I. R Program

```
read.table("eDistDimon.txt",h=T) -> ed
library(MASS)
glm.nb(data=ed,nEv2~offset(log(popdist/1000))+factor(distid)
      +factor(dimonthID)) -> ed.out
resDev <- ed.out$deviance
df <- ed.out$df.residual
"Residual deviance:"
resDev
"df:"
df

# set up plot window to have four plots
par(mfrow=c(2,2),mar=c(2.6,2.1,2.0,1.2),oma=c(0,0,0,0))

# get fitted values
fv <- ed.out$fitted.values
# ...and observed values with 0s replaced by 0.5 to enable
plotting
      on log scale
obs <- ifelse(ed$nEv2==0,0.5,ed$nEv2)
# ...and plot their logs against logs of the fitted values
in top
      left panel
plot(log(fv),log(obs),las=1,cex=0.5,pch=15,cex.axis=0.8,
      mgp=c(1.1,0.1,0),tcl=0.2,main="",ylab="",
      xlab="ln(Fitted Values)")
abline(0,1)
mtext("ln(Observed Counts*)",side=3,adj=-
0.1,cex=0.8,line=0.3)
# compute and plot deviance residuals in top right panel
resDev <- resid(ed.out,type="deviance")
qqnorm(resDev,las=1,cex=0.7,cex.axis=0.8,mgp=c(1.1,0.1,0),tc
l=0.2,
      main="",ylab="",xlab="Normal Scores")
abline(0,1)
mtext("Deviance Residuals",side=3,adj=-0.1,cex=0.8,line=0.3)
# get coefficients and SEs of dimonth effects
summary(ed.out) -> rez.out
diMonthCoef <- c(0,rez.out$coef[38:48])
meanY <- mean(log(fv))
diMonthCoefAdj <- diMonthCoef-mean(diMonthCoef)+meanY
diMonthSE <- c(0,rez.out$coef[86:96])
distCoef <- c(0,rez.out$coef[2:37])
distCoefAdj <- distCoef-mean(distCoef)+meanY
distSE <- c(0,rez.out$coef[49:84])
# ...and plot them in lower left panel
diMonthEffects <-
as.data.frame(cbind(diMonthCoefAdj,c(1:12)))
names(diMonthEffects)[2] <- "Two-month Period"
min0 <- min(c(diMonthCoefAdj-1.96*diMonthSE,distCoefAdj-
1.96*distSE))
max0 <-
max(c(diMonthCoefAdj+1.96*diMonthSE,distCoefAdj+1.96*distSE)
)
plot(diMonthEffects[,2:1],las=1,pch=16,xlim=c(0,13),
      ylim=c(min0,max0),cex.axis=0.8,mgp=c(1.1,0.1,0),tcl=0.
2,
      main="",ylab="",xaxt="n")
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distCoef <- c(0,rez.out$coef[2:37])
distCoefAdj <- distCoef-mean(distCoef)+meanY
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# ...and plot them in lower left panel
diMonthEffects <-
as.data.frame(cbind(diMonthCoefAdj,c(1:12)))
names(diMonthEffects)[2] <- "Two-month Period"
min0 <- min(c(diMonthCoefAdj-1.96*diMonthSE,distCoefAdj-
1.96*distSE))
max0 <-
max(c(diMonthCoefAdj+1.96*diMonthSE,distCoefAdj+1.96*distSE)
)
plot(diMonthEffects[,2:1],las=1,pch=16,xlim=c(0,13),
      ylim=c(min0,max0),cex.axis=0.8,mgp=c(1.1,0.1,0),tcl=0.
2,
      main="",ylab="",xaxt="n")
```

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in top
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      mgp=c(1.1,0.1,0),tcl=0.2,main="",ylab="",
      xlab="ln(Fitted Values)")
abline(0,1)
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0.1,cex=0.8,line=0.3)
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      main="",ylab="",xlab="Normal Scores")
abline(0,1)
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diMonthCoefAdj <- diMonthCoef-mean(diMonthCoef)+meanY
diMonthSE <- c(0,rez.out$coef[86:96])
distCoef <- c(0,rez.out$coef[2:37])
distCoefAdj <- distCoef-mean(distCoef)+meanY
distSE <- c(0,rez.out$coef[49:84])
# ...and plot them in lower left panel
diMonthEffects <-
as.data.frame(cbind(diMonthCoefAdj,c(1:12)))
names(diMonthEffects)[2] <- "Two-month Period"
min0 <- min(c(diMonthCoefAdj-1.96*diMonthSE,distCoefAdj-
1.96*distSE))
max0 <-
max(c(diMonthCoefAdj+1.96*diMonthSE,distCoefAdj+1.96*distSE)
)
plot(diMonthEffects[,2:1],las=1,pch=16,xlim=c(0,13),
      ylim=c(min0,max0),cex.axis=0.8,mgp=c(1.1,0.1,0),tcl=0.
2,
      main="",ylab="",xaxt="n")
```

```
# ...with dotted horizontal line through mean
abline(meanY,0,lty="13")
# ...and 95% confidence intervals for differences from
baseline month
for (i in 2:12) {

lines((0*(1:2)+i),(diMonthCoefAdj[i]+3.92*diMonthSE[i]*((0:1
)-0.5)))
}
# Put back the x-axis tick marks we zapped because we want
to put
      text for their labels
epsilon <- 0.02*(max0-min0)
for (i in 1:12) {
 lines((0*(1:2)+i),(min0-2*epsilon+epsilon*(0:1)))
}
# ...and now put the month names for these labels
diMonthNames <-
      c("JF","MA","MJ","JA","SO","ND","JF","MA","MJ","JA","S
O","ND")
xpos <- (1:12)/12.9
xpos[2] <- xpos[2]-0.01
mtext(diMonthNames,side=1,adj=xpos,cex=0.7,line=0.05)
# ...and the y-axis label at the top left to avoid twisting
your neck
      to read it
mtext("ln(Fitted Value): 2-Month Effects",side=3,
      adj=-0.13,cex=0.8,line=0.3)
# Do the same for the district effects
distEffects <- as.data.frame(cbind(c(distCoefAdj),c(1:37)))
names(distEffects)[2] <- "DistrictID"
plot(distEffects[,2:1],las=1,pch=16,ylim=c(min0,max0),cex.ax
is=0.8,
      mgp=c(1.1,0.1,0),tcl=0.2,xaxp=c(1,37,36),main="",ylab=
"")
# ...with dotted horizontal line through baseline diMonth
abline(meanY,0,lty="13")
# ...and 95% confidence intervals for differences from
baseline
for (i in 2:37) {
 lines((0*(1:2)+i),(distCoefAdj[i]+3.92*distSE[i]*((0:1)-
0.5)))
}
mtext("ln(Fitted Value): District Effects",side=3,
      adj=-0.13,cex=0.8,line=0.3)
```

II. Data used by R program

Distid	popdist	dimonthID	nEv2
9003	92163	1	1
9003	92163	2	5
9003	92163	3	1
9003	92163	4	1
9003	92163	5	6
9003	92163	6	8
9003	92163	7	21
9003	92163	8	4
9003	92163	9	9
9003	92163	10	11
9003	92163	11	5
9003	92163	12	2
9004	54772	1	0
9004	54772	2	0
9004	54772	3	0
9004	54772	4	2
9004	54772	5	1
9004	54772	6	0
9004	54772	7	1
9004	54772	8	1
9004	54772	9	2
9004	54772	10	6
9004	54772	11	0
9004	54772	12	1
9005	64636	1	4
9005	64636	2	7
9005	64636	3	1
9005	64636	4	2
9005	64636	5	1
9005	64636	6	6
9005	64636	7	16
9005	64636	8	5
9005	64636	9	9
9005	64636	10	3
9005	64636	11	7
9005	64636	12	12
9006	55735	1	0
9006	55735	2	11
9006	55735	3	3
9006	55735	4	2
9006	55735	5	2
9006	55735	6	8
9006	55735	7	0
9006	55735	8	4
9006	55735	9	10
9006	55735	10	3
9006	55735	11	3
9006	55735	12	8
9401	10827	11	5
9401	10827	12	30
9401	10827	13	15
9401	10827	14	19
9401	10827	15	15
9401	10827	16	4

Distid	popdist	dimonthID	nEv2
9401	10827	17	11
9401	10827	18	11
9401	10827	19	16
9401	108271	10	12
9401	108271	11	9
9401	108271	12	7
9402	61330	1	4
9402	61330	2	9
9402	61330	3	5
9402	61330	4	3
9402	61330	5	7
9402	61330	6	8
9402	61330	7	15
9402	61330	8	5
9402	61330	9	9
9402	61330	10	11
9402	61330	11	10
9402	61330	12	6
9403	70118	1	4
9403	70118	2	23
9403	70118	3	12
9403	70118	4	5
9403	70118	5	13
9403	70118	6	12
9403	70118	7	19
9403	70118	8	7
9403	70118	9	20
9403	70118	10	9
9403	70118	11	13
9403	70118	12	15
9404	40243	1	2
9404	40243	2	9
9404	40243	3	3
9404	40243	4	6
9404	40243	5	9
9404	40243	6	6
9404	40243	7	3
9404	40243	8	8
9404	40243	9	9
9404	40243	10	3
9404	40243	11	5
9404	40243	12	2
9405	50244	1	3
9405	50244	2	9
9405	50244	3	4
9405	50244	4	1
9405	50244	5	4
9405	50244	6	13
9405	50244	7	2
9405	50244	8	4
9405	50244	9	4
9405	50244	10	6
9405	50244	11	8
9405	50244	12	7
9406	17403	1	0
9406	17403	2	1
9406	17403	3	0
9406	17403	4	0

Distid	popdist	dimonthID	nEv2
9406	17403	5	3
9406	17403	6	4
9406	17403	7	0
9406	17403	8	1
9406	17403	9	8
9406	17403	10	5
9406	17403	11	4
9406	17403	12	5
9407	57873	1	1
9407	57873	2	13
9407	57873	3	7
9407	57873	4	4
9407	57873	5	9
9407	57873	6	5
9407	57873	7	18
9407	57873	8	9
9407	57873	9	19
9407	57873	10	16
9407	57873	11	9
9407	57873	12	12
9408	10072	1	1
9408	10072	2	1
9408	10072	3	1
9408	10072	4	3
9408	10072	5	0
9408	10072	6	3
9408	10072	7	4
9408	10072	8	4
9408	10072	9	3
9408	10072	10	2
9408	10072	11	12
9408	10072	12	2
9409	73545	1	1
9409	73545	2	7
9409	73545	3	2
9409	73545	4	8
9409	73545	5	6
9409	73545	6	15
9409	73545	7	5
9409	73545	8	29
9409	73545	9	15
9409	73545	10	12
9409	73545	11	8
9409	73545	12	0
9410	78740	1	6
9410	78740	2	15
9410	78740	3	3
9410	78740	4	8
9410	78740	5	9
9410	78740	6	25
9410	78740	7	21
9410	78740	8	18
9410	78740	9	21
9410	78740	10	18
9410	78740	11	16
9410	78740	12	17
9411	13848	1	1
9411	13848	2	1

Distid	popdist	dimonthID	nEv2
9411	13848	3	1
9411	13848	4	2
9411	13848	5	4
9411	13848	6	3
9411	13848	7	1
9411	13848	8	3
9411	13848	9	3
9411	13848	10	1
9411	13848	11	7
9411	13848	12	5
9412	14298	1	0
9412	14298	2	6
9412	14298	3	0
9412	14298	4	1
9412	14298	5	0
9412	14298	6	3
9412	14298	7	2
9412	14298	8	1
9412	14298	9	4
9412	14298	10	2
9412	14298	11	4
9412	14298	12	0
9501	154634	1	13
9501	154634	2	21
9501	154634	3	13
9501	154634	4	16
9501	154634	5	16
9501	154634	6	28
9501	154634	7	12
9501	154634	8	15
9501	154634	9	44
9501	154634	10	41
9501	154634	11	34
9501	154634	12	22
9502	50477	1	2
9502	50477	2	2
9502	50477	3	2
9502	50477	4	3
9502	50477	5	3
9502	50477	6	3
9502	50477	7	5
9502	50477	8	0
9502	50477	9	2
9502	50477	10	2
9502	50477	11	11
9502	50477	12	10
9503	44448	1	6
9503	44448	2	17
9503	44448	3	8
9503	44448	4	9
9503	44448	5	10
9503	44448	6	17
9503	44448	7	10
9503	44448	8	7
9503	44448	9	40
9503	44448	10	14
9503	44448	11	29
9503	44448	12	22

Distid	popdist	dimonthID	nEv2
9504	17716	1	1
9504	17716	2	14
9504	17716	3	7
9504	17716	4	3
9504	17716	5	10
9504	17716	6	13
9504	17716	7	9
9504	17716	8	4
9504	17716	9	14
9504	17716	10	10
9504	17716	11	5
9504	17716	12	6
9505	43695	1	2
9505	43695	2	3
9505	43695	3	2
9505	43695	4	3
9505	43695	5	2
9505	43695	6	2
9505	43695	7	4
9505	43695	8	8
9505	43695	9	4
9505	43695	10	6
9505	43695	11	9
9505	43695	12	5
9506	73408	1	5
9506	73408	2	10
9506	73408	3	12
9506	73408	4	2
9506	73408	5	6
9506	73408	6	17
9506	73408	7	16
9506	73408	8	26
9506	73408	9	54
9506	73408	10	20
9506	73408	11	26
9506	73408	12	18
9507	12851	1	0
9507	12851	2	2
9507	12851	3	0
9507	12851	4	0
9507	12851	5	0
9507	12851	6	1
9507	12851	7	5
9507	12851	8	0
9507	12851	9	0
9507	12851	10	0
9507	12851	11	1
9507	12851	12	2
9508	18308	1	1
9508	18308	2	3
9508	18308	3	2
9508	18308	4	3
9508	18308	5	3
9508	18308	6	6
9508	18308	7	2
9508	18308	8	4
9508	18308	9	8
9508	18308	10	7

Distid	popdist	dimonthID	nEv2
9508	18308	11	5
9508	18308	12	5
9601	104615	1	7
9601	104615	2	19
9601	104615	3	5
9601	104615	4	6
9601	104615	5	9
9601	104615	6	6
9601	104615	7	5
9601	104615	8	7
9601	104615	9	11
9601	104615	10	13
9601	104615	11	9
9601	104615	12	15
9602	61157	1	6
9602	61157	2	15
9602	61157	3	7
9602	61157	4	10
9602	61157	5	8
9602	61157	6	10
9602	61157	7	0
9602	61157	8	1
9602	61157	9	25
9602	61157	10	9
9602	61157	11	17
9602	61157	12	14
9603	45352	1	10
9603	45352	2	12
9603	45352	3	1
9603	45352	4	6
9603	45352	5	10
9603	45352	6	8
9603	45352	7	1
9603	45352	8	33
9603	45352	9	18
9603	45352	10	15
9603	45352	11	12
9603	45352	12	7
9604	39873	1	3
9604	39873	2	14
9604	39873	3	2
9604	39873	4	3
9604	39873	5	0
9604	39873	6	7
9604	39873	7	3
9604	39873	8	10
9604	39873	9	4
9604	39873	10	4
9604	39873	11	4
9604	39873	12	4
9605	80550	1	15
9605	80550	2	22
9605	80550	3	10
9605	80550	4	11
9605	80550	5	14
9605	80550	6	17
9605	80550	7	7
9605	80550	8	20

Distid	popdist	dimonthID	nEv2
9605	80550	9	35
9605	80550	10	16
9605	80550	11	16
9605	80550	12	21
9606	59108	1	4
9606	59108	2	26
9606	59108	3	11
9606	59108	4	3
9606	59108	5	10
9606	59108	6	14
9606	59108	7	7
9606	59108	8	14
9606	59108	9	23
9606	59108	10	18
9606	59108	11	25
9606	59108	12	17
9607	25986	1	2
9607	25986	2	7
9607	25986	3	1
9607	25986	4	2
9607	25986	5	2
9607	25986	6	4
9607	25986	7	3
9607	25986	8	3
9607	25986	9	3
9607	25986	10	4
9607	25986	11	6
9607	25986	12	11
9608	43050	1	4
9608	43050	2	14
9608	43050	3	9
9608	43050	4	7
9608	43050	5	7
9608	43050	6	3
9608	43050	7	1
9608	43050	8	1
9608	43050	9	10
9608	43050	10	4
9608	43050	11	2
9608	43050	12	2
9609	20715	1	3
9609	20715	2	5
9609	20715	3	4
9609	20715	4	2
9609	20715	5	4
9609	20715	6	4
9609	20715	7	4
9609	20715	8	0
9609	20715	9	8
9609	20715	10	3
9609	20715	11	2
9609	20715	12	0
9610	64640	1	6
9610	64640	2	16
9610	64640	3	4
9610	64640	4	18
9610	64640	5	9
9610	64640	6	2

Distid	popdist	dimonthID	nEv2
9610	64640	7	1
9610	64640	8	5
9610	64640	9	19
9610	64640	10	5
9610	64640	11	9
9610	64640	12	8
9611	54445	1	6
9611	54445	2	13
9611	54445	3	11
9611	54445	4	7
9611	54445	5	10
9611	54445	6	14
9611	54445	7	10
9611	54445	8	20
9611	54445	9	30
9611	54445	10	22
9611	54445	11	32
9611	54445	12	21
9612	28053	1	3
9612	28053	2	6
9612	28053	3	3
9612	28053	4	6
9612	28053	5	9
9612	28053	6	14
9612	28053	7	4
9612	28053	8	9
9612	28053	9	19
9612	28053	10	12
9612	28053	11	25
9612	28053	12	2
9613	34806	1	5
9613	34806	2	14
9613	34806	3	6
9613	34806	4	7
9613	34806	5	3
9613	34806	6	13
9613	34806	7	6
9613	34806	8	10
9613	34806	9	22
9613	34806	10	11
9613	34806	11	7
9613	34806	12	20

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MODELING UNREST EVENT IN SOUTHERNMOST PROVINCES OF THAILAND

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Abstract

This study aimed to describe how the risk rate of a terrorist event occurring in the population resident in southernmost provinces of Thailand depends on the place and time. The unrest data from the beginning of January 2004 to the end of December 2005 were obtained from police region 9. The outcome is defined as the occurrence of a terrorist event at any location in the region. The severity of the outcome was coded as an integer from 1 to 9. The risk rate of events for each sub-district in a specified period of time by dividing the total number of events recorded in the sub-district over the period by the corresponding population resident in the sub-district in 1000s according to the 2000 Population Census of Thailand. Negative binomial regression models were fitted. The results revealed that the most frequent periods were between 8 and 9 pm (13.7% and 11.8%, of the total, respectively, compared with an average of 4.5% for other hours of the day). The most likely days were Wednesdays and Thursdays (18.3% and 20.0% of events, respectively, compared with 12.3% events on average for other days). The period effects show a steadily increasing trend in the rate during 2004 stabilizing in 2005, with the exception of a high peak in March-April 2004 and a less pronounced peak in May-June 2005. The district effects revealed that terrorist event occurrences had expanded to the adjacent districts in Songkhla. In conclusion, the severity and expansion of terrorist event had been expanded to nearby districts. A suitable prevention and solving of the terrorist events must be implemented urgently together with healing the victim's families in this region.

Key words Terrorist, Unrest, Risk Rate, Severity, Southernmost provinces

1. Introduction

The southernmost provinces of Thailand comprise Pattani, Yala and Narathiwat. Eighty percent of the population is Muslim, with the remainder almost entirely Buddhist (National Statistical Office, 2002). The ethnicity of the people in this region is mixed, many being of Malay (Yusuf, 2006). For most of the 20th century the region was relatively peaceful, with Muslims, Thai and Chinese Buddhists, and persons of other faiths including Christians able to practice their religion and live, attend school and work together in villages, towns and cities (Parks, 2005).

However, the situation changed with the raid on a military base in Narathiwat by insurgents who stole a large quantity of weapons in early January 2004. Four soldiers were killed in this raid and twenty schools were set on fire around the same time. Since then, the insurgency has increased in strength and continued unabated, claiming more than 2000 lives and expanded to 4 districts of Songkhla province. The aim of our study is to describe how the risk rate of a terrorist event occurring in the population resident in the study region depends on the place and time, using actual data for 2004-2005. It is hoped that use of this model will be a tool to assist the Thai government in rectifying the situation in Southern Thailand.

2. Methodology

Data source

The occurrence of terrorist events at any location in the region in 4 provinces (all districts in the provinces of Narathiwat, Pattani and Yala, together with the four westernmost districts of Songkhla Province) was obtained from police region 9 from the beginning of January 2004 to the end of December 2005. The hour of the day, date, and subdistrict where the event took place were recorded. There are 37 districts and 290 subdistricts in this region. The outcome is the occurrence of a terrorist event at any location in the region.

Statistical methods

The risk rate of events for each subdistrict in a specified period of time by dividing the total number of events recorded in the subdistrict over the period by the corresponding population resident in the subdistrict in 1000s according to the 2000 Population Census of Thailand were computed. The average population of the 290 subdistricts was 6694, but these populations varied substantially. Six subdistricts had populations greater than 20,000 (Sateng, SatengNok and Betong in Yala Province with 73,077, 24,745 and 23,531 residents, respectively. BangNak and SungaiKolok in Narathiwat Province with 42,010 and 37,671 residents, respectively, and Sabarang in Pattani Province with 23,702 residents). At the other extreme, nine subdistricts had fewer than 2000 residents, the smallest being Tachi in Yala Province with 1288 residents.

The statistical methods comprise comparison of proportions including Pearson's chi-squared test, and generalized linear models for analyzing risks using negative binomial regression (Venables and Ripley 1999). R statistical system (Venables and Smith 2004) was used for statistical model fitting, plotting confidence intervals.

3. Results

Preliminary Analysis

Table 1 shows the numbers of events recorded in the region by severity in each of the two years. Overall, there was an increase of approximately 50% from 2004 to 2005. Over 50% of the events (56% in 2004 and 53% in 2005) resulted in at least one fatality.

Table 1: Classification of events by severity in each year

	Event severity								
year	1	2	3	5	6	7	8	9	Total
2004	54	36	2	62	34	458	700	125	1471
2005	72	130	35	166	162	483	906	260	2214
Total	126	166	37	228	196	941	1606	385	3685

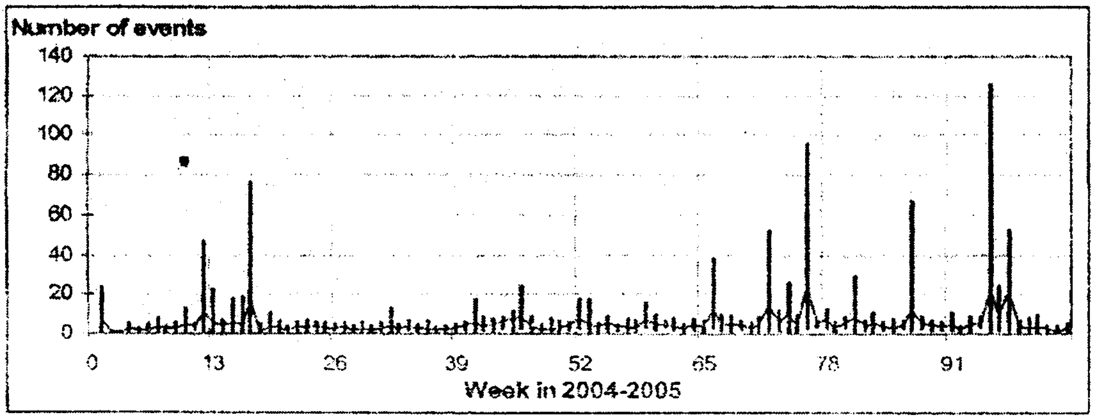

Figure 1: Minimum and maximum numbers of events by week

The daily incidence of events varied substantially over the two-year period, with a maximum of 126 events recorded on 26 October 2005. Relatively high incidences of events were recorded as well on 9 June 2005 (96 events), 22 April 2004 (76 events) and 31 August 2005 (67 events). No events were recorded on 47 days. Figure 1 shows the maximum and minimum numbers of events for each week (Monday to Sunday). The curve in this graph plots the average numbers of events in successive weeks.

Tables 2 and 3 show the distributions of events by hour of day and by day of the week. The most frequent periods were between 8 and 9 pm (13.7% and 11.8%, of the total, respectively, compared with an average of 4.5% for other hours of the day). The most likely days were Wednesdays and Thursdays (18.3% and 20.0% of events, respectively, compared with 12.3% events on average for other days). These differences are highly statistically significant, all giving p-values less than 0.0001 when assessed using Pearson chi-squared test for uniformity.

Table 2: Events by hour of day reported (1=12-1 etc; time unavailable for 151 events)

hour	1	2	3	4	5	6	7	8	9	10	11	12	Total
am	78	90	67	85	88	76	172	210	188	129	105	105	**1393**
pm	88	76	75	81	118	128	176	485	416	230	149	119	**2141**
Total	166	166	142	166	206	204	348	695	604	359	254	224	**3534**

Table 3: Events by day of week reported

Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday	Total
479	443	676	739	511	395	442	3685
(13.0)	(12.0)	(18.3)	(20.0)	(13.9)	(10.7)	(12.0)	(100.0)

4. Statistical Modeling

Figure 2 shows various plots based on fitting the negative binomial model to the observed event rates for 2-month periods in districts for 2004-2005. The plots show 95% confidence intervals for the period effects and the district effects, each expressed on a log scale as differences from the baseline values (Jan-Feb 2004 and District 3 in Songkhla, respectively). The overall mean is shown as a dotted line in these plots.

The period effects show a steadily increasing trend in the rate during 2004 stabilizing in 2005, with the exception of a high peak in March-April 2004 and a less pronounced peak in May-June 2005. The district effects revealed that terrorist event occurrences had expanded to the adjacent districts in Songkhla.

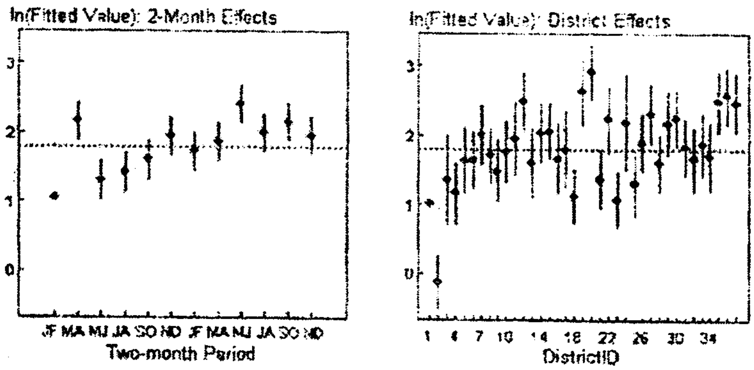

Figure 2 Results from fitting negative binomial model to event rates in districts in 2- month periods

(* Zero counts are replaced by 0.5 to avoid logarithms of 0)

5. Conclusion

The daily incidence of events varied substantially over the two-year period, with a maximum of 126 events recorded on 26 October 2005. Relatively high incidences of events were recorded as well on 9 June 2005, 22 April 2004 and 31 August 2005. The most frequent periods were between 8 and 9 pm. The most likely days were Wednesdays and Thursdays. The period effects show a steadily increasing trend in the rate during 2004 stabilizing in 2005, with the exception of a high peak in March-April 2004 and a less pronounced peak in May-June 2005. The terrorist event occurrences had expanded to the adjacent districts in Songkhla. A suitable method for prevention and solving of the terrorist events must be implemented urgently together with healing the victim's families in this region.

References

National Statistical Office, The 2000 Population and Housing Census, Southern Region Statistical Data Bank and Information Dissemination Division: National Statistical Office, 2002.

Parks, T.I., Maintaining Peace in a Neighborhood Torn by Separatism: The Case of Satun Province in Southern Thailand: Johns Hopkins University, USA, 2005.

Venables, W.N. and Ripley, B.D., Modern Applied Statistics with S-PLUS (4th ed): Springer-Verlag New York, 2002.

Venables, W.N., Smith, D.M. and the R Development Core Team, An Introduction to R: Revised and Updated: Network Theory Ltd, Bristol, 2002.

Yusuf, I., The Southern Thailand Conflict and the Muslim World: Public Seminar on "Southern Violence and the Thai State": Thamasat University, 2006.