Marine And Coastal Area Condition In Cambodia

Pao Srean

Faculty of Agriculture and Food Processing, University of Battambang, Cambodia
Email: **pao.srean@gmail.com**

ABSTRACT

Cambodia's coastline is 435 km extending along the Gulf of Thailand and covering area of 17,237 km^2. These marine and coastal areas provide very important resources for human wellbeing. Rapid expansion of fisheries in these areas have caused considerable economic and environmental concerns about their management. This study aims at exploring trends in marine and coastal activities and patterns of their association with socio-economic variables. The study is based on accessible secondary data over the last two decades. The stresses that the marine and coastal areas are facing include: increased human activities, rapid expansion of fisheries to meet the demand for food consumption, declining mangrove forest and decreased catch per unit effort associated with a rise in the number of fishermen. From 1961 to 2015, there has been rapid expansion of the marine catch, and the forecasted value showed that amount of annual catch would be raised to as much as 200 thousand tons in the next fifteen years. Conservation and management of these marine and coastal areas should be considered and should include providing alternative livelihoods to divert coastal residents from fishing to other occupations to generate income to support their families to ensure the sustainable development of Cambodia's marine and coastal areas.

Keywords: catch per unit effort, coastal situation, marine fisheries, overfishing, socio-economic.

INTRODUCTION

The coastline of Cambodia extends along the northeastern shore of the Gulf of Thailand between the Thai and Vietnamese borders for approximately 435 km, covering an area of 17,237 km^2 (Fig. 1). The coast consists of estuaries, bays and approximately 64 islands. Over the last two decades, infrastructure (i.e. roads, ports and coastal resorts) in these areas have been developed and people have migrated from inland areas to coastal areas for economic opportunity reasons (Rizvi and Singer 2011). Although the land use map shows natural forest covering most parts of the coastal zone, this is projected to change rapidly due to human activities and unsustainable development.

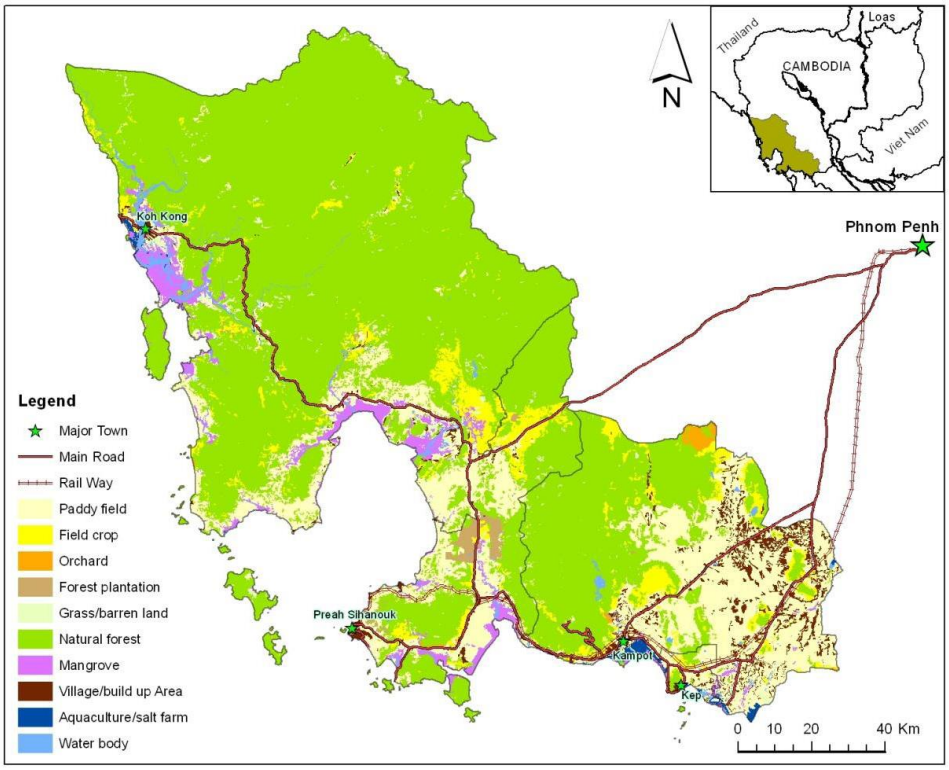

Fig. 1: Map showing land use in the coastal zone of Cambodia in 2011 (adapted from MoE 2013).

The marine and coastal zone plays an increasingly important role in the country's development, supporting the industrial, agricultural, fisheries and transport sectors and offering growing attraction for recreation and tourism. However, the rapid expansion of fisheries in the Gulf of Thailand, as well as in Cambodia generally has raised considerable economic and environmental concerns about their management (e.g. Amhed et al. 2007; Puthy and Kristofersson 2007; MoE 2009; Rizvi and Singer 2011). This study aims at exploring trends in marine and coastal activities and patterns of their association with socio-economic variables, based on accessible secondary data over the last two decades.

MATERIAL AND METHODS

Data compilation

Data on annual marine catch (i.e., fishes, shrimps, squids and molluscs), number of fishing boats (i.e. total boats, boats with engines, and boats without engines used in the coastal zone) over the last twenty six years (1990 – 2015); and socio-economic variables including extent of mangrove forest area, agricultural land area, human population and population density in the coastal zone were obtained from reports of the Department of Fisheries (DoF 2016), Food and Agriculture Organization (FAO 2010) and the Ministry of Environment (MoE 2007; 2012). Total population data was obtained from the database of

World Bank (http://data.worldbank.org/), international tourist arrivals to Cambodia from the Ministry of Tourism (MoT 2015), and also minimum and maximum temperatures from the Preah Sihanouk Provincial Department of Water Resource and Meteorology (PDWRM 2012 as cited in MoE 2013). Data from published figures were obtained using the DATATHIEF III software (Thumers 2006), when the exact values were not reported in the articles. Catch per unit effort was estimated from dividing the total annual catch by the total number of fishing boats. All these predictors were used to explore patterns of association among the variables.

Data analyses

To explore trends in marine catch and number of fishing boats used in the coastal zone, time series plots were performed by using the package 'ggplot2' (Wickham, 2011). To visualize correlations between all pairwise combinations of the marine catch and socio-economic variables, bivariate relationships were analyzed using Pearson's correlation coefficient for numerical variables by performing correlation matrix using scatter plots in the 'PerformanceAnalytics' R package (Carl and Peterson 2010). The "forecast" R package (Hyndman and Khandakar 2008) was used for time-series forecasting for annual marine catch over the next fifteen years, based on the data from 1961 to 2015. All statistical analyses were performed with the R statistical software, version 3.3.1 (R Core Team 2016).

RESULTS

In the coastal area, human population increased 19% between 1998 and 2011 and the current total population is 1.01 million, with a density of 54 persons per square kilometer (Fig. 2A&B). This population increase forced the area of agricultural land to change from 11.5% in 1993 to 23% in 2011, whereas areas of mangrove forest and forest cover decreased from 94,600 ha in 1976 to 50,860 ha in 2011, and 67.5% in 1993 to 51.5% in 2011, respectively (Fig. 2C-E). However, the number of fishery communities established increased from 9 in 2001 to 45 in 2011 (Fig. 2F). The communities have been established for coordination and management of fishery resources and conservation. However, the number of households involved in fisheries peaking in 2004 and has declined subsequently (Fig. 2G). The minimum and maximum temperatures varied generally between 24 and 34 ^{o}C over the last two decades (1990 – 2011; Fig. 2H).

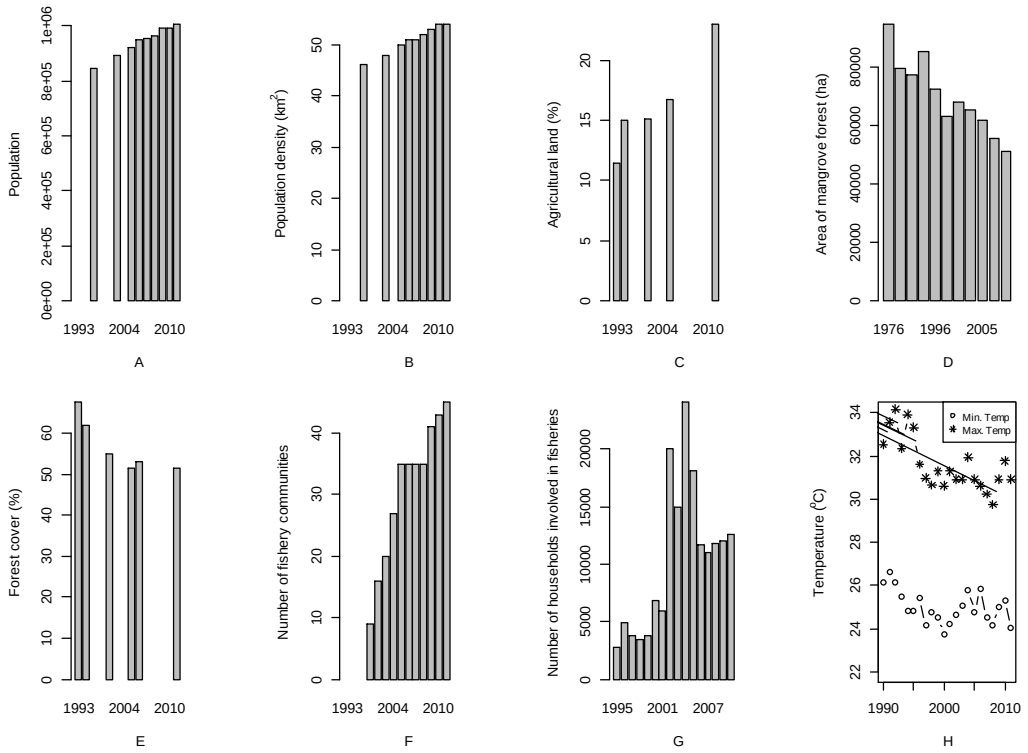

Fig. 2: Status changes of the marine and coastal areas of Cambodia: A) human population, B) population density (persons/km^2), C) area of agricultural land (% of the total coastal area), D) area of mangrove forest (ha), E) forest cover (% of the total coastal area), F) number of fishery communities established, G) number of households involved in fisheries, and H) annual minimum and maximum temperatures (°C).

Correlations between all pairwise combinations of marine catch and socio-economic variables are given in Fig. 3. The catch increased annually and correlated positively with total population and number of international tourists, indicating that the population growth is a factor causing pressure on the marine catch through demand for food consumption. Surprisingly, the catch significantly increased with number of fishing boats, but was negatively related to the catch per unit effort (CPUE), particularly for fish, suggesting that as the CPUE was declining from 14.3 tons in 1995 to 7.2 tons per boat in 2011, the share of high valued fish was also declining.

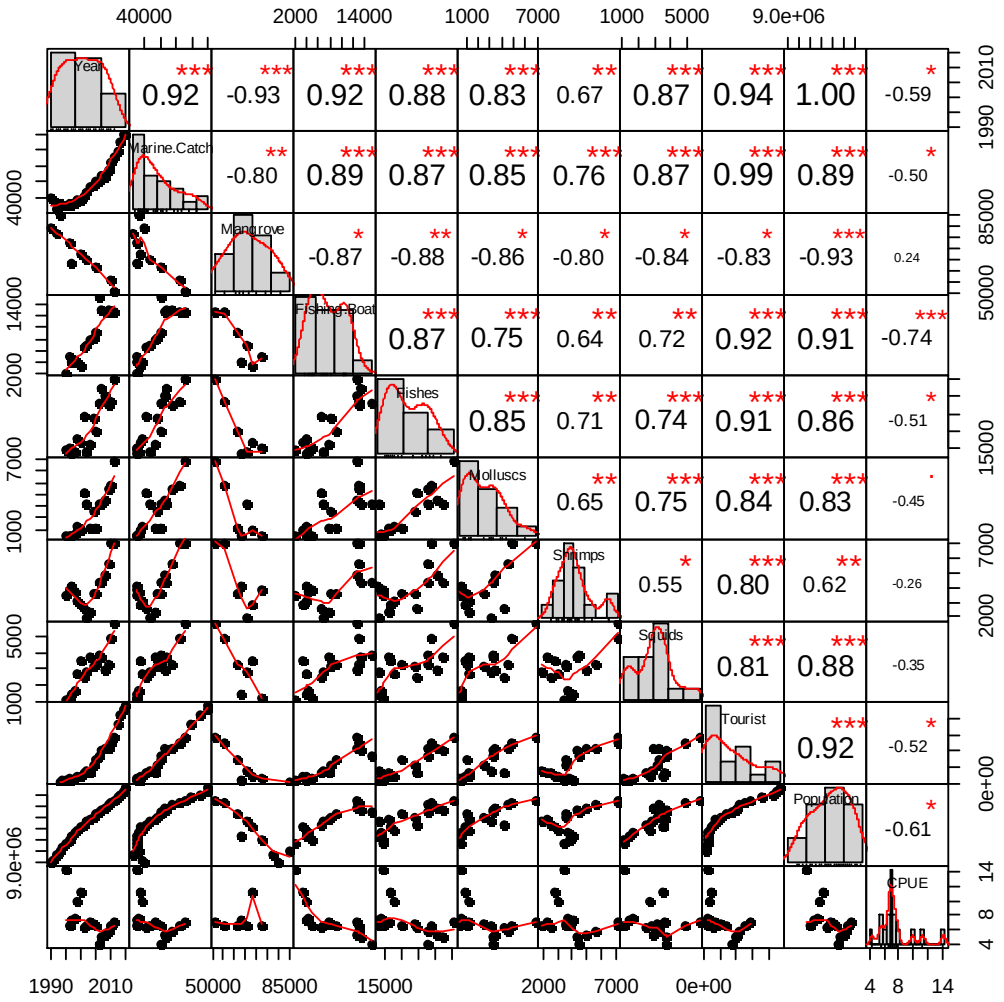

Fig. 3: Correlations matrix of marine catch and socio-economic variables (Pearson's correlation). Note: Correlations were based on all available data (•P < 0.1; *P < 0.05; **P < 0.01; ***P < 0.001). Agri.Land: agricultural land area in the coastal zone (%), CPUE: catch per unit effort (tons per boat per year), Fishing.Boat: number of fishing boats used in the coastal area, Fishes: annual fishes catch (tons), Forest: forest area in the coastal zone (%), Mangrove: area of mangrove forest (ha), Molluscs: annual molluscs catch (tons), Population: human population, Shrimps: shrimp catch (tons), Squids: annual squid catch (tons), Tourist: international tourist arrivals to Cambodia.

Two types of fishing boats were used in the coastal areas, i.e. fishing boats with and without engines attached. Both together increased from 1,235 in 1995 to 12,691 in 2011 or a tenfold increase over six years (Fig. 4A). The figure shows an increase in annual catch overall, from 30.5 thousand tones in 1995 to 120 thousand tons in 2015, notably after 2000 (Fig. 4B). The annual fish catch increased from 14,283 tons in 1995 to 35,242 tons in 2011; and generally, fishes contributed more than 50% of the total catch over the years.

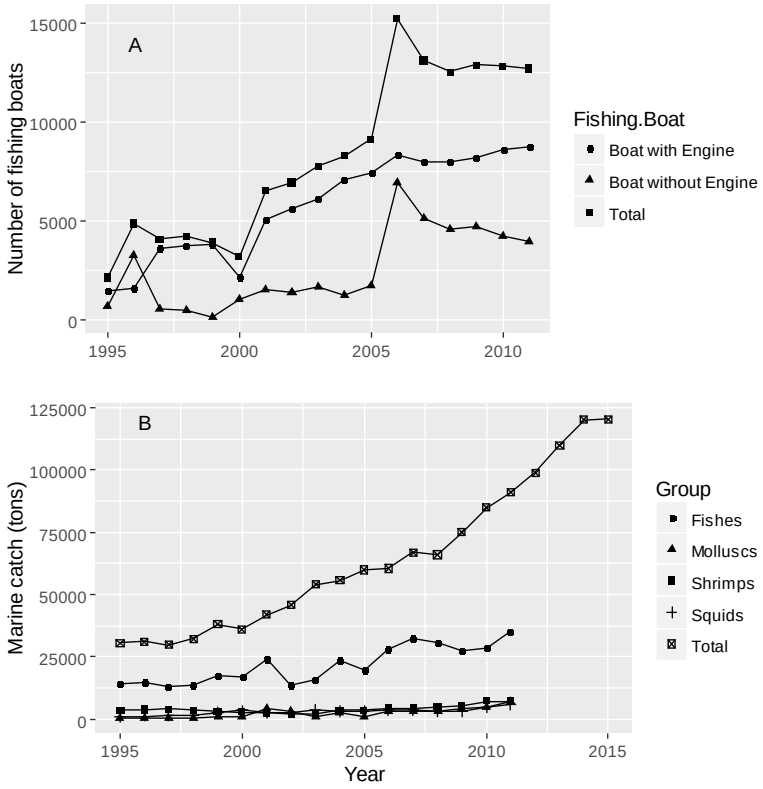

Fig. 4: Trends in A) number of fishing boats used in the coastal area (i.e. boats with and without engines attached), and B) annual marine catch (i.e. Total, Molluscs, Shrimps, Squids) over the last two decades (1995 – 2015).

However, increasing number of fishermen caused rapid expansion of the marine catch year by year due to rise in food demand for population and tourist growth in the coastal areas. The forecasted value showed that amount of marine catch would be raised to as much as 200 thousand tons in the next fifteen years (Fig. 5).

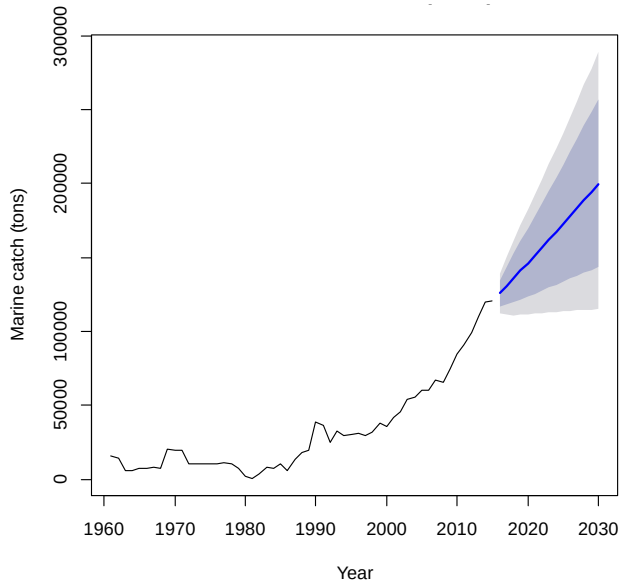

Fig. 5: Time-series of annual estimates for total marine catch of Cambodia from 1961 to 2030.

DISCUSSION

The population has been growing faster than the estimated growth rate because many of the people are recent migrants who have moved from inland areas to the coastal zone for economic opportunity reasons and through the improved infrastructure (i.e. roads, ports and coastal resorts) that has been developed over the last two decades (Rizvi and Singer 2011). The favorable coastal area has encouraged coastal zone growth as a favorite coastal tourism site; for instance, foreign visitor arrivals to the coastal area has increased by 20% over the last two years, from 513,891 in 2013 to 610,458 in 2015, and makes up annually about 11.4% of the total international tourist arrivals to Cambodia (MoT 2016). The increase in residents and tourists has led to the expansion in the number of fishermen, fishing gears and agricultural activities to meet the demand for food for local consumption. Human activities are having a significant impact on marine ecosystems; for example forest and mangroves have declined. Mangroves are cut for shrimp farming, firewood, charcoal, and building materials and burnt to control mosquitoes and other insects (MoE 2009), all of which are alternative sources of income for some people living in coastal areas. The impact of these activities has led to the loss of habitat and shelter for marine stocks, reduced shoreline protection from storms, increased erosion and coastal water pollution (due to high concentration of Nitrogen and Phosphate and oily-water); and acid soils (World Bank 2003; MoE 2009).

The annual catch has expanded rapidly due to the rise in number of fishermen and fishing gears, however the CPUE has decreased and the share of high valued fish has also decreased, which has caused the income per household from fishing generally to decrease. Overfishing in the Gulf of Thailand has been a cause for concern and led to suggestion for resource conservation and management (Ahmed et al. 2007; Puthy and Kristofersson 2007; DoFT 2015). Aquaculture is one of the alternative options when the CPUE has declined. Shrimp culture has recently been developed and is carried out mostly along the coastline of the country (Hav and Leap 2005). However,the total shrimp farming area was 850 ha in 2000, and decreasing gradually each year, with the total annual production declining from 500 tons in 1993 to 75 tons in 2004. White spot syndrome virus has been the most serious threat and is probably the major cause of direct losses of up to $14.5 million per year for shrimp farming in Cambodia (Touch and Todd 2002).

Overall, Cambodia's marine and coastal areas are faced with many human activities including rapid expansion of fisheries to meet the demand for food consumption together

with declining mangrove forest and catch per unit effort due to the rise in number of fishermen. Coastal fisheries are under threat from direct and indirect factors creating a declinein fisheries. Conservation and management of marine and coastal areas should be considered and include the provision of alternative livelihoods to divert coastal residents from fishing to other occupations to generate income to support their families and so aim at the sustainable development of these important areas.

ACKNOWLEDGEMENTS

This paper is based on an invited presentation given at the International Seminar on "Sustainable Utilization of Coastal Resources in Tropical Zone" – ISECoastal, held in October 19 – 20, 2016 at the University of Bengkulu, Indonesia. The author is grateful to Dr. E. Sulistyowati for the invitation, and Rien Sothea for data collection. I also thank Ms. A. Montague and Dr. K. Magellan, who assisted in editing this paper. Financial support was provided by the University of Bengkulu and University of Battambang, Cambodia.

REFERENCES

Ahmed, M., Boonchuwongse, P., Dechboon, W. and Squires, D. 2007. Overfishing in the Gulf of Thailand: policy challenges and bioeconomic analysis. *Environment and Development Economics*, 12: 145-172.

Carl, P. and Peterson, B.G. 2010. PerformanceAnalytics: Econometric tools for performance and risk analysis. R package version 1.0.2.1.

DoF. 2016. Statistic of inland, marine and aquaculture production. Department of Fisheries (DoF), Ministry of Agriculture, Forestry and Fisheries, Phnom Penh, Cambodia. Retrieved on 25 September, 2016, from www.fia.gov.kh/english/.

DoFT. 2015. Marine Fisheries Management Plan of Thailand - A National Policy for Marine Fisheries Management: 2015 – 2019. Department of Fisheries, Ministry of Agriculture and Cooperatives, Thailand.

FAO. 2010. Global forest resources assessment 2010 – Country report: Cambodia. Forest Department, Food and Agriculture Organization of the United Nations, Rome.

Hav, V. & Leap, H. 2005. Status of shrimp farming in Cambodia. In: Regional Technical Consultation on the Aquaculture of P. vannamei and Other Exotic Shrimps in Southeast Asia, Manila, Philippines (pp. 38-41). Tigbauan, Iloilo, Philippines: SEAFDEC Aquaculture Department.

Hyndman, R.J. and Khandakar, Y. 2008. "Automatic time series forecasting: the forecast package for R." *Journal of Statistical Software*, 26: 1-22.

MoE. 2007. 2nd State of the coastal environment and socio-economy report 2007. Ministry of Environment (MoE), Phnom Penh, Cambodia.

MoE. 2009. Cambodia environment outlook. Ministry of Enviroment, Phnom Penh, Cambodia.

MoE. 2013. 3rd state of the coastal environment, climate change and socio-economy report 2013. Ministry of Environment, Phnom Penh, Cambodia.

MoT. 2016. Tourism statistics report: year 2015. Statistics and Tourism Information Department, Ministry of Tourism (MoT), Phnom Penh, Cambodia.

PDWRM. 2012. Statistic of Meteorology, Preah Sihanouk Station, Provincial Department of Water Resource and Meteorology. In MoE. 2013. 3rd state of the coastal environment, climate change and socio-economy report 2013. Ministry of Environment, Phnom Penh, Cambodia.

Puthy, E. and Kristofersson, D.M. 2007. Marine fisheries resource management potential from mackerel fisheries of Cambodia. Department of Economics, University of Iceland, Reykjavik, Iceland.

R Core Team. 2016. R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. URL https://www.R-project.org/.

Rizvi, A.R. and Singer, U. 2011. Cambodia Coastal Situation Analysis, Gland, Switzerland: IUCN. 58 pp.

Thumers, B. 2006. DataThief III. http://www. datathief. org/.

Touch, S.T. and Todd, B.H. 2002. The Inland and Marine Fisheries Trade of Cambodia. Oxfam America.

Wickham, H. 2011. ggplot2. *Wiley Interdisciplinary Reviews: Computational Statistics*, 3: 180-185.

World Bank. 2003. Cambodia: Environment monitor. World Bank Phnom Penh Office, Phnom Penh, Cambodia.

World Bank. 2016. Data on countries and economies. Retrieved on 30 May, 2016, from http://data.worldbank.org/country.