CONTENTS

Management of an Ecosystem at risk: the tropical dry deciduous Anogeissus pendula forest ecosystem, Ranthambore National Park, India ................... 3
  Biophysical Interactions of the ecosystem .................................................. 3
  Traditional management practices ............................................................... 4
  Contemporary management of the forest ecosystem in Ranthambore ............ 4
  Evaluation of contemporary management strategies ...................................... 5

Climate change and population health ......................................................... 9
  Climate Change ......................................................................................... 9
  How will climate change impact upon our health? ...................................... 9
  Climate Change and Human Vulnerability ............................................... 11
  Conclusion ............................................................................................... 12
MANAGEMENT OF AN ECOSYSTEM AT RISK:
the tropical dry deciduous Anogeissus pendula forest ecosystem, Ranthambore National Park, India

Anne Holland, Assistant Head of Geography Department, Canberra Grammar School

The tropical dry deciduous Anogeissus pendula forest ecosystem of the Aravali and Vindhyan hill ranges in Ranthambore National Park (RNP), India is located at 26°01’N and 76°30’E in the Sawai Madhopur district of SE Rajasthan, 130 km south-east from Jaipur (see Figure 1). Until the mid-1920s, dry deciduous forest covered an extensive area of Ranthambore, but as the population density of the area increased, large areas of the ecosystem became degraded and fragmented. RNP (with an area of 392 km²), is the largest single area of this ecosystem remaining in India and is critical habitat for the endangered Indian/Bengal tiger.

Current management of the ecosystem has to balance a number of conflicting objectives: preserving the ecosystem to support a viable tiger population, accommodating a growing wildlife tourism industry based on game drives to sight tiger, and meeting the social and economic needs of the low income indigenous population who traditionally rely on the forest resources.

Biophysical Interactions of the ecosystem

The climate of the ecosystem is a subtropical dry climate (Köppen classification Cwg, Monsoon type with dry winters). The climate has 3 seasons: summer (March to June), winter (October to March) and the monsoon (July to September). As shown in Figure 3, the mean monthly temperatures range from 41°C in May to 21°C in January; however, in winter, temperatures can fall to 2°C at night. The annual precipitation (800mm) falls on just 37 days per year with 85% of this occurring during the monsoon season.

Figure 1: The location of Ranthambore National Park, Rajasthan state, India. (PlaneMad (2008) modified by A Holland 28 January 2018)

The dry deciduous forest ecosystem is dominated by the Dhok tree (Anogeissus pendulus). The Dhak tree or Flame of forest (Butea monosperma) is also common within the ecosystem and shrubby undergrowth of Grewia flavescens (seyal) and Caparice sepiaria (jal) grows on the forest floor. There are more than 300 species of plants in the ecosystem, (see Figure 2).

Figure 2: Tropical dry deciduous Anogeissus pendula forest. Image: author’s own (January 2018)

In this semi-arid climate, there are marked seasonal variations in the availability of water and many streams are temporary. Many of the plant and animal species, including the Dhok tree, are tolerant of drought and the forest ecosystem helps to maintain groundwater reserves, which are an important source of water in the region. Even so, this is an important water catchment area for the River Chambal, (a tributary of the River Ganges) which flows to the east of the RNP.

The relief of the area is highly undulating and rocky and dominated by the Aravali and Vindhyan hill ranges with an altitude approximately 300-500m above MSL. The ranges are separated by the Great Boundary Fault which crosses the park in an ENE-WSW direction. The Aravali hills to the northwest of the fault have sharp ridges and conical hill tops, whereas the Vindhyan hills to the southwest form extensive plateaus (dangs) with deep narrow gorges (khohs) eroded by temporary streams. The variation in terrain, and associated changes in climate and soil, give rise to several vegetation associations within the ecosystem. Anogeissus pendula forest favours the gentle slopes and valleys, where the soil is deeper, more fertile and moist. On the gentle slopes, the canopy cover may be 60% at a height of 10-15m whereas in the valleys, with temporary water courses and a cooler more humid climate, the forests have dense undergrowth and include evergreen plants. The steep slopes and plateau areas have soil that is rocky and shallow and here the growth of trees and shrubs is sparse and stunted; however, during the monsoon season on the plateau areas, there is seasonal growth of grasses, herbs and shrubs.

The variety of plant associations within the ecosystem contributes to a rich biodiversity. The dry deciduous forest ecosystem provides a habitat and food source for more than 40 species of mammals including the Indian or Bengal tiger (see Figure 4), leopard, Sloth bear, Spotted deer, Blue bull and Wild boar. There are also 40 species of reptiles, and 320 species of birds. The distribution of wildlife within the ecosystem is influenced by the spatial and temporal variations of vegetation and climate. The dry deciduous forest of the gentle slopes and valleys has the highest biomass production and attracts a rich variety of wildlife. The valleys are particularly attractive to wildlife as they provide important corridors for movement and during the hot, dry summer season they remain cool and moist. On the plateau areas, biomass production is low for most of the year, but during the monsoon the seasonal growth of grass attracts ungulates (such as the Spotted deer and Blue Bull) and their predators to the area.

Traditional management practices

Traditionally, the forests of Ranthambore were used as private hunting reserves by the Maharajas of Jaipur and Karauli and managed by the Shikar Khana Department (Hunting Department) of the state. Some commercial felling occurred (mainly for firewood and charcoal) under the system of royalty permits, and indigenous tribes could use the forest resources on payment of an annual tax. These forest resources included timber for tools, transport and fuel, leaves for fodder, and gum which was used in medicines, food, drink, and cultural rituals.

The human impact on the forest ecosystem was negligible while the population density remained low. However, by the mid-1920s, human-induced modification of the ecosystem had increased as a result of population growth. The forest became degraded and fragmented which increased the vulnerability of the ecosystem. Although Anogeissus pendula has a high potential to regenerate following disturbance, the density of most other woody plant species decreases and as a result the forest ecosystem degrades into dry scrub and dry grassland with a reduced carrying capacity for wildlife. Fragmentation of the ecosystem, through forest clearance, also isolates populations and reduces their genetic diversity. The areas of habitat that remain are often insufficient for the territorial needs of the larger mammals such as the tiger. By 1947, tigers had become locally extinct in most of the forests of Rajasthan and the need to conserve the critical tiger habitat of the dry deciduous forest ecosystem in Ranthambore was recognised.

Contemporary management of the forest ecosystem in Ranthambore

In 1955, the area of dry deciduous forest in Ranthambore became part of the Sawai Madhopur wildlife sanctuary. This provided the ecosystem with protection against hunting of wildlife, clearing of land for agriculture and commercial sale of forestry produce. However, as the local people were still allowed to occupy the area and
small scale collection of forest produce was permitted, there were human stresses on the ecosystem.

In 1973, following further loss of tiger habitat and the continued decline of the tiger population, the Government of India and the World Wildlife Fund (WWF) initiated Project Tiger, which is still operational today. The objective of Project Tiger is to maintain a viable tiger population in India for scientific, economic, aesthetic, cultural and ecological reasons. Initially, nine areas of critical tiger habitat were designated as tiger reserves including the Ranthambore Tiger Reserve (RTR), centred on the dry deciduous Anogeissus pendula forest in Sawai Madhopur wildlife sanctuary. RTR has an area of 1334 km² and is now one of 50 Tiger reserves within India.

A key management strategy of each tiger reserve is the designation of core and buffer areas within the reserve. The ecosystem of the core area is critical habitat for the tiger and the objective of its management is to preserve this habitat and minimise human impact; the core area is usually legislated as a national park or wildlife sanctuary and in 1980 the core area of RTR was designated as Ranthambore National Park (RNP). Buffer areas surround the core and provide a layer of protection against human disturbance to this area of critical habitat. In the buffer areas the ecosystem is managed both for the protection of wildlife and the subsistence needs of the local population; major changes in land use, such as mining are, however, prohibited. In the buffer area of RTR, the critical habitat of the core area is linked to the Keladevi and Sawai Mansingh wildlife sanctuaries by corridors of tiger habitat; these facilitate the migration of wildlife so essential for maintaining genetic diversity which contributes to the resilience of an ecosystem.

In RTR, human stresses arising from wildlife tourism in the core and buffer areas also need to be managed. RTR is a major ecotourism attraction worth over AUS775 000 per year (Scroll.in, 2016). The reserve is famous for its flagship species and the heritage ruins that occur within the reserve, (see Figure 5). Tourists can take guided game drives along a network of forest tracks within the reserve in 20 seater Canter light trucks or 6 seater Jeeps. Disturbance to the ecosystem is managed by regulating vehicle access over time and space. The reserve is only open to game drives from October to June and is closed to visitors during the monsoon and tiger mating season. Vehicles can only access 20% of the core area and the number of vehicles in any one area of the reserve is controlled by randomly allocating each vehicle to one of 10 zones within the reserve. Until 2016, game drives were limited to sessions of 3 hours at dawn and dusk, but in 2016, half day or full day safaris were introduced which allow tourists to travel between the zones to maximize their chances of seeing tiger.

Evaluation of contemporary management strategies

There are conflicts arising from the objectives of managing the RTR for both wildlife protection and wildlife tourism. The growth of wildlife tourism has averaged 15% per year (Karanth Krithi, 2012) and 125,000 tourists visited RTR in 2010-11 (India Today, 2012). The movement of vehicles disturbs the wildlife, interferes with their movements and erodes the forest tracks. The area permitted to be visited by vehicles on game drives has increased over time from 5 to 10 zones. Although the number of vehicles allowed in each zone of the park is controlled, this is not always adhered to (Scroll.in, 2016). Sighting of a tiger results in vehicles crowding around the animal or water holes that may be visited by the animal, potentially altering behavior (see Figure 6). The recent change to half-day and full-day safaris although popular with tourists has resulted in movement of vehicles throughout the day and has increased the potential for crowding when a tiger is sighted.

In terms of increasing the tiger population, the RTR has seen success. By the mid to late 1980s, the tiger population of RTR had increased such that the reserve
was the best place in the world to sight wild tigers. As new zones were opened up to game drives, and local villagers were prevented from using the forest resources, the tigers had opportunity to expand their territory. Today there are approximately 62 tigers in RNP which has one of the highest density of tigers in the world. However, this is now more than the carrying capacity of the reserve (The Times of India, 2017).

There are also conflicts arising from the objectives of protecting the critical tiger habitat and meeting the social and economic needs of the indigenous population. Following the designation of the RTR, the area of forest available to the increasing indigenous population has decreased. Residents of 12 of the 16 villages located in the Sawai Madhopur sanctuary were resettled outside of the protected area and access to forest resources was denied in zones designated for game drives. As a result, human stresses in the buffer area have increased affecting its ability to provide protection to the critical habitat of the core. These human stresses arise from:

- increased demand for agricultural land particularly in the ravines where land is flattened
- collection of timber for firewood, some of which is used in pottery manufacture in the villages
- intense grazing pressure
- removal of vegetation resulting in erosion of topsoil which silts up waterholes in the reserve
- spread of disease between livestock and the wildlife
- spread of invasive weeds by grazing sheep and goats. Prosopis juliflora was introduced for fuelwood and has affected approximately 8% of the reserve
- unregulated mining of boulders, limestone and sand e.g. along the Banas River, an important corridor for movement of wildlife
- poaching of wildlife which may result when migrating wildlife comes into conflict with human settlement e.g. where wildlife raid crops and livestock, the resident population may kill the wildlife to protect their livelihood. The Mogiyas who have traditionally relied on hunting and selling of bush meat, have limited alternative sources of income and continue to hunt wildlife when necessary. Poaching is less well patrolled in the buffer areas.

There are few alternative sources of livelihood for the indigenous population although some income and employment has become available through tourism and the introduction of women’s craft cooperatives. Economic and social development in the area has remained limited and it is the perception of many local people that this is a result of creating the reserve which benefits tourists more than the needs of the local population. Protecting the ecosystem in the reserve has resulted in restricted development of infrastructure and industry, restricted access to forest resources and loss of earnings when wildlife raids nearby crops and livestock. Restrictions have also been placed on local people visiting religious sites inside the reserve (The Ranthambhore Bagh, 2011). In 2002, the local people invaded the park with their animals to protest against the lack of fodder and water for the cattle outside of RNP (Aline, 2004).

Successful management of the dry deciduous Anogeissus pendula forest ecosystem in Ranthambore National Park relies on balancing the requirements to protect critical tiger habitat, managing wildlife tourism in the park and providing for the sustainable development of the indigenous population who have traditionally relied on the resources provided by the ecosystem. Future management solutions may include the introduction of alternative energy options to the use of fuelwood, removing invasive plant species, monitoring and managing potential sources of human-wildlife conflict, and continuing to provide alternative source of livelihood. Community engagement of the local population, as well as seasonal grazers from other areas, is essential to the conservation and restoration of critical ecosystems at risk in the core and buffer areas.
Student Activities:

1. Describe the spatial patterns and dimensions of the tropical dry deciduous Anogeissus pendula forest at Ranthambore.
2. Discuss the biophysical interactions in the tropical dry deciduous Anogeissus pendula forest ecosystem at Ranthambore.
3. Outline the factors that affect the vulnerability of the tropical dry deciduous forest ecosystem in Ranthambore National Park.
4. With reference to the tropical dry deciduous Anogeissus pendula forest in Ranthambore discuss the statement ‘ecosystems at risk may be both vulnerable and resilient to change’.
5. Outline the importance of ecosystem management and protection at Ranthambore.
6. Explain why the aims of a national park are conflicting.
7. To what extent have contemporary management strategies for the RTR been successful in protecting the dry deciduous forest ecosystem from human stresses resulting from wildlife tourism?
8. Discuss the importance of local community involvement in conserving an ecosystem at risk.
9. Compare and contrast the success of tiger reserves within India.

References and further reading


Anon., 2018. Tigers footprint are increasing at Safari Zone 6 to 10 in Ranthambore. [Online] Available at: http://www.ranthamborenationalpark.in/blog/tigers-footprint-increasing-safari-zone-6-to-10-


Available at: https://upload.wikimedia.org/wikipedia/commons/thumb/e/eb/India_Rajasthan_locator_map.svg/2000px-India_Rajasthan_locator_map.svg.png [Accessed 28 January 2018].


It is generally accepted that climate change will have important consequences for the health and wellbeing of our world’s population. In 2017 the World Bank stated that climate change was a risk multiplier, which threatened to unravel decades of development gains throughout the world. From heat waves to food insecurity resulting from droughts, from a possible resurgence of vector-borne infections, the range of potential health issues sensitive to climate change is enormous.

The links between human health and climate are not new. Human health has always been influenced by climate and weather. Hippocrates in the 5th century BC remarked on the fact that the distribution of many diseases were closely linked to changes in temperature or season. Some years later Aristotle wrote a major study of the links between weather and human health, which remained a standard text for centuries. Today, “feeling under the weather” has become an accepted and common expression hinting at the close relationship that exists between weather patterns and our health and wellbeing. There is little doubt that many fundamental body processes seem to be linked to changes in the weather, for example during the passage of a cold front when air pressure and temperatures fall. Just before a cold front, blood-clotting time changes markedly joint mobility decreases and our blood pressure rises. As temperatures fall, our blood vessels dilate and nerve endings cease to conduct sensations. As a cold front passes, blood volume decreases (the converse is true during heat stress) and after a steep barometric fall, white blood cells increase. It is also true that some weather patterns are closely linked to asthma attacks, arthritis, stroke and heart attacks.

Climate Change

Climate change is not new. It has been a feature of our planet’s history and there are examples of cooling followed by warming temperatures. Prior to the Industrial Revolution all this was triggered by the earth’s natural system. Today, we are in another phase of global warming, this time triggered by human behaviour through the release of greenhouse gases such as carbon dioxide into the atmosphere, mainly from fossil fuel combustion and the burning of forestland. Over the last 150 years or so, global concentrations of carbon dioxide, methane and nitrous oxide have all increased substantially. These emitted gases have a long lifespan and cause major global warming. The Intergovernmental Panel on Climate Change (IPCC) noted in 2013 that the previous three decades had been warmer at the earth’s surface than in any preceding decade since 1850 (5th IPCC Assessment Report, 2013). But the fact remains that predicting what might happen in the future is difficult because of the dynamics of our biophysical environment and the vagaries of human behaviour.

How will climate change impact upon our health?

The effects of climate change on our health will be both direct and indirect. Direct effects will include heat stress due to warming temperatures as well as the impact of extreme weather events. Indirect effects will involve the impact that climate and weather patterns may have on the lifecycle and distribution of disease vectors such as mosquitoes, fleas and ticks as well as aeroallergens such as fungal spores, pollens and dust mites.

There is evidence that climate change will impact on our health and wellbeing in the following ways.

1. Climate change will increase the likelihood of extreme climate events, particularly high temperatures, heat waves, droughts, hurricanes and floods with considerable implications for our health especially for older people and those dependent upon a daily routine of medication.

2. Climate change may influence the life cycle and geographical distribution of a number of vector-borne diseases.

3. Climate change will increase the production and geographic distribution of aero-allergens such as pollens with considerable implications for people suffering from respiratory diseases such as asthma.

4. Climate change will also impact upon food security around the world.

5. Climate change will play an important role in helping determine human migration and displacement.
1. Extreme Weather Events

The relationship between climate change and human health is perhaps best seen with reference to temperature extremes. In Australia, mortality is higher during the winter months and hot summers, and low during mild winters and cool summers. Global warming will have mixed outcomes with fewer deaths from exposure to cold temperatures but more deaths due to high temperatures. These outcomes will vary across the world. Urban populations will be particularly at risk due to what is called the urban heat island effect. As well as frequent and intense heatwaves, climate change will also produce other extreme weather events such as hurricanes, cyclones, floods, droughts; these are likely to result in deaths and illnesses related to human exposure as well as food shortages and population displacement. Such events can also produce acute gastro-intestinal illness caused by water pollution and acute respiratory infections. Over the last three years two of the world’s major cities, Sao Paulo and Cape Town have suffered severe droughts where water availability and management has become critical with daily restrictions.

2. Climate Change and Vector-Borne Diseases

Increasing temperatures and changing rainfall patterns may also have important effects on the lifecycle and geographic distribution of vector-borne diseases such as Dengue, Malaria, Ross River Virus, Yellow Fever and Encephalitis. Vector-borne diseases are those transmitted by vectors such as mosquitoes, fleas and ticks. These vectors carry infective pathogens such as viruses and bacteria. Australia is no stranger to such diseases with Dengue, Ross River Virus and Barmah Forest Virus accounting for an important number of illnesses every year.

Table 1. Source: Australian Government Department of Health.

<table>
<thead>
<tr>
<th>Disease</th>
<th>2016</th>
<th>2017</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dengue</td>
<td>2237</td>
<td>1071</td>
</tr>
<tr>
<td>Ross River Virus</td>
<td>3735</td>
<td>6915</td>
</tr>
<tr>
<td>Barmah Forest Virus</td>
<td>329</td>
<td>448</td>
</tr>
<tr>
<td>Chikungunya Virus</td>
<td>114</td>
<td>98</td>
</tr>
</tbody>
</table>

As Table 1 shows, there is a long history of major Dengue epidemics in Queensland but which on occasions extends into New South Wales. The 1925-26 epidemic was by far the greatest mosquito-borne epidemic in Australian history resulting in more than 550,000 cases (Table 2).

Major Dengue outbreaks in Australia

<table>
<thead>
<tr>
<th>Year</th>
<th>Number of Cases</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>1897-98</td>
<td>40,000</td>
<td>Qld/ Nth NSW</td>
</tr>
<tr>
<td>1904-05</td>
<td>20,000</td>
<td>Qld/Nth NSW</td>
</tr>
<tr>
<td>1909-10</td>
<td>10,000</td>
<td>NW Australia</td>
</tr>
<tr>
<td>1925-26</td>
<td>560,000</td>
<td>Qld/NSW</td>
</tr>
<tr>
<td>1941-43</td>
<td>40,000</td>
<td>Nth Territory/ Qld</td>
</tr>
<tr>
<td>1953-55</td>
<td>20,000</td>
<td>Nth Qld</td>
</tr>
<tr>
<td>1992-93</td>
<td>25,000</td>
<td>Nth Qld</td>
</tr>
</tbody>
</table>

Table 2. Source: Author.

The geographical distribution, seasonality and prevalence of vector-borne diseases are influenced by climate factors such as high and low temperature extremes, rainfall and humidity. It is argued that climate change will increase the risk of vector-borne diseases like Dengue by allowing mosquitoes to breed more prolifically and colonise new parts of Australia. Predicting the effects of climate change is, however, not simple as vector-borne diseases are permanently maintained in nature in a complex relationship with zoonotic or animal hosts as well as influenced by human activity and behaviour.

3. Air Quality and Climate Change

Changes in climate affect air quality in a number of important ways. Firstly, climate change has modified weather patterns influencing the level and distribution of outdoor air pollutants. Secondly, increasing levels of carbon dioxide can also promote the growth of plants that release airborne allergens which can affect indoor and outdoor air quality.

Chronic respiratory diseases such as asthma, emphysema and chronic bronchitis remain important health issues throughout the world, including Australia. The prevalence of such diseases are closely linked to the biophysical environment, particularly climate and weather patterns as well as to human behaviour. Asthma in particular is among the most sensitive of human diseases to weather and climate although the relationship is far from simple and in many ways still poorly understood. Climate would seem to affect the human respiratory tract in a variety of ways including the effect of cold and dry air on human Airways. There are a broad series of seasonal effects that can influence our physiological and biochemical processes. Temperature and humidity can influence our Airways: rapid falls in temperature, low temperatures and cyclonic and frontal activity can directly affect respiratory sensitivity and stimulate Airways.

People suffering from asthma seem to be highly sensitive to such changes in temperature and humidity. A sudden...
Climate change is already having a detectable effect. Natural disasters continue to be an important instigator of human movement. As climate change increases the frequency of natural disasters, such as hurricanes, cyclones, floods and droughts, the outcome can impact upon people and force many to move or flee as they struggle to adapt to environmental change. Sea and river level rise can also produce a major hazard affecting agriculture and coastal populations threatening to render people homeless.

**Climate Change and Human Vulnerability**

While there is little doubt that our health and wellbeing will be influenced by climate change the real impact will depend upon the social, economic and geographic situation of the affected population. Human vulnerability to climate and weather is often heightened by poverty, marginality, human neglect, home and job location, oversight and mismanagement (Figure 2).

> Figure 2. Climate Change and Human Vulnerability

Prolonged exposure to heat waves and high temperatures which can cause a wave of illness and premature death, particularly among the elderly, is a case in point. Like excessively cold temperatures, susceptibility to high temperatures and heat waves conditions are closely related to human vulnerability, particularly to such things as old age, disability, social marginality and depressed living conditions. The severe heat wave which affected Western Europe in 2003 is a good example; more than 70,000 people died as a result in France, Spain and Italy. Most of those who died were elderly, either living alone and/or living in poorly funded, overcrowded and under-staffed rest homes. Australia’s current health and demographic situation will make a large proportion of people increasingly vulnerable to any change in the physical environment. Australia’s population is rapidly ageing. Today approximately 3.7 million Australians are aged over 65, 15% of the total population, and it is projected that by 2046 there will be more than seven million Australians or 22% of the population aged over 65 years. The fastest growing sector of the population over the next 25 years will be the old old. Today, 1.7 million Australians are aged over 90.
75; within 25 years this number will increase to more than three million. Levels of chronic illness and disability are currently high in Australia particularly among the elderly and are likely to substantially increase over the next few decades; 87 percent of all Australians aged over 65 suffer from some form of chronic condition the majority from asthma, arthritis, hypertension, diabetes and circulatory disease, while more than four million or one in five Australians suffer from some form of disability. It is a sobering thought that Australia’s current and future demographic situation will make a large proportion of the population more vulnerable to the impacts of climate change.

**Conclusion**

Climate change has the potential to affect many aspects of our health and wellbeing in many ways that are not direct but complex and synergistic. The ultimate outcome will depend upon a variety of factors including the rate of environmental change and the increasing vulnerability of sectors of the population. There is strong evidence of our increasing vulnerability to climate change. This is closely linked to a variety of social, economic and demographic factors the most important of which is age, living longer and putting up with disability, chronic illness and social marginality. Other trends will also contribute to our vulnerability to climate change. In particular the resurgence of infectious disease, the importance of vector-borne infections and increasing environmental degradation will all play a part.

**Student Activities:**

1. Explain the meaning of the term ‘risk multiplier’; support your answer with examples from the article.
2. Read the following webpage [http://ar5-syr.ipcc.ch/topic_futurechanges.php](http://ar5-syr.ipcc.ch/topic_futurechanges.php)
   a) Outline the current projections of how climate might change in the future.
   b) Suggest reasons why there is uncertainty regarding the changes that might occur to the climate.
3. Using the information in the article, outline the impact of the passage of a cold front on human health.
   b) Suggest adaptation strategies that individuals or societies could apply to address the impact of heat stress on human health.
   c) Choose ONE adaptation strategy to evaluate. You should consider social, economic and environmental factors in your analysis.
5. Draw a concept map to show the direct and indirect effects of climate change on human health that are outlined in this article.
6. Explain the link between climate change and human displacement and migration.
7. The impact of climate change on human health and wellbeing is closely linked to a variety of social, economic and demographic factors. Using your own knowledge and information from the article:
   a) Create a table of these factors.
   b) Choose one factor and outline how it influences vulnerability to climate change.
8. Investigate the predicted impact that climate change will have on the region of Australia where you live.
References:


Curson, Peter, Guest, Charles and Jackson, E., (Editors), Climate Change and human health in the Asia-Pacific region, Australian Medical Association/Greenpeace International 1997.


WHO, Climate Change and human health. www.who.int/globalchange/en/