Strenghthened capacity for climate change adaptation in health: integrated response to climate sensitive vector-borne diseases in Cambodia

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Introduction

Cambodia is one of the dengue-endemic countries in South-East Asia, and has been affected by a number of serious epidemics of severe dengue over the last decade. The epidemics appear at intervals of 3-7 years with each epidemic culminating in a higher peak. The most recent epidemic in 2012 saw 42,362 reported cases and 189 deaths. Transmission occurs mostly during the wet season from May to November.

It has been suggested that climate change may contribute to an increase in dengue incidence [1]. Dengue viruses and the vectors are sensitive to climatic conditions, so changes in temperature, rainfall and humidity have well-defined roles in the transmission cycle and may thus play an important role in changing dengue incidence [2]. In this study, statistical analyses were conducted to examine the relationship between the dengue incidence and climatic conditions in three provinces in Cambodia in order to strengthen the national climate change adaption capacity in dengue control.

Method

Banteay Meanchey, Kampong Thom and Siem Reap were three provinces with complete climate and dengue incidence data from January 1998 to December 2012 selected for the study.

The total monthly number of dengue cases (dependent variable), and the monthly average minimum, maximum, mean temperature, and the monthly cumulative rainfall (independent variables), were used in the analysis. Population was included as the offset variable in the models.

Poisson regression and Negative Binomial analysis were performed to investigate association between the dengue incidence and climatic factors. Piecewise linear function was adopted to estimate Incidence Rate Ratio (IRR) for simplicity. Analyses were performed using STATA 13.

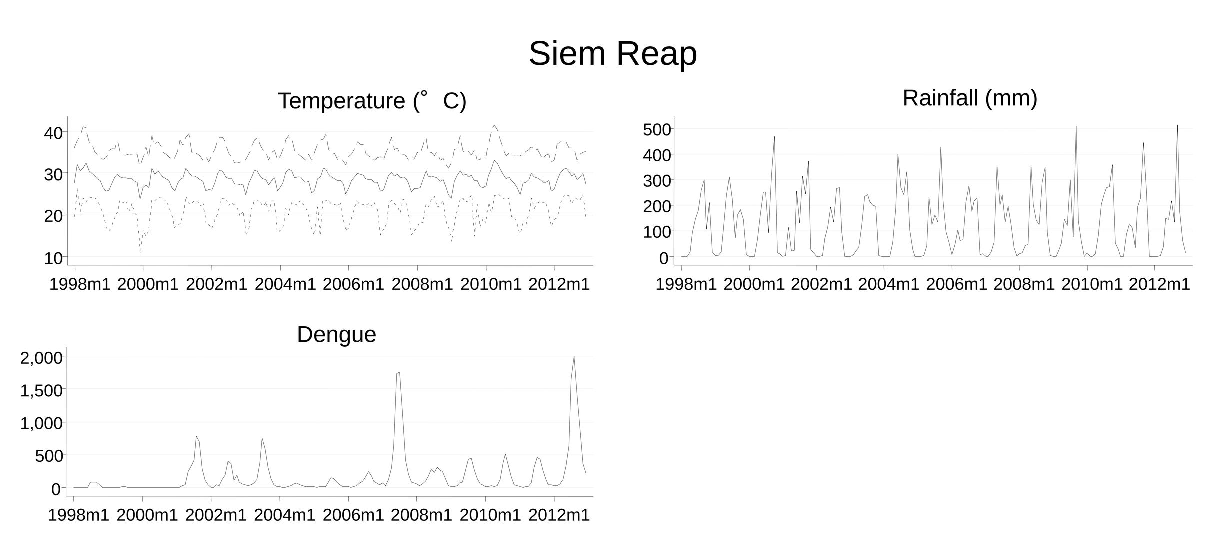
The following model was used:

$$\log_e(\textit{dengue cases}) = \beta_0 + \beta_1 s(\textit{temperature})_{t-i} + \beta_2 s(\textit{rainfall})_{t-i} + \textit{year} + s(\textit{month}) + \text{offset}(\textit{population}) + \textit{ar}$$

β_0 is the constant, β_1-β_2 are the unknown parameter values to be estimated and *i* is a given lag-time; s means a natural cubic spline function with 3 df; *year* denotes indicator variables for the years; *ar* indicates an autoregressive term.

Results

Fig. 1 showed that climate conditions showed similar patterns along with each season within the same province. However, there were some differences in terms of temperatures and rainfalls among the three provinces.



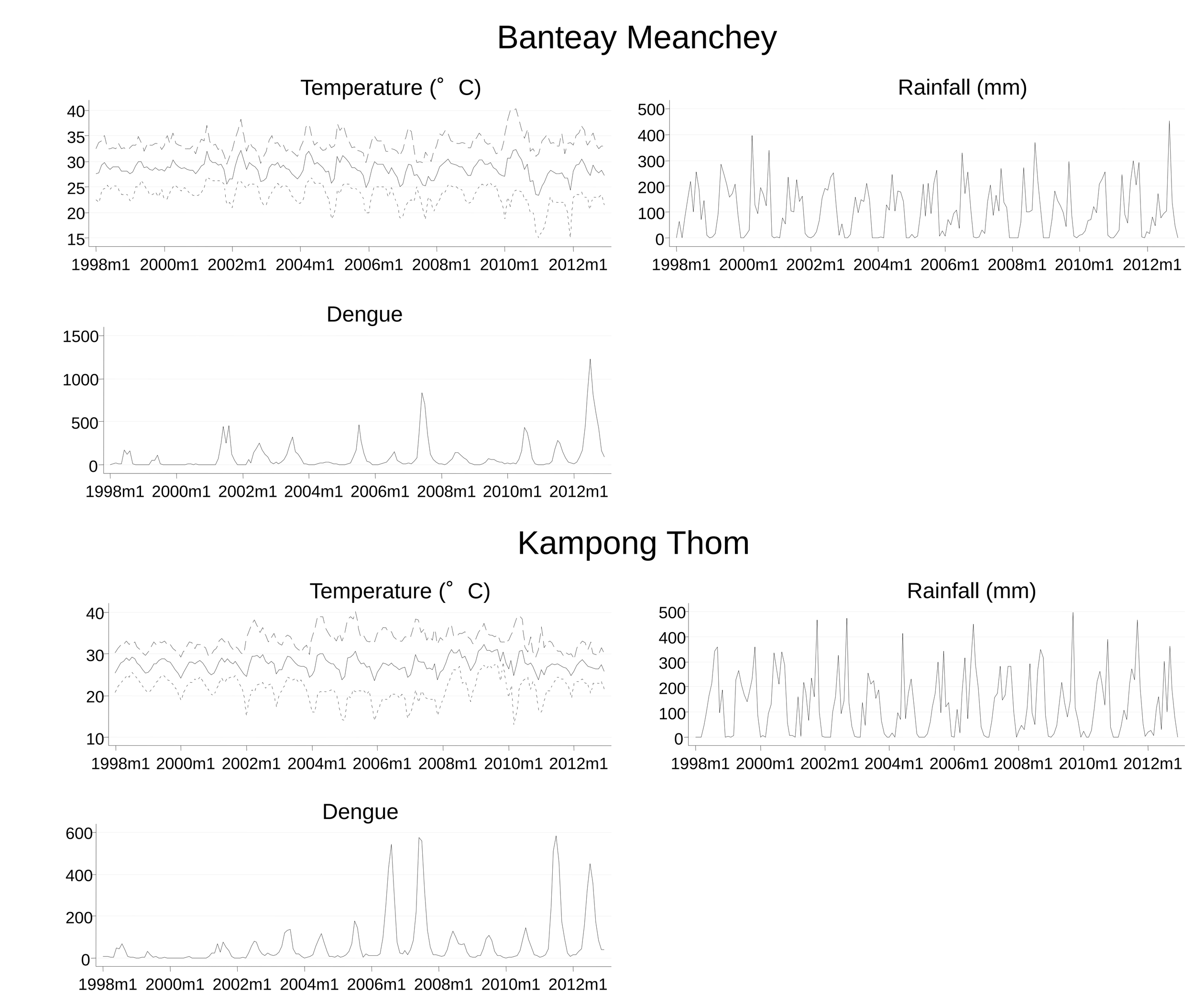


Fig. 1. Seasonal variation in dengue cases and climatic factors per month,1998-2012.

In order to investigate the different relative risk of dengue incidences due to climatic factors among the provinces, risk response curves at a lag of 3 months were created as shown in Fig. 2. The curves suggested that as the unit of climatic factors increased, the patterns of relative risks of dengue cases differed among the three provinces.

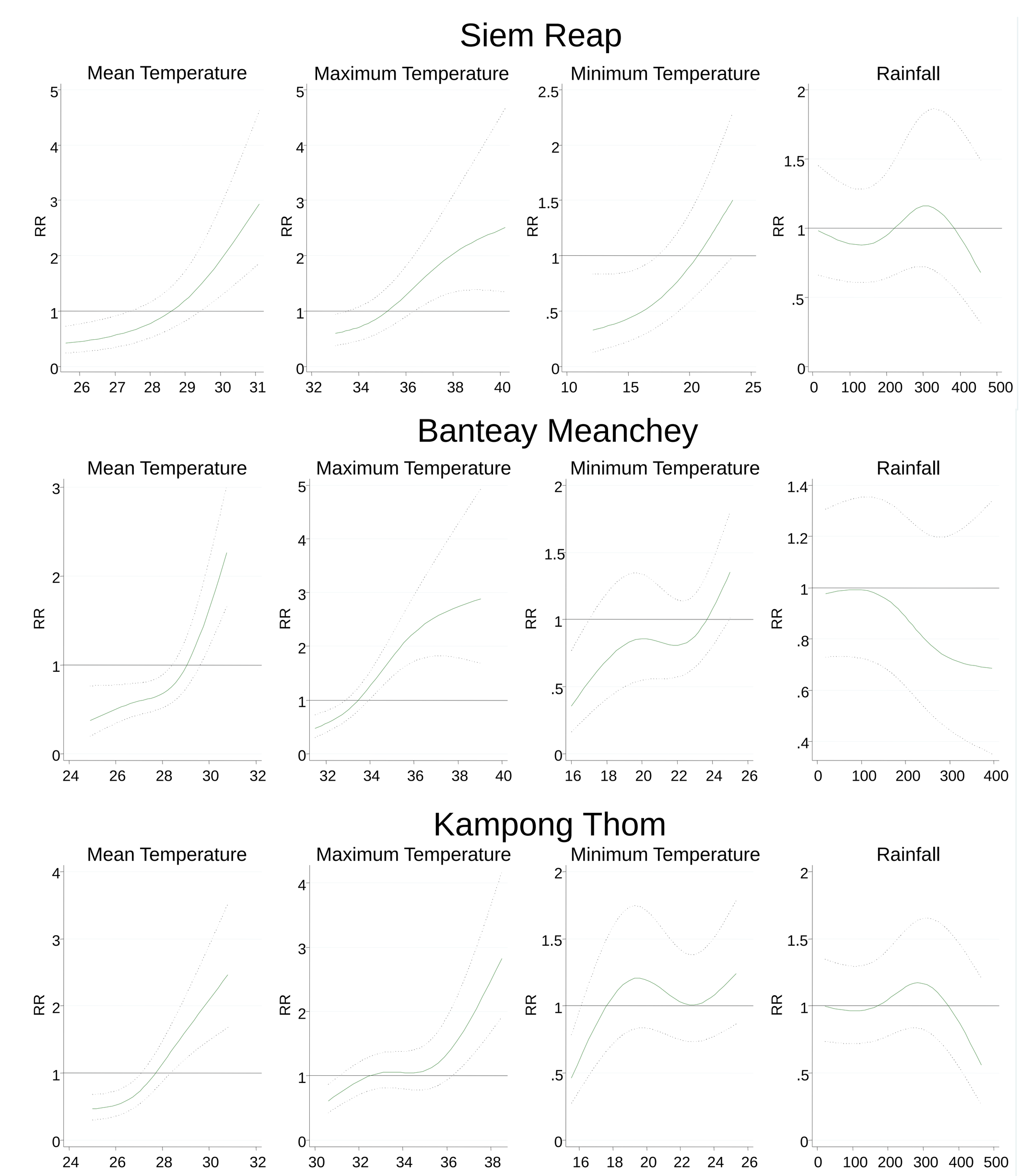


Fig. 2. Risk response curves of dengue cases at a lag of 3 months. solid lines: relative risks of dengue cases, dotted lines: the upper and lower of 95% confidence intervals

Fig. 3 described the change in the number of dengue cases associated with climatic factors in 3 provinces. A 1°C increase in average mean temperature led to an increase in the number of dengue cases of 38.6%, 39.1% and 19.9% in Siem Reap, Banteay Meanchey and Kampong Thom, respectively. A 1°C increase in average maximum temperature led to an increase in the number of dengue cases of 36.9% and 22.9% in Siem Reap and Kampong Thom, respectively. A 1°C increase in average minimum temperature led to an increase in the number of dengue cases of 7.8% and 21.8% in Siem Reap and Banteay Meanchey, respectively. For a 1mm increase in average cumulative rainfall, the number of dengue cases increased by 0.4% in Siem Reap.

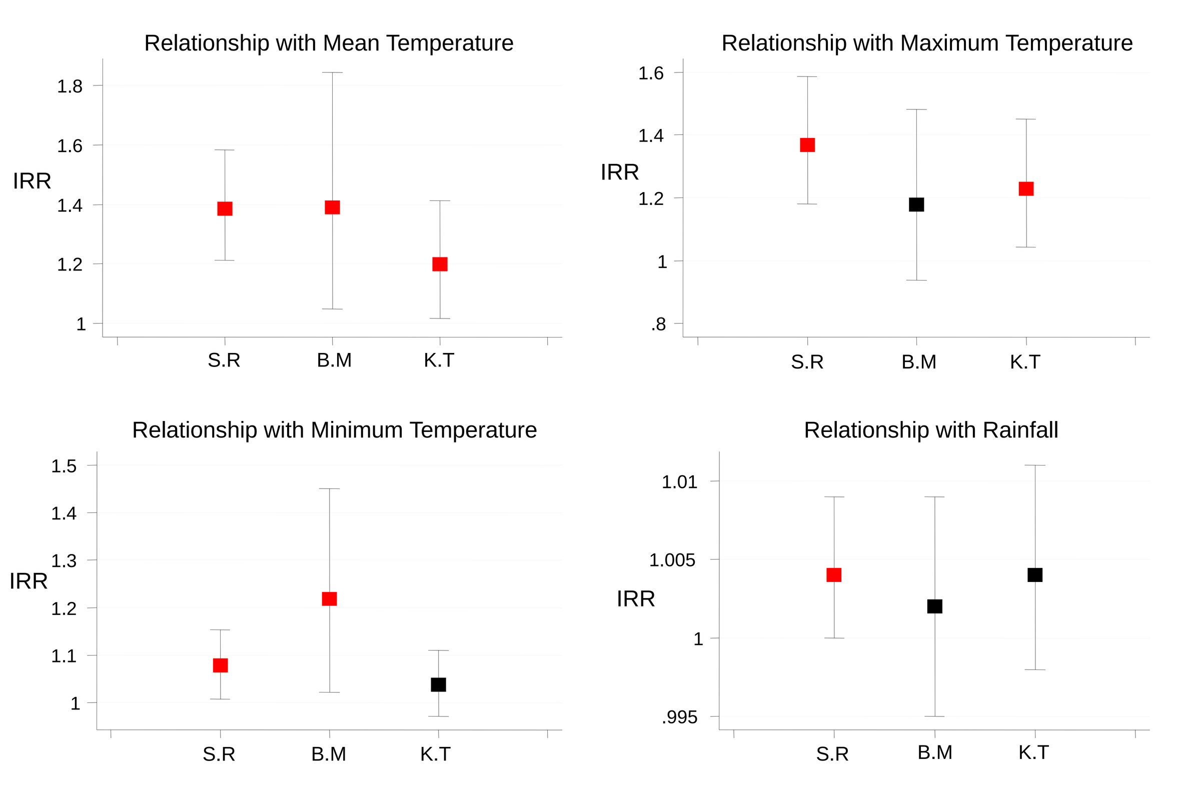


Fig. 3. Incidence Rate Ratio of dengue incidence at a lag of 3 months estimated by Negative Binomial model. S.R: Siem Reap, B.M: Banteay Meanchey, K.T: Kampong Thom, Red square: p-value < 0.05

Conclusion

This study showed that the average mean temperature has a significant effect on the incidence of dengue in Cambodia. The monitoring of average mean temperature could be incorporated into an early warning system mechanism, to enable prediction and earlier detection of dengue fever epidemics in certain regions, and public health-led interventions to minimize or avoid the burden of such epidemics. The results also showed that association between dengue incidence and climatic factors varied by locality, therefore, developing a dengue early warning should be done by locality specific rather than a national system so that dengue control measures can be more targeted and effective.

Further study on other climatic parameters should be conducted so that a combined early warning for dengue epidemic prediction model can be developed for cost-effective adaptation to climate change.

Reference

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