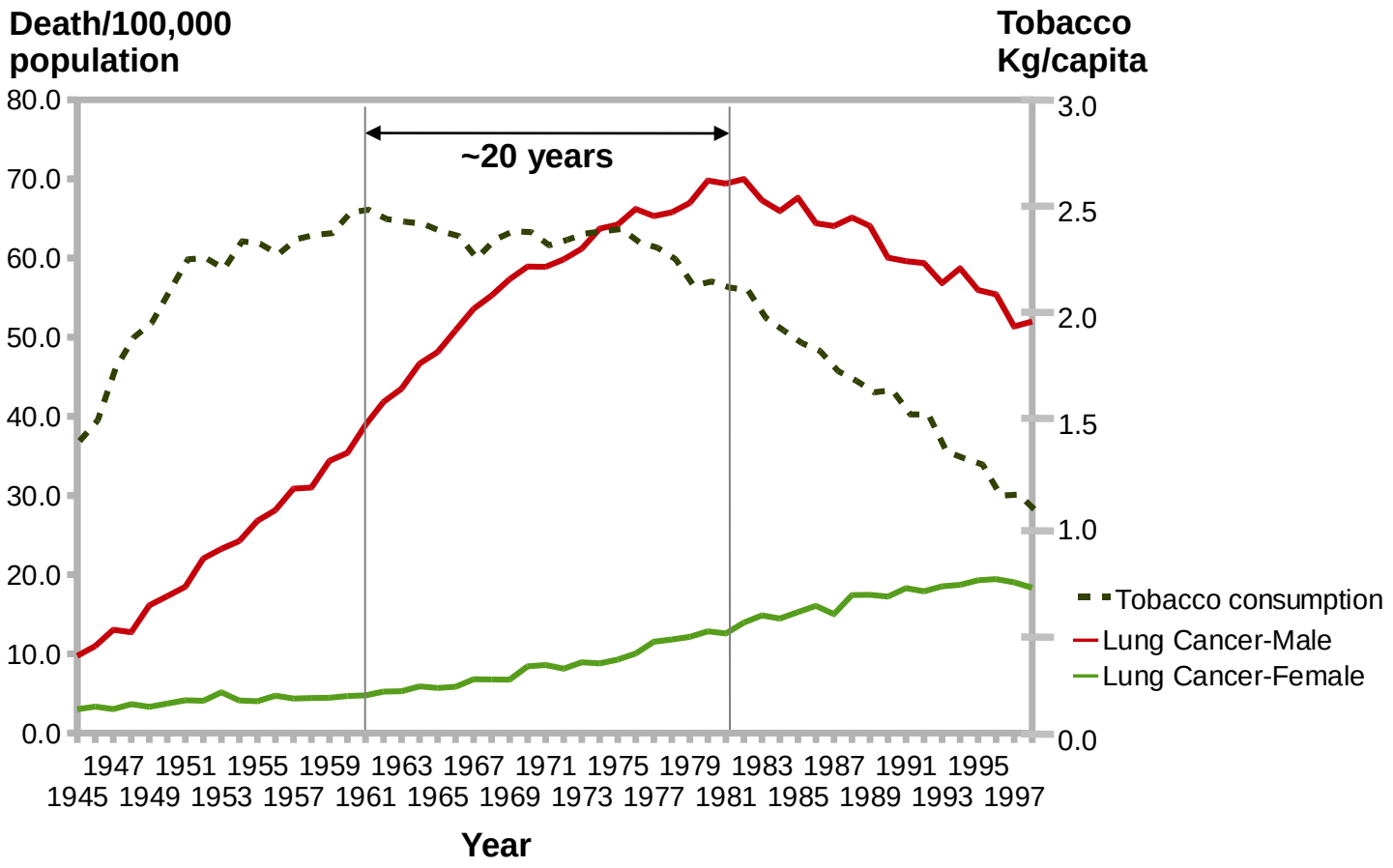
Female breast cancer in Thailand



Male colo-rectal cancer in Thailand



Tobacco consumption and lung cancer in Australia



AIHW: deloop M & Bhatia K 2001: Australian Health Trends 2001. AIHW Cat. No. PHE 24. Canberra: AIHW; the National Mortality Database.

The End – Thank you