### Appendix: Data structure and programs used

**A. Data structure**

The data was collected in the file *boon.num* file and consists of 12 columns including Coast, Provinces, Year, Month, Cases, Deaths, rainfall, rain days, Max temp, Min temp, humidity, and Population in four provinces include Krabi, Trang, Nakhon Si Thammarat and Songkhla, as follows

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B. Programming using preliminary result and statistical analysis and modelling

To obtain Figure 3.1 and Figure 3.2, showing histograms and statistics of data for all variables before and after transformation using logarithms and cube root respectively, using matlab together with functions (getfile, getnum, putnum, getfn, putfn, describe) in the ASP (McNeil et al 1998) package, the following programs are used.

Program chap31.m to create Figure 3.1
getfile boon
y = getnum;
y(:,2) = floor(y(:,2)/100);
y(:,7) = y(:,7)*100;
y(:,12) = round(y(:,12)*1000);
y = [y y(:,5)/y(:,12)];
fn = getfn;
fn([1]) = 'rainfall(cm)';
fn([12]) = 'pop(1000s)';
fn(13) = 'nec/1000';
putfn(fn)
putnum(y)
describe hist=1 font=8 type=2 fnwid=15

Program chap32.m to create Figure 3.2
getfile boon
y = getnum;
y(:,2) = floor(y(:,2)/100);
y(:,12) = round(y(:,12)*1000);
y = [y y(:,5)/y(:,12)];
f = getfn;
fn[12] = 'pop(10000);
fn[7] = 'inc/1000';
putfn(fn)
putnum(y)
y1 = y(:,7).^((7/3));
y1(:,7) = y(:,7)/100;
awt = y(:,1/3);
by = y(:,7)^((7/3));
y2 = log10(0.005*y(:,13));
nw = [a y1 b y2];
plot(num(new); fn= getfn;
fn[7] = 'rainfall(cm)';
fn[8] = 'cloud(cf)';
fn[9] = 'rain days';
fn[10] = 'max temp';
fn[11] = 'min temp';
fn[12] = 'humidity';
fn[13] = 'pop';
fn[14] = 'inc/1000';
fn[15] = 'loginc';
pufn(fn)
describe hot=1 font=10 type=2 fnw=18 col=[7 8 : 13]

Figure 3.3 and Figure 3.4. the relationship between the incidence of DHF and year by latitude and coast. by using matlab together with functions (getfile, getfn, putnum, putfn, getlab, psetlab, setvar, stratify, track) in the ASP (McNeil et al 1998) package, the following programs are used.

Program clap33.m to create Figure 3.3

getfile boon
y = getnum;
norh = y(:,2)<=800;
y(:,2) = floor(y(:,2)/1000);
y(:,12) = y(:,12)/1000;
y = [y y(:,5)/y(:,12)];
fn = getfn;
fn[13] = 'incidence/1000';
y(:,7) = y(:,7)^((7/3));
y(:,13) = log10(0.005+y(:,13));
fn[7] = 'curt(rainfal)';
fn[13] = 'loginc';
y = [y(:,1 3 7 13) norh]
\begin{verbatim}
program chap34.m to create Figure 3.4

getfile boon
y = getnum;
north = y(:,2)<6800;
y(:,2) = floor(y(:,2)/100);
y(:,12) = y(:,12)/1000;
y = [y y(:,5)
y(:,12)];
fn = getfn;
fn[13] = 'incidence/1000';
y(:,7) = y(:,7)/1000;
y(:,13) = log10(0.005+y(:,13));
fn[7] = '1000';
fn[13] = 'log';
y = [y(:,1 7 13)];
putnum(y);
fn[2] = fn[3];
fn[3] = fn[7];
fn[4] = fn[13];
fn[5] = 'latitude';
putfn(fn)
lab = getlab;
lab[2] = lab[3];
lab[3] = lab[7];
lab[4] = lab[13];
lab[5] = '0 South' '1 North';
putlab(lab);
setvar y=4 x=[1 2 5]
stratify
setvar res=1 y=4 x=[2 3 1];
track res=1 font=10 size=8
\end{verbatim}
Figure 3.5 and Figure 3.6, the relationship between the incidence of DHF month by latitude and coast, by using matlab together with functions (getfile, getfn, putnum, putfn, getlab, putlab, setvar, stratify, track) in the ASP (McNeil et al 1998) package, the following programs are used.

**Program chap35.m to create Figure 3.5**

```matlab
getfile boon
y = getnum;
north = y(:,2)<6800;
y(:,2) = floor(y(:,2)/100);
y(:,12) = y(:,12)/1000;
y = [y y(:,5)/y(:,12)];
fn = getfn;
fn[13] = 'incidence/1000';
y(:,7) = y(:,7).^1/3;
y(:,13) = log(0.005+y(:,13));
fn[7] = 'curt(rainfall)';
y(:,13) = log(y(:,13));
y = [y(:,1 4 7 13)] north;
putnum(y)
fn(2) = fn(4); fn(3) = fn(7); fn(4) = fn(13); fn(5) = 'latitude'; put* (fn)
lab = getlab;
lab[2] = lab[4];
lab[3] = lab[7];
lab[4] = lab[13];
lab[5] = ['0 South' '1 North']; putlab(lab)
setvar.x=4 x=[1 2 5]; stratify
setvar res=1 y=4 x=[2 3 1]; track res=1 font=9 size=8
```

**Program chap36.m to create Figure 3.6**

```matlab
getfile boon
y = getnum;
north = y(:,2)<6800;
y(:,2) = floor(y(:,2)/100);
y(:,12) = y(:,12)/1000;
y = [y y(:,5)/y(:,12)];
fn = getfn;
fn[13] = 'incidence/1000';
```
y(:,7) = y(:,7) * (1/2);
y(:,13) = log10(0.005 + y(:,13));
fn[7] = 'curt(rainfall)';
fn[13] = 'log(inc)';
y = [y(:,1 4 7 13)] north;
putnum(y);
fn[2] = fn[4];
fn[3] = fn[7];
fn[4] = fn[13];
fn[5] = 'latitude';
putfn(fn)
lab = getlab;
lab[2] = lab[4];
lab[3] = lab[7];
lab[4] = lab[13];
lab[5] = '0 South ' '1 North';
putlab(lab)
setvar y=4 z=[1 2 5]
stratify
setvar res=1 y=4 x=[2 1 3];
track res=1 font=9 size=8

Figure 3.7 and Figure 3.8, the relationship between rainfall and year by latitude and
count, by using matlab together with functions (getfile, getn, putnum, putfn, getlab,
putlab, setvar, stratify, track) in the ASP (McNeil et al 1998) package, the following
programs are used.

Program chap37.m to create Figure 3.7

getfile boon
y = getnum;
north = y(:,2)<6800;
y(:,2) = floor(y(:,2)/100);
y(:,12) = y(:,12)/1000;
y = [y(:,5) y(:,12)];
fn = getfn;
fn[13] = 'incidence/1000';
y(:,7) = y(:,7) * (1/3);
y(:,13) = log10(0.005 + y(:,13));
fn[7] = 'curt(rainfall)';
fn[13] = 'log(inc)';
y = [y(:,1 3 7 13)] north;
putnum(y)
fn[2] = fn[3];
;3 = fn[7];
fn[4] = fn[13];
fn[5] = 'latitude';
putfn(fname)
lab = getlab;
lab[2] = lab[3];
lab[3] = lab[7];
lab[4] = lab[13];
lab[5] = {'9 South' '1 North'};
putlab(lab)
setvar y=3 x=[1 2 5]
stratify
setvar res=1 y=4 x=[2 3 1];
track res=1 font=9 size=8

Program chap3.8.m to create Figure 3.8

getfile boon
y = getnum;
north = y(:,2)<6800;
y(:,2) = floor(y(:,2)/100);
y(:,12) = y(:,12)/1000;
y = [y y(:,5)./y(:,12)];
f = getf;
fn[13] = 'incidence/1000';
y(:,7) = y(:,7).^0.53;
y(:,13) = log10(0.005*+y(:,13));
f(7) = 'sqrt(rainfall)';
f(13) = 'log(inc)';
y = [y(:,1 3 7 13)] north;
pitsnum(y);
fn[2] = fn[3];
fn[3] = fn[7];
fn[4] = fn[13];
fn[5] = 'latitude';
putfn(fn)
lab = getlab;
lab[2] = lab[3];
lab[3] = lab[7];
lab[4] = lab[13];
lab[5] = {'0 South' '1 North'};
putlab(lab)
setvar y=3 x=[1 2 5]
stratify
setvar res=1 y=4 x=[2 3 1];
track res=1 font=9 size=8

Figure 3.7 and Figure 3.8, the relationship between rainfall and month by latitude and coast, by using matlab together with functions (getfile, getf, pitsnum, putf, getlab,
putlab, setvar, stratify, track) in the ASP (McNeil et al. 1998) package, the following programs are used.

Program chap39.m to create Figure 3.9

getfile boon
y = getnum;
north = y(:,2)<5800;
y(:,2) = floor(y(:,2)/100);
y(:,12) = y(:,12)*1000;
y = [y y(:,5:y(:,12))];
fn = getfn;
fn{13} = 'incidence/1000';
y(:,7) = y(:,7).*1(13);
y(:,13) = log10(0.005+y(:,13));
fn{17} = 'curt(rainfall)';
fn{13} = 'log(in)';
y = [y y(:,14) 7 13]) north];
putnum(y)
fn{2} = fn{4};
fn{3} = fn{7};
fn{4} = fn{13};
fn{5} = 'latitude';
putfn(fn)
lab = getlab;
lab{2} = lab{4};
lab{3} = lab{7};
lab{4} = lab{13};
lab{5} = {'9 South' '1 North'};
putlab(lab)
setvar res=3 x=[1 2 5];
stratify setvar res=1 y=4 x=[2 3 1];
track res=1 font=9 size=8

Program chap310.m to create Figure 3.10

getfile boon
y = getnum;
north = y(:,2)<6800;
y(:,2) = floor(y(:,2)/100);
y(:,12) = y(:,12)*1000;
y = [y y(:,5:y(:,12))];
fn = getfn;
fn{13} = 'incidence/1000';
y(:,7) = y(:,7).*1(13);
y(:,13) = log10(0.005+y(:,13));
fn{17} = 'curt(rainfall)';
fn[13] = 'log(inc)';
y = [y(:,[1 4 7 13]) aorth];
putnum(y);
fn[2] = fn[4];
fn[3] = fn[7];
fn[4] = fn[13];
fn[5] = 'latitude';
putfn(fn)
lab = getlab;
lab[2] = lab[4];
lab[3] = lab[7];
lab[4] = lab[13];
lab[5] = '0 South '1 North';
putlab(lab)
setvar y=3 x=[1 2 5]
stratify
setvar res=1 y=4 x=[2 1 3];
track res=1 font=9 size=8

Figure 3.11, the associations between month rainfall and DHF incidence in each province, by using matlib together with functions (getfile, getfn, putnum, putfn, getlab, putlab, relate) in the ASP (McNeil et al 1998) package, the following programs are used.

Program chap011.m to create Figures 3.11

getfile boot
y = getnum;
y(:,2) = floor(y(:,2)*160);
y(:,12) = round(y(:,12)/1000);
y = y*y(:,5).\2.*y(:,12));
fn = getfn;
fn[12] = 'pop(1000s)';
fn[13] = 'u=-1000';
putfn(fn)
putnum(y)
y1=y(:,7).\1./3);
y(:,7) = y(:,7)/100;
amy(:,1.7);
b=ym(:,8:13);
y2= log10(0.005*y(:,13));
new=w+a y1 b y2;
putnum(new);
fn= getfn;
fn[7] = 'rainfall(cm)';
fn[8] = 'cubic(t)';
fn[9] = 'rain days'.
\texttt{fn[10] = 'max temp';}
\texttt{fn[11] = 'min temp';}
\texttt{fn[12] = 'humidity';}
\texttt{fn[13] = 'pop';}
\texttt{fn[14] = 'inc/1000';}
\texttt{fn[15] = 'log(inc)';}
\texttt{putfn(fn)}
\texttt{y = getnum;}
\texttt{krabi = y(:,2)==65;}
\texttt{y1 = y(krabi,:);}
\texttt{putnum(y1)}
\texttt{putdn("DHF study in Krabi: 1982-98")}
\texttt{relate col=[8 15] cor=1 line=1}
\texttt{ust = y(:,2)==67;}
\texttt{y1 = y(ust,:);}
\texttt{putnum(y1)}
\texttt{putdn("THF study in Nakorn ST: 1978-98")}
\texttt{relate col=[8 15] cor=1 line=1}
\texttt{trang = y(:,2)==68;}
\texttt{y1 = y(trang,:);}
\texttt{putnum(y1)}
\texttt{putdn("DHF study in Trang: 1978-98")}
\texttt{relate col=[8 15] cor=1 line=1}
\texttt{songkla = y(:,2)==69;}
\texttt{y1 = y(songkla,:);}
\texttt{putnum(y1)}
\texttt{putdn("DHF study in Songkla: 1978-98")}
\texttt{relate col=[8 15] cor=1 line=1}

\textbf{Figure 3.12, bivariate time series of DHF and rainfall in each province, by using matlab together with functions (gesfile, getfn, putnum, putfn, getlab, putlab, sort, setvar, tsplit, plot, plot) in the ASP (McNeil et al 1998) package, the following programs are used.}

\textbf{Program gesfile.m to create Figure 3.12}
\texttt{gesfile boon}
\texttt{y = getnum;}
\texttt{t = y(:,3)+y(:,4)/12; \quad \% compute time in year/12}
\texttt{[st I] = sort(t); \quad \% find time order}
\texttt{y = y(I,:); \quad \% sort data by time}
\texttt{y(:,2) = floor(y(:,2)*100); \quad \%}
\texttt{y(:,12) = round(y(:,12)/1000); \quad \%}
\texttt{y = [y y(:,5)/y(:,12)]; \quad \%}
\texttt{fn = getfn;}
\texttt{fn[12] = 'pop/1000s';}
\texttt{fn[13] = 'inc/1000';}
putfn(f0)
putnum(y)
y(1)=y(1)^((1/3))
y(2)=y(2)/100;
aw=y(1);7;
b=wx.;8;13;
y2=x-l01(0.002+y(1);13));
new=x[a y b y2];
setnum(new);
 outcome;
fn1[7]=runfall(cm);
fn[8]=cubrt(rf);
fn[9]=rain days;
fn[10]=max temp;
fn[11]=min temp;
f(12)=humidity;
fn[1]=pop;
fn[14]=inc/1000;
fn[15]=log(inc);
fn[16]=year/12;
putfn(f0)
y=genum;
kraib=y(1);2==65;
yl=y(kraib);
putnum(y)
putdn(DHF study in Krahi: 1982-98)
setvar y=8 13 x=16
tsbplot cob=0 ccf=0
setvar y=15 x=8 z=16
tsbplot pg=3 cfs=1 ar=1 harm=16
nat=y(1);2==67;
yl=y(optional);
putnum(y)
putdn(DHF study in Nakorn ST: 1978-98)
setvar y=8 15 x=16
tsbplot cob(at) ccf=0
trang=y(1);2==68;
yl=y(trang);
putnum(y)
putdn(DHF study in Trang: 1978-98)
setvar y=8 15 x=16
tsbplot cob=0 ccf=0
songkla=y(1);2==69;
yl=y(songkla);
putnum(y)
putdn(DHF study in Songkla: 1978-98)
setvar y=8 15 x=16
Figure 4.1 – 4.7, time series analysis for DHF incidence in each province, by using matlab together with functions (getfile, getfn, putnum, putfn, getlab, putlab, sort, setvar, tplot) in the ASP (McNeil et al 1998) package, the following program are used.

Program chap41.m to create Figures 4.1-4.7

getfile boon

\[ t = y(:,3) + y(:,4) / 12; \] % compute time in years/12
\[ [st, I] = \text{sort}(t); \] % find time order
\[ y = y(\text{I,:}); \] % sort data by time
\[ y(:,2) = \text{floor}(y(:,2) * 100); \]
\[ y(:,12) = \text{round}(y(:,12) / 1000); \]
\[ y = \text{ly}(y(:,5:7), y(:,12)); \]
\[ fn = \text{getfn}; \]
\[ fn(12) = \text{pop}(1000s); \]
\[ fn(13) = \text{inc}/1000; \]
\[ \text{putfn}(fn); \]
\[ \text{putnum}(y) \]
\[ y(\text{ly}(y(:,7) * 1/3); \]
\[ y(:,7) = y(:,7) / 100; \]
\[ a = y(:,1:7); \]
\[ b = y(:,8:13); \]
\[ y2 = \log(10(0.005 + y(:,13))); \]
\[ \text{new} = [a y b y2 st]; \]
\[ \text{putnum}(\text{new}); \]
\[ fn = \text{getfn}; \]
\[ fn(7) = \text{rainfall(cm)}; \]
\[ fn(8) = \text{cubic(cm)}; \]
\[ fn(9) = \text{'rain days'}; \]
\[ fn(10) = \text{'max temp'}; \]
\[ fn(11) = \text{'min temp'}; \]
\[ fn(12) = \text{humidity}; \]
\[ fn(13) = \text{'pop'}; \]
\[ fn(14) = \text{'inc}/1000'; \]
\[ fn(15) = \text{'log(inc)'}; \]
\[ fn(16) = \text{'year/12'}; \]
\[ \text{putfn}(fn); \]
\[ y = \text{getnum}; \]
\[ krabi = y(:,2) == 65; \]
\[ y1 = y(krabi,:); \]
\[ \text{putnum}(y1) \]
\[ \text{putdn('DHF: study in Krabi: 1982-97')} \]
\[ \text{setvar } y = 15 \ z = 16 \]
tsplot pg=3
% Figure 4.1
tsplo\text{t} pg=3 cf=-1 ar=1 harm=16
mst = y(\cdot,2)\approx=67;
y1 = y(mst,\cdot);
putnum(y1).

setvar y=15 z=16

% Figure 4.2
tsplo\text{t} pg=3 harm=20 ar=1 cf=-1
% Figure 4.3
tsplo\text{t} pg=3 harm=20 ar=1:2 cf=-1
trang = y(\cdot,2)\approx=68;
y1 = y(trang,\cdot);
putnum(y1)

% Figure 4.4
putdn(DHF study in Nakorn ST: 1978-97)

setvar y=15 z=16

% Figure 4.5
tsplo\text{t} pg=3 harm=20 ar=1:2 cf=-1
% Figure 4.6
tsplo\text{t} pg=3 harm=20 ar=1:2 cf=-1 liu=1
songkla = y(\cdot,2)\approx=69;
y1 = y(songkla,\cdot);
putnum(y1)

% Figure 4.7
putdn(DHF study in Tung: 1978-97)

setvar y=15 z=16

% Figure 4.8

% Figure 4.9

getfile boon
t = y(\cdot,3)+y(\cdot,4)/12;
% compute time in years/12
[st \text{f}] = sort(t);
% find time order
y = y(1:t);
% sort data by time
y(\cdot,2) = root(y(2:2)/100);
y(\cdot,12) = root(y(\cdot,12)/1000);
y = y(y(\cdot,5)/y(\cdot,12));
fn = getfn;
fn[12] = 'pop(1000s)';
fn[13] = 'int/1000';
putnum(fn)

% output
y1=y(\cdot,7)^{\cdot(1/3)};
y(\cdot,7) = y(\cdot,7)/100;
ae=y(\cdot,1:7);
b=y(\cdot,8:12);
y2=log(1000.005+y(\cdot,13));

Program chup42.m to create Figures 4.8-4.13

Figure 4.8 – 4.13, time series analysis for rainfall, by using matlab together with
functions (getfile, getfn, putnum, putfr, getlab, putlab, sort, setvar, tsplo\text{t}) in the ASP
(McNeill et al 1998) package, the following programs are used.
new=[a y1 b y2 st];
putnum(new);
fn=getfn;
fn(7) = 'rainfall(cm)';
fn(8) = 'subtr(rf)';
fn(9) = 'rain days';
fn(10) = 'max temp';
fn(11) = 'min temp';
fn(12) = 'humidity';
fn(13) = 'pop';
fn(14) = 'anr/1000';
fn(15) = 'log(mo)';
fn(16) = 'year/12';
putfn(h)
y=genunum;
krahi = y(:,2)==65;
y1 = y(krahi,:);
putnum(y1)
putdn('DHF study in Krabi: 1992-97')
setvar y=8 z=16
tsplot pg=3 new=0
% Figure 4.8
tsplot pg=3 cf=1 ar=1 harm=16 32
% Figure 4.9
nat = y(:,2)==67;
y1 = y(nat,:);
putnum(y1)
putdn('DHF study in Nakorn ST: 1978-97')
setvar y=8 z=16
tsplot pg=3 harm=20 40] ar=1 cf=-1
% Figure 4.10
tsplot pg=3 harm=[20 40 60] cf=-1
% Figure 4.11
trans = y(:,2)==58;
y1 = y(trans,:);
putnum(y1)
putdn('DHF study in Trang: 1978-97')
setvar y=8 z=16
tsplot pg=3 harm=[20 40] ar=1 cf=-1
% Figure 4.12
songksa = y(:,2)==69;
y1 = y(songksa,:);
putnum(y1)
putdn('DHF study in Songkla: 1978-97')
setvar y=8 z=16
tsplot pg=3 harm=[20 40 60] cf=-1
% Figure 4.13

Figure 4.14 – 4.17, time series analysis for DHF incidence and variable, by using matlab together with functions (getfile, getfn, putnum, putfn, getlab, putlab, sort, setvar, tsplot) in the ASP (McNeil et al 1998) package, the following programs are used.
Program chap43.m to create Figures 4.14-4.17

getfile boon

% compute time in years/12
y = getnum,
t = y(:,3)+y(:,4)/12;
% find time order
[st I] = sort(t);
% sort data by time
y = y(I,:);
% compute total
y(:,2) = floor(y(:,2)/100);
y(:,12) = round(y(:,12)/1000);
y = [y y(:,5)y(:,12)];
fn = getfn;
fn{12} = 'pop(1000n)';
fn{13} = 'inc/1000';
putn(fn)
putnum(y)
y=yt(7,:)*((1/3);)
y(:,7) = y(:,7)/100;
% two ys
y(1:7);
% two ys
y(:,8:13);
% log10(0.005+y(.13))
new=[a y b y2 st];
% putnum(new);
fn=putn;
fn{7} = 'rainfall(cm)';
fn{8} = 'cubrt(rf)';
fn{9} = 'rain days';
fn{10} = 'max temp';
fn{11} = 'min temp';
fn{12} = 'humidity';
fn{13} = 'pop';
fn{14} = 'inc/1000';
fn{15} = 'log(inc)';
fn{16} = 'year/12';
% putnum(fn)
y=getnum;
%Krabi:
krabi = y(:,2)=-65;
y1 = y(krabi,:);

putnum(y1)

putn('DHF study in Krabi: 1982-97')
setvar y=15 xe=10 xe=16
% Figure 4.14
tsplot pg=3 cef=1 ar=1.2 harm=[16 32]
xst = y(:,2)==67;
y1 = y(xst,:);
putnum(y1)

putn('DHF study in Nakorn ST: 1978-97')
setvar y=15 xe=9 xe=16
% Figure 4.15
tsplot pg=3 cef=1 ar=1/2 harm=20 new=0
songkla = y(:,2)==69;
y1 = y(songkla:);  
putnum(y1)  
pudn('DHF study in Songkla: 1978-97)  
setvar y=15 x=9 z=16  
tsplo t pgs=3 harm=20 cf=-1 ar=1:2  
% Figure 4.16