ISSN: 2347-7431
EPRA International Journal of Climate and Resource Economic Review
-Peer Reviewed Journal
Volume: 10 | Issue: 3 | April 2022 || SJIF Impact Factor : 7.254 || Journal DOI: 10.36713/epra1213

ADVERSE EFFECTS OF CLIMATE CHANGE ON INDIAN MANGROVES:
A SOCIOECONOMIC CRISIS AND A THREAT TO THE RURAL DEVELOPMENT

Suvadip Jana[1], Sourav Dolai[2]

[1] Ex Student of PG Zoology Department of Midnapore College Autonomous Midnapore – 721101, Dist- Paschim Medinipur, W.B,

[2] Ex Student of PG Physiology Department of Midnapore College Autonomous Sundarnagar, Dist- Purba Medinipur, W.B,

Article DOI: https://doi.org/10.36713/epra10116
DOI No: 10.36713/epra10116

ABSTRACT---
Mangroves are highly loaded with immense nutrient and always share it with adjoining coastal habitats. Interestingly this system supports number of endemic and endangered species throughout the tropical coast. India has more than 7500 km coastal line within this, it supports 4, 87,100 ha of mangroves and harbours 3985 species of flora and fauna. During late 80s India lost considerable areas of its mangrove cover due to several anthropogenic pressures [1]. The ongoing climate change turned out to be a potential threat to the remaining Indian mangroves and other coastal ecosystem. Ironically there is no sound study till date about the impacts of ongoing climate change on Indian mangroves [2]. The loss of mangroves will spread its impact on the adjoining system in a significant way. So, the mangrove loss will negatively influence the fishery resource of the tropical region and initiate regional and global socioeconomical crisis.
KEYWORDS :- ***Climate Change, Mangroves, Biodiversity loss, Socioeconomic Crisis*****--**

INTRODUCTION

Mangrove forests are one among the pivotal coastal systems around the world. Interestingly mangroves are one of the world's richest storehouses of biological and genetic diversity [3]. Moreover 90% of the marine species need to spend some stages of their life in this precious ecosystem. Furthermore it has been proved that 80% of the global fish catches are directly or indirectly dependent on tropical mangroves [4]. It is mainly due to the immense productivity, nutrient and suitable microclimate offered by mangroves since ages [5]. Especially the nutrient load is incomparable, for instance the Pichavaram mangroves of southern India alone produce 7,457 tons of leaf litter per year [6]. Moreover, dense mangroves always inhibit the speed and intensity of tropical cyclones and storms and minimize the damages. Number of studies in different parts of the tropical regions elucidates the ability of mangroves against the impacts of cyclones [7-8].

Inter alia Forest Survey of India [9] stated that within 7500 km coastal line, India supports 4,87,100 ha of mangrove wetlands, in that nearly 56.7% *i.e.* 2,75,800 ha is spread along the east coast region and 23.5% (1,14,700 ha) in the west coast region and the remaining 19.8% (96,600 ha) is found in Andaman and Nicobar islands.
The major mangrove harboring states in India are provided in Fig. 1.

ISSN: 2347-7431
EPRA International Journal of Climate and Resource Economic Review
-Peer Reviewed Journal
Volume: 10 | Issue: 3 | April 2022 || SJIF Impact Factor : 7.254 || Journal DOI: 10.36713/epra1213

Current Status of Mangroves

Losses of mangroves occur almost every country that harbours mangroves, on the other hand the developing countries which supported huge mangrove cover witnessed significant decline (>90%) . Duke *et al* [10] disclosed that mangrove forests have been declining at a faster rate than inland tropical forests To support this Millennium Ecosystem Assessment MA [11], reported,

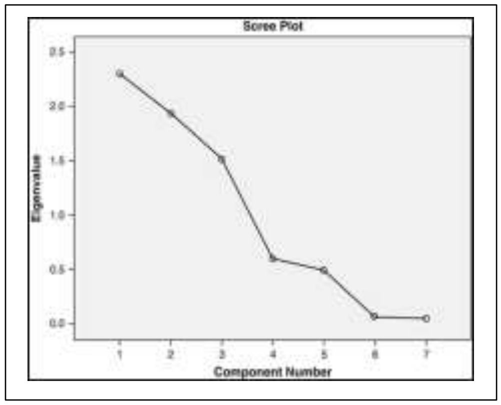

Fig:-1 Mangrove Degradation in the Sundarban

35% of mangrove losses from 1980 to 2000 in the tropical region. Furthermore recent report by Global Marine Species Assessment declared, Southeast Asian countries alone lost

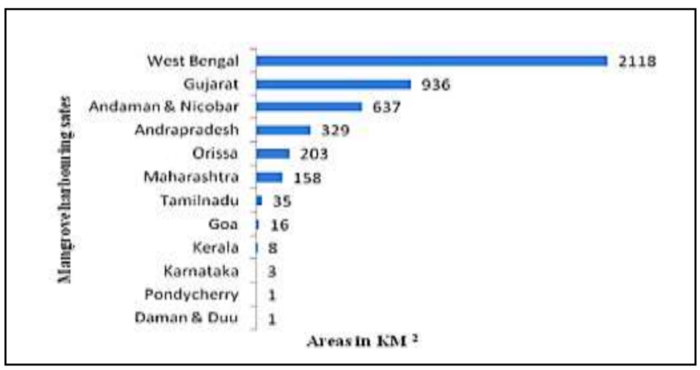

Fig2- Top mangroves supporting states of India based on the report of MOEF 2007

80% of its mangrove [12]. India also lost maximum cover during this period (e.g. Pichavaram mangroves South East Coast of India lost 80% of its mangrove cover [9].

ASSESSMENT OF MANGROVE AREA SINCE 1987

The National Remote Sensing Agency (NRSA), Hyderabad, India recorded a decline of 59.18 sq. km of mangrove between 1972-75 and 1980-82. According to the Government of India report, India lost 40% of its mangrove area during the last century. Of this, east coast has lost about 26%; west coast area about 44%; and Andaman and Nicobar Islands about 32%.

Biodiversity Values of Indian Mangroves

Indian mangrove supports a unique group of fungi, microbes, plants and animal species including crustaceans, mollusks, fishes, waterbirds and a number of endangered mammals like fruit bats, dolphin and the Royal Bengal tiger [5]. It was reported that Indian mangroves support 3985 species of flora and fauna that includes 919 (23%) flora and 3066 (77%) of fauna (Table 1). Interestingly 2 million water birds of about 200 species over-winter in Indian coast heading back to colder northern climes in April [13] and among them most of the species effectively utilize the Indian mangroves. No other country in the world supports so many species in the mangrove ecosystem alone and most of the species are

Table 1: Flora and fauna species recorded from Indian Mangroves up to 2008.

Groups	Number of Species
Floral groups	
Mangroves	39
Mangrove associates	86
Sea grass vegetation	11
Marine algae (Phytoplankton + sea weeds)	557
Bacteria	69
Fungi	102
Actinomycetes	23
Lichens	32
Faunal groups	
Prawns and lobsters	55
Crabs	134
Insects	705
Mollusks	302
Other invertebrates	740
Fish parasites	7
Fin fish	543
Amphibians	11
Reptiles	82
Birds	419
Mammals	68
Total number of species	3985

Source: [6].

endemic to this habitat. Notably Indian mangroves support numerous endangered flora and fauna (Table 2). Ironically such an important ecosystem is in continuous jeopardy and in recent decades this vital ecosystem is facing unimaginable threat due to continuous human intervention throughout India and faces a profound emergency. Moreover natural calamities such as cyclone and tsunami are the great challenges to this system. Above all, it has been predicted that the ongoing climate change could be the greatest threat to the existing global mangroves [14] and 100% of the mangrove forests could be lost in the next 100 years if the present situation continues everywhere [15].

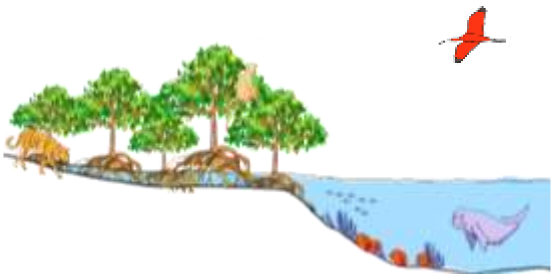

Fig3 i) Endangered Flora & Fauna recorded from Indian Mangroves up

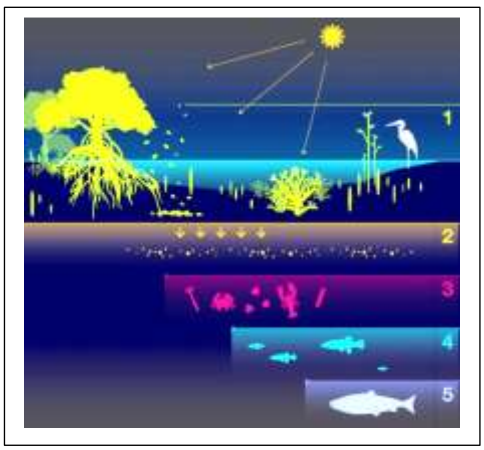

Fig3 ii) Mangroves Food

ISSN: 2347-7431
EPRA International Journal of Climate and Resource Economic Review
-Peer Reviewed Journal
Volume: 10 | Issue: 3 | April 2022 || SJIF Impact Factor : 7.254 || Journal DOI: 10.36713/epra1213

Table 2: Endangered flora and fauna recorded in India mangroves up to 2005.

Species name	IUCN status	Source
Plants		
Acanthus ebracteatus	Endangered	[67]
Acrostichum speciosum	Endangered	[67]
Cynometra ramiflora	Endangered	[67]
Excoecaria indica	Endangered	[67]
Lumnitzera littorea	Endangered	[67]
Nypa fruticans	Endangered	[67]
Rhizophora annamalayana	Endangered	[67]
Rhizophora lamarckii	Endangered	[67]
Rhizophora stylosa	Endangered	[67]
Scyphiphora hydrophyllacea	Endangered	[67]
Sonneratia griffithii	Endangered	[67]
Invertebrates		
Cardisoma carnifex	Endangered	[68]
Gelonia erosa	Endangered	[68]
Uca tetragonon	Endangered	[68]
Macrophthalamus convexus	Endangered	[68]
Pilodius nigrocrinitus	Endangered	[68]
Fishes		
Boleophthalmus dussumieri	Endangered	[68]
Scartelaos viridis	Endangered	[68]
Reptiles		
Crocodilus porosus	Endangered	[69]
Varanus bengalensis	Endangered	[69]
Varanus. salvator	Endangered	[69]
Varanus. flavescens	Endangered	[69]
Lepidochelys olivacea	Endangered	[69]
Lissemys punctata	Endangered	[69]
Trionyx gangeticus	Endangered	[69]
Trionyx. hurun	Endangered	[69]
Batagur baska	Endangered	[69]
Python molurus	Endangered	[69]
Birds		
Pelecanus philippensis	Endangered	[69]
Theskiornis melanocephalus	Endangered	[69]
Ardea goliath	Endangered	[69]
Mammals		
Panthera tigris	Endangered	[69]
Platanista gangetica	Endangered	[69]

ISSN: 2347-7431
EPRA International Journal of Climate and Resource Economic Review
-Peer Reviewed Journal
Volume: 10 | Issue: 3 | April 2022 || SJIF Impact Factor : 7.254 || Journal DOI: 10.36713/epra1213

MAJOR THREAT TO MANGROVES:- CLIMATE CHANGES

The ongoing global climate change is recognized as a great threat to natural habitats and ravage species survival [16]. Worldwide researchers investigate the ecological and hydrological impacts resulting from the ongoing climate change in several important habitats. Especially climate change will significantly alter many of the world's coastal wetland habitats [17]. Considering the global importance, coastal marine environments are a major focus of concern regarding the potential impacts of present anthropogenic climate change [18]. It was predicted that the ongoing global climate change is expected to intensively alter the air and water temperatures, ocean and atmosphere circulation, sea-level rise, the intensity and incidence of hurricanes and then timing, frequency and magnitude of precipitation. In natural conditions, coastal wetlands have the ability to adjust the rising seas and changes in local storm patterns, but unfortunately combination of climate changes and human activities jointly alter natural conditions and disrupt coastal wetland hydrology, biogeochemical cycling and other processes.

It was established that various extreme climatic events can significantly affect most of the wetlands species (e.g. Plankton, Benthic animals), which also can significantly affect the demographic rates in the given year and the productivity of the wetland. But unfortunately limited studies related to mangroves are available and especially there are no case studies in India. To support this, a recent international conference on climate change and sustainable agriculture held in the Indian capital concluded that there are no conclusive studies in India on the prospective impact of climate change on several fronts including coastal habitats and admitted that the knowledge and understanding of implications of climate change at the national level is inadequate and fragmentary or still in its infancy. So, the foregoing review is highlighting the impacts of extreme climate on Indian coastal system. It is needless to state that mangroves are one among the coastal systems and the numbers of problem which affect the coastal system are applicable to mangroves also.

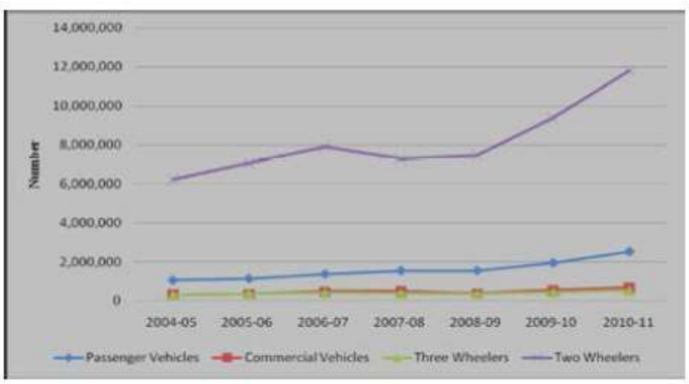

Fig. 4: The growth of automobile industry in India between 2004 and 2011. Source (SIAM 2011).

- **Increasing CO_2**

Climate change events are accelerated mainly due to the dumping of green house gases such as CO, CO_2 and CH_4. Especially elevated level of CO_2 together with other green house gases result in global mean temperature rise and which will yet again result in a cascade of physical and chemical changes in marine systems. The atmospheric concentration of CO_2 has increased 35% from a pre-industrial level from 280 parts per million by volume (ppmv) in 1880 to 379 ppmv in 2005 and it is expected to rise further. Moreover, it was reported that roughly half of the CO_2 released by human activities between 1800 and 1994 is now stored in the ocean. The continuous entry of atmospheric CO_2 is expected to substantially decrease marine pH expected to change the saturation horizons of aragonite, calcite and other minerals essential to calcifying organisms [19]. It was found that for some mangrove species, the response to elevated level of CO2 may be sufficient to induce substantial change of vegetation along natural salinity and aridity gradients [20]. However, the impact of more CO2 on mangroves is poorly understood and there is a less understanding in this area till date in India. On the other hand the annual automobile sales trend in India gets increasing in an alarming way; Fig. 4) which will further increase the anthropogenic gases in the Indian environment. It is worth to mention here that India is the fifth largest crude oil consumer in the world during 2009-10 India's motor sprit consumption was estimated to 1, 28,18, 000 tones (Fig. 5).

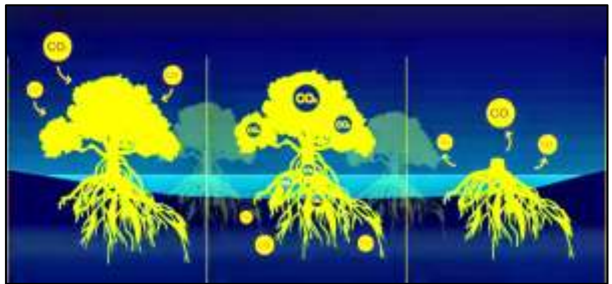

Fig 5- Carbon Dynamics in Mangroves

- **Increasing Temperature**

Increasing CO level in the atmosphere resulted in increasing global mean temperature. Between 1906 and 2005, the global average surface temperature has increased by 0.74°C (±0.18 °C) and it is further expected to increase 1.1-6.4°C at the end of this century. Several studies emphasize the negative impacts of rising temperature on species. The increasing temperature not only affects the biodiversity but also devastates the entire system. For instance, as a result of warming seawater, the world oceans are expanding, which coupled with freshwater input from 'ice-melt' and thermal expansion of the oceans is causing sea level to raise both at regional and global scale [21]. This will strongly affect mangrove forest.

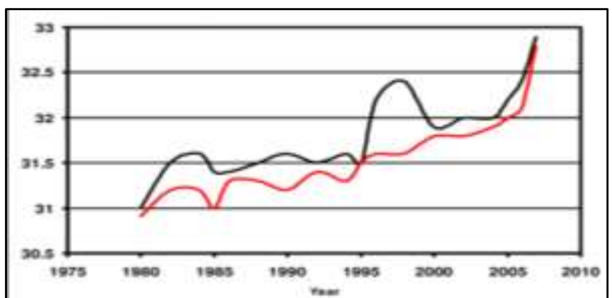

Fig 6- Increasing temperature in Western(red) & Central(black) Indian

Furthermore it is stated that increasing temperature affects physiological processes ranging from protein damage to membrane fluidity to organ function. Especially the marine organisms are highly prone to increasing temperature, because many coastal organisms already live close to their thermal tolerances.

- **Sea Level Rise**

Global sea-level rise is one of the more certain outcomes of global warming, it is already taking place (12-22 cm occurred during the 20th century). The most obvious consequence of sea level rise will be an upward shift in species distributions. For example, intertidal habitat area may be reduced by 20-70% over the next 100 years in ecologically important zones [22]. Climate modeling clearly pointed out that larger changes in sea level have led to mangrove ecosystem collapse. In the future, landward migration of fringing mangrove species, such as *Rhizospora mangle*, will likely be limited due to coastal development and associated anthropogenic barriers . So sea level rise will be the greatest threat to Indian mangroves.

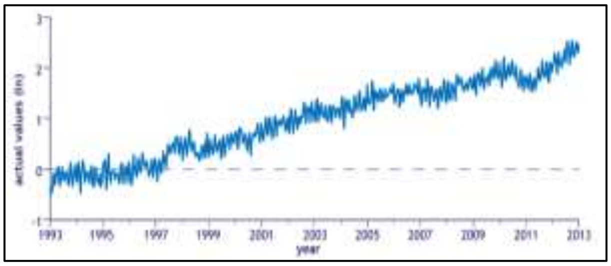

Fig 7- Sea Level rise since

- **Poor Rain Fall**

Globally, rainfall is predicted to increase by about 25% by 2050 in response to climate change. However, the regional distribution of rainfall will be the uneven. A recent assessment of IPCC highlights the significant increase of precipitation in parts of Central Asia and poor in parts of Southern Asia for the forthcoming years [23].

Naturally the poor rainfall and increased evaporation will lead to the rise in salinity in mangroves. For the impacts of salinity on mangroves and decreasing net primary productivity of mangroves, growth and seedling survival, altering competition between mangrove species, is decreasing the diversity of mangrove zones and causing a notable reduction in mangrove area which is due to the conversion of upper tidal zones to hyper saline flats [24].

Fig 8- Mangroves- surviving in "the hursh space the between the tides"

IMPLICATIONS OF LOSS OF MANGROVES

Exposure to cyclones, hurricanes and sea water intrusion

A healthy mangrove forest can also prevent salt water intrusion preventing damage of freshwater ecosystems and agricultural areas. Mangrove forests reduce the fury of cyclonic storms and gales and minimize the effect of the rising of sea level due to global warming. The physical stability of mangroves helps to prevent shoreline erosion, shielding inland areas from severe damage during hurricanes. The roots of mangrove trees are physically very strongly attached to the substratum and supports against the ocean's wave and tide. The roots of mangrove trees are physically very strongly attached to the substratum and supports against the ocean's wave and tide.

Fig 9- Mangroves reduce Stroms and effect of rising of sea level

Case of Field Report of Bankiput, a pristine golden sand sea beach, West Bengal, India

Bankiput is an unexplored virgin sea beach nearby Contai (Kanthi). The mangrove forest of Bankiput and the associated coast house the adequate diversity of Indian mangrove flora and fauna. Among Flora named Casuarina trees and Fauna named Red Crabs found under this Mangrove Biodiversity. They have measured the economic losses attributed to the 1999 super cyclone relative to the prevailing socioeconomic conditions of the study villages. The local people were aware of and appreciated the functions performed by the mangrove forests in protecting their lives and property from cyclones. But now a days due to Climate change and adverse atmosphere, mangroove forest lost their structure and composition, which result major threats to rural development. The case study revealed the connection between loss of mangroves due to climate change and threats to rural development of the area concerned.

***Field Study Pic 1* : - Report of Field Study in one side of Bankiput Mangrove Forests**

***Field Study Pic 2*- Among Flora named Casuarina trees found in Bankiput Mangrove Forest**

***Field Study Pic 3*- Among Fauna named**

***Field Study Pic4 :* - Report of Field Study in other side of Bankiput Mangrove Forests**

ISSN: 2347-7431
EPRA International Journal of Climate and Resource Economic Review
-Peer Reviewed Journal
Volume: 10 | Issue: 3 | April 2022 || SJIF Impact Factor : 7.254 || Journal DOI: 10.36713/epra1213

Carbon sequestration in mangroves and climate change

Carbon sequestration is the process through which plant life removes carbon dioxide from the atmosphere and stores it as biomass. Mangrove forests play a major role in carbon cycle in removing CO2 from the atmosphere and storing it as carbon in plant materials. Loss of mangroves by clearing, conversion for aquaculture and other anthropogenic activities lead to changes in soil chemistry resulting in rapid emission rates of GHGs, especially CO2. Therefore, mangrove restoration could be a novel mitigation option against climate change.

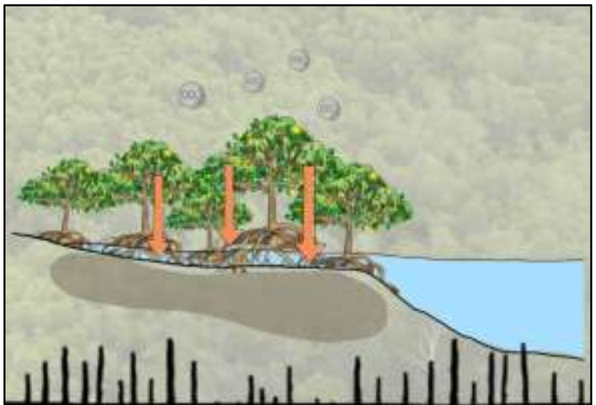

Fig 10- Mangroves play a role in Carbon Cycle in removing CO2

CONCLUSIONS

The ongoing climate change is a looming danger for the pivotal Indian coastal systems, especially the mangroves which are highly vulnerable to climate change. Adverse effects on mangroves extend its serious consequence to the adjoining fragile and important ecosystems such as coral reef and sea grass bed. It was reported that mangrove is the only marginal ecosystem which share the resources with the adjoining ecosystem. Moreover, the ecological and socioeconomic values offered by the mangroves are innumerable, immeasurable and incomparable. So conserving mangroves might be a vital agenda in any nation's conservation programs. Practically conserving the mangroves from ongoing climate change is not an easy task and on the other hand it is high time to adopt a road map to minimize the damages.

REFERENCES

1. *Easterling, D.R. et al. Climate extremes: observations, modelling and impacts. Science 289: 2068 (2000).*
2. *Sachs, J. & Malaney, P. The economic and social burden of malaria. Nature 415: 680–686 (2002).*
3. *World Health Organization (WHO). El Niño and its health impacts. Weekly Epidemiological Record 20: 148–152 (1998b).*
4. *Bouma, M.J. & van der Kaay, H.J. Epidemic malaria in India's Thar Desert. Lancet 373: 132–133 (1995).*
5. *Gill, C.A. The relationship of malaria and rainfall. Indian Journal of Medical Research 7(3): 618–632 (1920).*
6. *Bouma, M.J. & Dye, C. Cycles of malaria associated with El Niño in Venezuela. Journal of the American Medical Association 278: 1772–1774 (1997).*
7. *Diaz, H.F. et al. Climate and human health linkages on multiple timescales. Climate and climatic impacts through the last 1000 years. Jones, P.D. et al. Cambridge, UK, Cambridge University Press 2000.*
8. *Cedeno, J.E. Rainfall and flooding in the Guayas river basin and its effects on the incidence of malaria 1982–1985. Disasters 10(2): 107–111 (1986).*
9. *Russac, P.A. Epidemiological surveillance: malaria epidemic following the Niño phenomenon. Disasters 10(2): 112–117 (1986).*
10. *Poveda, G. et al. Climate and ENSO variability associated to malaria and dengue fever in Colombia. In: El Niño and the Southern Oscillation, multiscale variability and global and regional impacts. Diaz, H.F. & Markgraf, F. Cambridge, UK, Cambridge University Press: pp. 183–204 2000.*
11. *Poveda, G. et al. Coupling between annual and ENSO timescales in the malaria climate association on Colombia. Environmental Health Perspectives 109(5): 307–324 (2001).*

12. *Gagnon, A. et al. The El Niño Southern Oscillation and malaria epidemics in South America. International Journal of Biometeorology 46: 81–89 (2002).*
13. *Brown, V. et al. Epidemic of malaria in north-eastern Kenya. Lancet 352: 1356–1357 (1998).*
14. *Lindblade, K.A. et al. Highland malaria in Uganda: prospective analysis of an epidemic associated with El Niño. Transactions of the Royal Society of Tropical Medicine and Hygiene 93: 480–487 (1999).*
15. *Allan, R. et al. MERLIN and malaria epidemic in north-east Kenya. Lancet 351: 1966–1967 (1998).*
16. *Mouchet, J. et al. Evolution of malaria in Africa for the past 40 years: impact of climatic and human factors. Journal of the American Mosquito Control Association 14: 121–130 (1998).*
17. *Hay, S.I. et al. Etiology of interepidemic periods of mosquito-borne disease. Proceedings of the National Academy of Sciences 97(16): 9335–9339 (2000).*
18. *Hay, S.I. et al. Climate change and the resurgence of malaria in the East African highlands. Nature 415: 905–909 (2002).*
19. *Gubler, D.J. Dengue and dengue hemorrhagic fever: its history and resurgence as a global public health problem. In: Dengue and dengue hemorrhagic fever. Gubler, D.J. & Kuno, G. New York, USA, CAB International: 1–22 1997.*
20. *Rodriguez-Moran, P. et al. Hantavirus infection in the Four Corners region of USA in 1998. Lancet 352: 1353–1353 (1998).*
21. *Engelthaler, D.M. et al. Climatic and environmental patterns associated with hantavirus pulmonary syndrome, Four Corners region, United States. Emerging Infectious Diseases 5: 87–94 (1999).*
22. *Atherton, F. et al. An outbreak of waterborne cryptosporidiosis associated witha public water supply in the UK. Epidemiology and Infection 115: 123–131 (1995).*
23. *Curriero, F. et al.The association between extreme precipitation and waterborne disease outbreaks in the United States, 1948–1994. American Journal of Public Health 91(8): 1194–1199 (2001).*
24. *Schwartz, J. & Levin, R. Drinking water turbidity and health. Epidemiology 10: 86–89 (1999).*