Climate impact on seasonal patterns of diarrhea diseases in Tropical area

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Abstract

Statistical investigation has been made for the effect of the climate on the epidemic diseases using the time series of meteorological elements and the number of patients. We apply correlation and EOF analysis method to time series of diarrhea patients and meteorological elements in Bangladesh. The anomaly of the number of the diarrhea patients has different signs for the periods before and after June, corresponding to the two peaks of the number of the patients. Higher maximum temperature and more sunshine in the pre-monsoon period are found to have a tendency to enhance the first peak of the diarrhea occurrence.

Key words: climate, diarrhea disease, correlation, EOF analysis, Bangladesh

1. Introduction

Associated with the global warming, the climate impact on tropical infectious diseases is getting more attention recently. For example, malaria, cholera and dengue fever in tropical area in Asia and Africa are considered to prevail broadly in the middle latitude countries. In South Asia, such as India and Bangladesh, prevalence of diarrhea diseases is a serious problem of public health. Diarrhea patients have been increasing for a few decades (Fig. 1) and this seasonal variation has two peaks in the pre-monsoon (March and April) and at the end of the monsoon (September and October) in Dhaka (Fig. 2). Wagatsuma et al. (2002) that reported the correlation analysis shows the patient occurrence is related to the meteorological elements a few months before the peak of infection. There's also a research reporting that the distinct increase of diarrhea takes place in the years of El Nino and Southern Oscillation (Pascual M. et al. 2002). These researches clarified somewhat the qualitative relation between the variations of meteorological elements and the number of patients. In this paper, we apply the correlation and the EOF analysis to the time series of diarrhea patients and meteorological elements in Bangladesh, to understand the effects of the meteorological variation on the prevalence of diarrhea disease.

2. Data

The International Centre for Diarrhoea Disease, Bangladesh: Centre for Health and Population research (ICDDR, B) in capital city Dhaka supplied the daily number of diarrhea diseases patient for 22 years from 1980 to 2001. The patients were classified to V.Cholera or Rota for 21 year from 1981 to 2001.

The surface observation data for 22 years (1980-2001) in Dhaka are provided by Bangladesh Meteorological Department (BMD). Among maximum temperature, precipitation, sunshine, relative humidity, dry bulb temperature, minimum temperature, wind and cloud pressure, we used the first four elements for analysis: temperature and relative humidity were 3 hourly and the other daily. Since a deficit is found from 1990 to 1992 in sunshine data, the period has been removed from analysis.

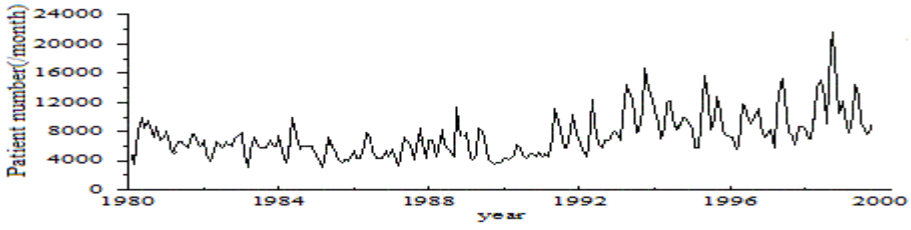

Fig.1 Time series of monthly diarrhea patients number in ICDDR,B from 1980 to2001.

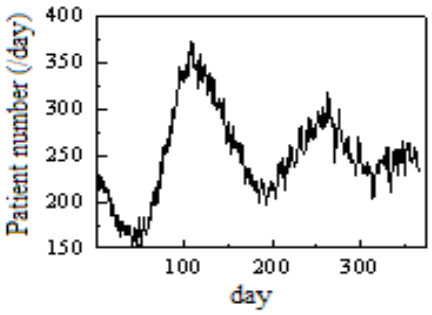

Fig. 2 Seasonal variation of diarrhea patients in ICDDR,B. The number of patients are averaged for 22years from 1980-2001.

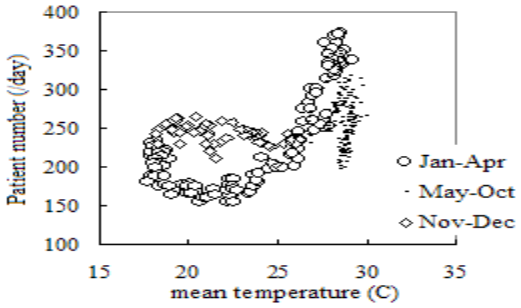

Fig.3 Seasonal relationship of diarrhea patients to mean temperature. (Teshima A. and Hayashi T. et al. 2004)

3. Method of Analysis

We made correlation analysis and the EOF analysis for the time series of patient and meteorological elements. We take averages every two weeks in each year from 1981 to 2001. That is, yearly data are divided to 26 portions and each portion contains 22 data for 22 years. The patient data are normalized by the yearly total patient number to remove the year-to year increasing trend. Two types of correlation analysis below were carried out for meteorological elements and patient number. A certain portion of climate precedes that of diarrhea occurrence.

a) lag correlation of meteorological elements to one fixed portion of patient.
b) lag correlation of patient number to one fixed portion of meteorological elements.

The *i*th portion in *w*th year is expressed as *X(w,i)* for patient data, and *Y1(w,i)~Y4(w,i)* for meteorological 4 elements. We have applied the EOF analysis to *X(w,i)~Y4(w,i)* by correlation matrix of the anomaly $x_i(w) = X(w,i) - \bar{X}(i)$ and $y_i(w) = Y(w,i) - \bar{Y}(i)$, where $\bar{X}(i), \bar{Y}(i)$ are averages on *i*.

4. Result

Fig. 4(a-1) shows the lag correlation of meteorological elements to the fixed portion of total diarrhea patients in April. The time lag for the meteorological elements is set from October to April. The maximum temperature and the sunshine duration have positive correlation and the precipitation and relative humidity have the negative correlation. Generally correlation is not clear in October-January, then increases from February and reaches the peaks with correlation coefficient more than 0.5 in March in maximum temperature and the sunshine duration. The inverse correlations for the precipitation and the relative humidity also have peaks about -0.5 around February and March.

Fig. 4(a-2) shows the similar correlation as Fig. 4(a-1) except for diarrhea patients in August. The signs of correlations are reverse compared with Fig. 4(a-1) with positive correlation in the precipitation and the relative humidity and negative one in the maximum temperature and the sunshine duration. The correlation coefficients increase from March and don't have large peaks.

Fig. 4(b-1) is the lag correlation of the diarrhea patients to the fixed portion of the meteorological elements in April. The correlation coefficients more than absolute value 0.5 in April decreases gradually and crosses at zero in the middle of June. Therefore that indicates the similar effect of the meteorological elements lasts two months.

Fig. 4(b-2) shows the similar correlations as Fig. 4(b-1) except for meteorological elements in September. The correlation coefficients are significant up to October and cross zero in November.

Fig. 5 shows the result of the EOF analysis for the patients of total diarrhea, diarrhoeal cholera and rota. In the dominating component, the anomaly of the number of patients has different signs for specific month. In the first principle component of total diarrhea and in the second one of diarrhoeal cholera, the signs change in June and July. In the first principle component of diarrhoeal cholera and the second one of diarrhoeal rota signs change in February and in the first principle

component of diarrhoeal rota in December.

This indicates the different characteristics of each type of diarrhea. Diarrhoeal cholera shows similar tendency to total diarrhea diseases, but the rota shows different characteristics with total diarrhea and cholera.

5. Summary

The diarrhea patient in the first peak in April is sensitively correlated to climate elements in pre-monsoon.

Climate in pre-monsoon has influence on total diarrhea patient through the spring peak (April-May) and the effect of climate in the August lasts through Aug-Oct, the autumn peak of patient. Meteorological elements play reverse role on the peak of spring and autumn diarrhea patient.

Total diarrhea diseases and diarrhoeal cholera show common anomaly pattern but rota seems different. The characteristics of the former two change mainly in Jun-Jul, but that of the latter one changes in Jan-Feb.

Reference

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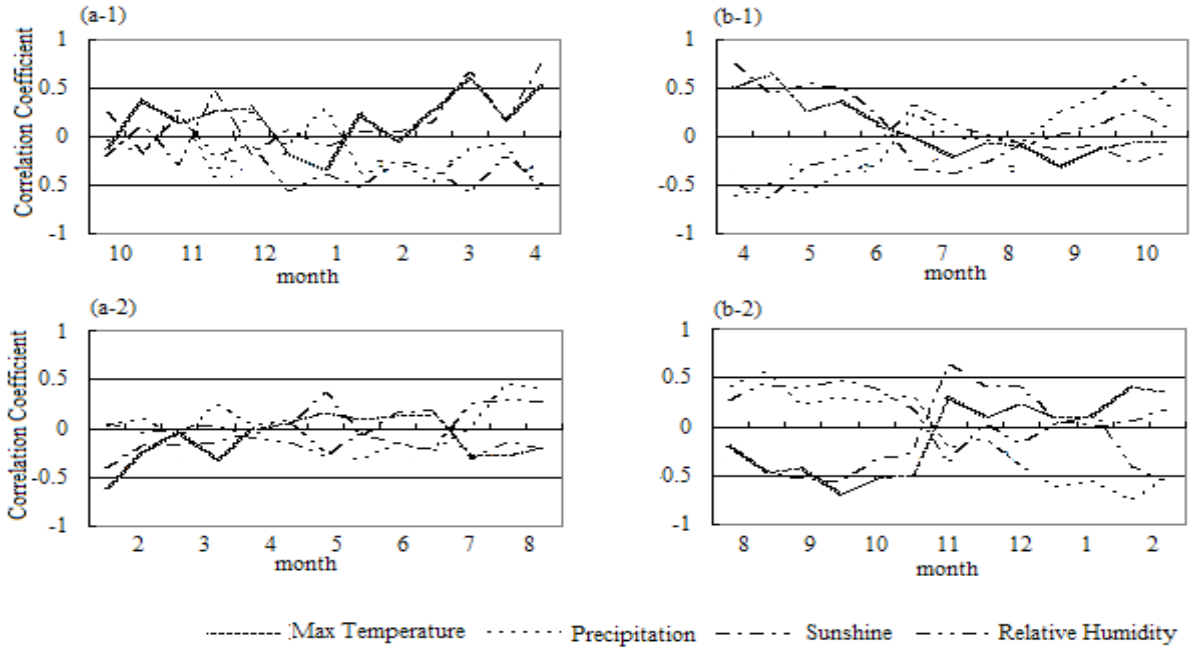

Fig.4 Correlations between the meteorological elements and the fixed diarrhea patients in Spring (a-1), and in August (a-2). Correlations between the diarrhea patients and the fixed meteorology in April (b-1), and in August (b-2).

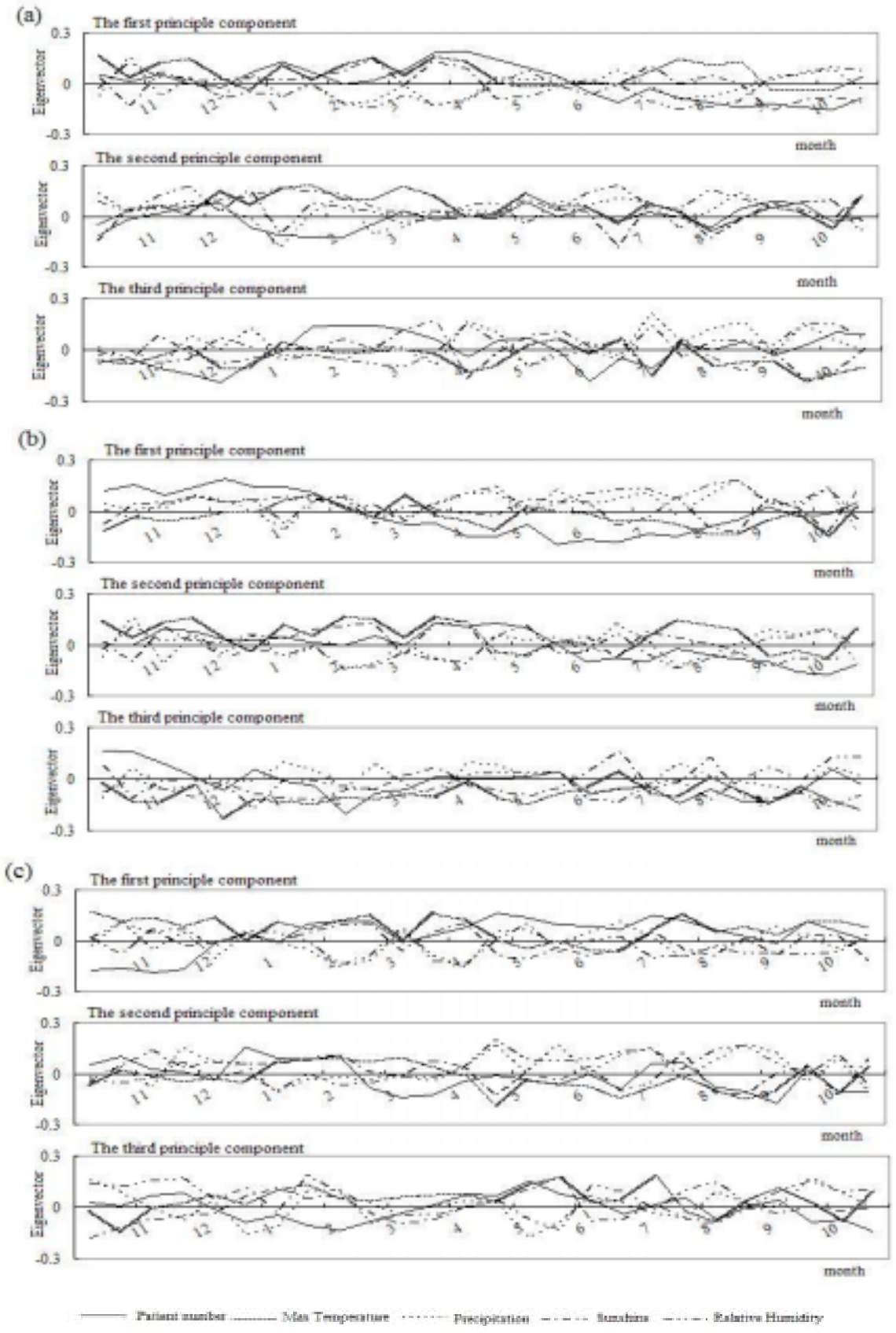

Fig.5 The EOF analysis result for the meteorological elements and diarrhrea patients(a),Chorela(b) or rota(c).