

The impact of climate change on horses, and horse industries

Some gaps and opportunities identified using available literature



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Overview

This literature summary was funded by RIRDC through the “Climate Change for Horse Owners” research project, managed by HorseSA. It is a step toward understanding the impact of climate change on horses and horse industries. Funding was provided for three days including desktop research using the web of science, cab extracts and Google scholar as well as general web searches. In the time available for the searches we found 40 papers that related to the impact of climate change and horses in Australia.

The literature search found information relating to the following topics; land management, pasture production, weeds, pests, breeding and fertility, horse health including arboviruses and wildlife borne diseases, bacterial infection and heart disease. We also found other topics likely to effect horses and industries include event management, track maintenance and the carbon farming scheme.

The next steps are to expand upon the gaps in knowledge and prioritise research and collaborative industry programs that work toward adaptation to climate changes for horses and horse industries as well as supporting the horse owners and industry to mitigate climate change.

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1. Climate change projections

The following projections are from the International Panel on Climate change 4th assessment report. There have been many downscaled projections for various regions in Australia and could be sourced for local concerns such as insect outbreaks spreading disease. However these are the broad projections likely to impact on horses and industries in Australia.

1a. Temperature

Australian average temperatures are projected to rise by 0.6 to 1.5 °C by 2030, 0 to 5.0 °C by 2070 and when compared with the climate of 1980 to 1999.

1b. Rainfall

Wet years are likely to become less frequent and dry years more frequent. In particular, drying is expected over southern and eastern areas in winter and eastern areas can expect further drying in spring. The direction of projected changes to average rainfall over northern Australia is unclear.

1c. Extreme events

Long term average temperature increased will be experienced through an increase in the number of hot days (heat waves) and warm nights, and a decline in cool days and cold nights. Projections suggest that it is likely (with more than 66 per cent probability) that there will be fewer tropical cyclones in the Australian region, on average, but the proportion of intense cyclones is expected to increase. Droughts are expected to become more frequent in southern Australia; however, periods of heavy rainfall are still likely to occur. Economic damage from extreme weather is very likely to increase and provide major challenges for adaptation (IPPC 4th assessment report).

2. Breeding and Fertility

2a. Fertility

Heat stress already affects livestock in many Australian regions, reducing production and reproductive performance and enhancing mortality. Increased thermal stress on animals is very likely (Howden et al., 1999a). Mares grazing pasture have been shown to begin ovulating sooner than those being fed hay (Carnevale 1997). However, reduced rainfall may decrease pasture growth with resulting adverse effects on breeding activities (Knight and Muscatello 2006). Warmer temperatures in general are suggested to enhance fertility but may also be counteracted by extreme weather stressors and potential limitations on feed and water. The impact upon breeding may be further compounded in the Thoroughbred industry by the tightly regulated breeding seasons. (Muscatello and Knight, 2006).

2b. Breeding

As noted above, warming may also impact on breeding. Positive effects may accrue from increases in average temperature. Guerin and Wang (1994) identified a significant negative correlation between the mean minimum weekly temperature and the time of first ovulation in mares on a stud at latitude 35° South, with a tendency towards a positive correlation with the mean weekly maximum temperature. From their results they calculated that a theoretical increase of 1°C in the mean minimum temperature would advance the mean ovulation date by 9 days.

Zeller (2000) found that the average number of days from parturition to the onset of the first post-partum oestrus was significantly longer in colder years, and was significantly longer in colder months. It was also shown to be related to the average air moisture after birth. These changes may ultimately require an adjustment in the timing of breeding seasons. An increase in the average temperature in warmer climates may increase heat stress in stabled horses. These observations may also apply to horses that are being transported. It is possible that the effects of climate change may render existing infrastructure unsuitable in the future, and this potential impact should be considered.

Progressionary Caterpillar outbreaks

Studies, field trials, tests & investigations revealed that Progressionary Caterpillar outbreaks cause abortions in horses. Ingestion of as little as 1g of the nest or outer shell of the progressionary hairy caterpillar causes pregnant mares to abort within day. The progressionary caterpillar is an Australian native and found in acacias and eucalypts across the country therefore wherever the caterpillar exists, there is the potential for abortions (RIRDC publishing, 2005).

Research opportunities /Gaps:

There are other papers available on this.

In combination with water, and only to a certain degree?

3. Land Management

Climatic changes are likely to increase major land-degradation problems such as erosion and salinisation.

3a. Pasture production

Pasture production is projected to decline by 2030 over much of southern and eastern Australia. However recent research funded by Department of Agriculture WA showed that pasture production will be effected differently by climate change around Australia. Temperature and Carbon Dioxide increases are mostly positive for pasture production, and rainfall changes will have more significant impacts in lower rainfall areas. Doubled CO₂ concentrations and warming are likely to result in only limited changes in the distributions of native C₃ and C₄ grasses (Howden et al., 1999b).

A 20% reduction in rainfall is likely to reduce pasture productivity by an average of 15%. However in Tasmania for example temperature pasture production is likely to increase (DAFWA, 2012).

Please see the Power Point presentation by Melissa Rebbeck on this on the Horse SA website for much more detailed information.

3b. Weeds

Climate change is likely to increase the potential distribution and abundance of exotic weeds, e.g., *Acacia nilotica* and *Cryptostegia grandiflora* (Kriticos et al., 2003a, b) and native woody species, e.g., *A. aneura* (Moore et al., 2001). However, the same CO₂ and climate changes are likely to provide increased opportunities for woody weed control through increased burning opportunities (Howden et al., 2001b).

3c. Pests

A warming of 2.5°C is likely to lead to a 15 to 60% reduction in rabbit populations in some areas via the impact on biological control agents, e.g., myxomatosis and rabbit haemorrhagic disease virus (Scanlan et al., 2006).

4. Horse Health

4a. Horse Disease

There are a number of diseases that impact upon horses. The literature suggests increased risk of the some diseases due to climate change. Climate change may impact on livestock diseases through its effect on a number of factors including the range and abundance of vectors and wildlife reservoirs, survival of pathogens in the environment, and farming practice. These factors may interact with each other and also with social and anthropogenic changes, including habitat destruction and changes in land use, which occur both globally and locally, and increased mobility of people and movement of goods including livestock (Gale et al, 2009)

An increased incidence of neurological disease in horses has been reported across a number of Australian states in 2011. Heavy summer rainfall and flooding across Queensland, New South Wales, Victoria and South Australia have increased mosquito activity and the neurological signs in horses have been linked to mosquito-borne diseases known as 'arboviruses'.

Affected horses have shown varying signs, such as muscle and joint soreness, stiff gait, depression, incoordination and tremors. Most horses have recovered with supportive care. Some of the more severely affected horses have been euthanized on animal welfare grounds. (DAFWA fact sheet, 2012).

Arboviruses

Many diseases are spread by biting insects that prefer warmer and wetter conditions. Recent climate events that have caused the spread of biting insects include flooding in Northern Australia, these insects and wet conditions are spread into Southern Australia where they are not typically found or originate. Moreover, new diseases such as bluetongue are also emerging at a greater rate since temperature has been on a sharp rise over the last 30 years (Summers, 2009).

However, decreases in the transmission of some vector-borne disease may also occur if climatic change results in an environment in previously endemic areas that becomes unsuitable for vectors. Arboviruses are insect-borne viruses transmitted by *Culicoides* midges. (Once Arboviruses are translocated into new regions, subsequent virus dissemination requires that resident *Culicoides* are able to acquire and transmit the specific virus. Until better predictive models are available it would be unwise for any country with resident populations of *Culicoides* insects, regardless of current status for Arbovirus infection, to assume that one or more of these viruses could not emerge at some time in the future. Incursion can now be rapidly identified through appropriate surveillance utilizing sensitive and specific molecular diagnostic assays (MacLachlan et al, 2010) and Alan J. Guthrie²

It is important to consider climate change in combination with other factors. Host ecology, host behaviour and increased globalization including the transportation both of people and cargo containers are important (Gale et al, 2009).

African Horse Sickness

African Horse Sickness (AHSV) is transmitted by *Culicoides* midges. There is international concern for African Horse Sickness. The mortalities in susceptible equine (horses and mules) can reach 95% (Summers, 2009). Climate change does increase the predicted risk of incursion of African Horse Sickness (AHSV) through the entry of vectors (increase in the 90th percentile). All 9 serotypes of African Horse Sickness (AHSV) occur in eastern and southern Africa. However, there recently has been an increase in the number of serotypes present within the northern limits of the virus' range in sub-Saharan Africa. This spread of at least 3 different serotypes into these areas is disconcerting because recent experiences with Bluetongue Virus (BTV) indicate that once these viruses reach North Africa they can readily spread throughout the Mediterranean basin. The incursion of AHSV into countries of Europe or the Middle East that are extensively involved in the international trade and movement of horses would be economically devastating, thus there is substantial current concern regarding potential spread of AHSV from Africa into adjacent regions [26, 29] (MacLachlan, et al 2010).

If only isolated cases of African horse sickness reach Australia and are successfully restricted by appropriate control measures or unfavourable climatic conditions, it is feasible that the economic and social effect on the horse industry will be minimal.

West Nile Virus

West Nile (WN) virus is a mosquito-transmitted flavivirus. It is widely distributed in Africa, the Middle East, Asia, and southern Europe and was recently introduced to North America. Birds are involved in the cycle of transmission as amplifying hosts. Humans and horses are considered accidental dead-end hosts. Phylogenetic studies have shown two main lineages of WN strains. Strains from lineage I are present in Africa, India, and Australia and are responsible for the outbreaks in Europe and in the Mediterranean basin, and strains from lineage II have been reported only in sub-Saharan Africa. Outbreaks of WN virus remain unpredictable. Further coordinated studies are needed for a better understanding of the ecology and the pathogenicity of the WN virus (Zeller, H.G. and I. Schuffenecker, 2004).

Kunjin virus

Kunjin virus disease is a viral infection caused by a flavivirus (Kunjin virus) found in mainland Australia and Papua New Guinea. It is closely related to West Nile virus which is found in Africa, Europe and the USA. Kunjin Virus has been in Australia for a long period of time. It is primarily a disease of waterbirds and is carried by mosquitoes. Very occasionally the virus can be transferred from mosquitoes to horses. In the past, this has resulted in mild clinical signs in a very small proportion of affected horses.

The recent floods and wet weather in large parts of Australia have resulted in large bird breeding events and these weather conditions obviously favour mosquito breeding. It is likely that many horses may be infected but only a small proportion of infected horses will become ill (Scone equine hospital, 2011).

It has recently been found to have mutated and infects horses by causing neurological symptoms. In some cases horses have to be euthanized.

The virus is spread by the bite of the common banded mosquito, *Culex annulirostris*. This mosquito breeds in fresh water and tends to be found in spring, summer and autumn around natural wetlands and irrigation waters. The mosquito is especially common around the Murray Darling River basin areas in NSW during summer and into autumn. This mosquito tends to be most active after sunset and around dawn. Kunjin virus was first detected in South Australia in February, 2011.

Gaps:

A recent outbreak was thought to be caused by Cyclone YASI (reference). Also West Nile Virus and Kunjin is thought to have a tolerance in some horse populations. It is thought also that northern Australia have a higher natural tolerance than those down south. Thus the impact of disease may differs in relation to different horse populations and their environments (reference)

Peruvian horse sickness

PHSV is a mosquito-transmitted Arbovirus that is the cause of outbreaks of encephalitis amongst horses in South America [8]. A very similar, likely identical virus, Eley virus, is present in the Northern Territory of Australia where infection can cause encephalitis like that described with PHSV. The epidemiology of the infections caused by these viruses is poorly characterized, and it is uncertain how identical viruses came to be present in such distinct regions of the world. This is another reminder of the need to think beyond geographical boundaries and reconsider the permeability of horse populations to overseas diseases.

Gaps:

Other Arboviruses affecting horses in Australia such as Ross River Virus

Wildlife-borne disease

Hendra Virus

Hendra Virus is an emerging disease transmitted by Flying Foxes in Australia. Hendra virus can occasionally spread from flying foxes to horses. This is an unusual event, and the circumstances that allow the spread from flying fox to horse are not fully understood. Although, it has been shown that the seroprevalence for Hendra virus in the Flying Fox population is highest in animals showing evidence of nutritional stress, suggesting that climate change may increase infection and transmission (Plowright et al. 2008). However, heat stress is thought to decrease flying fox populations (Scone equine hospital, 2011).

Hendra virus can cause a range of signs in horses. Usually there is a rapid onset of illness, fever, increased heart rate and rapid deterioration with respiratory and/or neurological (nervous system) signs. (Hendra Virus Fact sheet, NSW Govt, Health 2011). Once a horse becomes affected with Hendra, the death rate is very high. The horses rapidly deteriorate within a short period of time (few days). Hendra virus is not very contagious, and it requires very close contact between a Hendra affected horse and a healthy horse, or a Hendra affected horse and a human, for the virus to be transferred.

As at August 2011 there were 21 confirmed cases of Hendra virus infection in horses in Queensland (eleven cases on nine properties) and New South Wales (ten cases on eight properties). One dog on one of the Queensland properties tested positive although it showed no signs of disease. Each of this year's fifteen incidents are attributed to different groups of flying foxes and the infections are not being spread from property to property (Scone equine hospital, 2011).

Gaps

Exactly how much climate change effects Hendra needs more research

Disease implications

Along with disease comes increased health & safety compliance with animal welfare legislation & regulations the fastest growing area of law today (Lavelle, 2011).

Gaps:

Health and safety for people? Where do horses fit with horse welfare? In the National Animal Welfare strategy for eg, horses can fit under several categories. Does this make the legislation difficult to apply? Which diseases are more susceptible to climate change? With more time we could use a stematic approach to discussing each disease. That is what it is, aetiology, symptoms, how it affects horses, if it also affects humans, is it zoonotic, what aspects of climate change increase its likelihood in Australia etc.

4b. Other horse health issues

Bacterial Infection

Infection caused by a bacteria (*Corynebacterium pseudotuberculosis*) is known to increase in dryer warmer conditions. High environmental temperatures and drought conditions have preceded all reported outbreaks. The bacteria grows in dry soil with faecal contamination. It can then be spread by insects such as the house fly and horn fly through contact on wounds, dermal abrasions or mucal membranes, and it can also spread by horse to horse contact. The bacterial infection can cause

swelling to various parts of the body and organs. To date references relate to it being found in the western US arid regions. (Spier, 2008).

It has been suggested that an observed increase in *Corynebacterium tuberculosis* infections in horses may be associated with global warming (Spier 2008).

Rhodococcus equi pneumonia

Another disease that may be influenced by climatic variation is *Rhodococcus equi* pneumonia in foals. The prevalence of *R. equi* pneumonia is associated with the airborne burden of virulent *R. equi*. Lower soil moisture concentrations and lower pasture heights, changes that may occur in some regions as a result of climate change, significantly increase airborne concentrations of virulent *R. equi* (Knight and Muscatello et al. 2006).

Worms and heat

Larval populations are negatively impacted by hot weather conditions regardless of moisture level. When conditions are hot and wet, larval development will occur rapidly and L3 will have the opportunity to escape the faecal ball onto pasture, but its life span will be quite short. Life spans of small ruminant trichostrongyle L3 of <9 weeks (Banks et al., 1990) and 3–7 weeks (Barger et al., 1994) have been found under hot and humid tropical conditions in Pacific Island countries. Free-living stages of equine strongyles are highly dependent on climatic influences. In Northern temperate climates, refugia are smallest during the winter. In contrast, refugia are lowest during the summer in warm temperate and subtropical/tropical climates. Although adverse seasonal changes clearly have significant effects on the ability of free living stages of strongyle nematode parasites to survive and develop, available data suggest that climatic influences cannot effectively “clean” pastures from one grazing season to the next (Nielsen, 2007).

Gap

What about horse husbandry and impact on worm counts, ie rich pasture but small area = increased exposure.

Re emerging disease.

Respiratory Disease

Chronic pulmonary disease

Climatic changes influence the symptomatology and the course of chronic pulmonary disease in certain horses. There seems to be a cause-effect relationship between the occurrence of bronchiolitis and emphysema. Viral influenza combined with bad management seems to be important in the development of chronic bronchiolitis. Allergic phenomena have been involved pathogenetically in at least 25 per cent of cases. It could be shown mathematically, therefore, that the recommendation to keep patients in cool, dry surroundings is not always justified: stables should be cool, dry and well ventilated, but some at least of the horses require a rather high humidity, the optimum appearing to lie in the range 60 to 80 per cent. Gillespie and Tyler (1969) state that no geographical or seasonal incidence is recognized. These authors have found, however, that emphysema can occur as a primary disease without bronchiolitis, whereas our material does not contain any such confirmed cases. (Gerber, 1973).

Gaps:

The text here is from old publications and there is apparently a whole new body of publications on this

Other Horse health problems thought to be increased by climate change such as greasy heel, bot flies, snake bite, colic, skin infections, Queensland itch, allergic headshaking and horses, and heart disorders. Also more up to date information on heart disease and respiratory disease.

5. Event management: Training, competition and race days

In a study of wastage in South African racing stables, Olivier et al. (1997) found that 11% of lost training days were due to bad weather. If the predicted increase in severe weather events occurs, there could be an adverse effect on training.

5a. Heat recovery

There are some important differences that impact on the ability of horses to thermo regulate and to regulate fluid and electrolyte balance. The major differences are the low surface area to body mass ratio in horses compared to man; and the high metabolic capacity of equine skeletal muscle. These two factors may limit the ability of horses to dissipate heat when exercise is performed under hot conditions (Maughan and Lindinger, 1995).

Field research has shown that the majority of body water losses occur during the first 30-50 km of competitive and endurance rides; and that the losses increase with increasing temperature and humidity, difficulty of terrain and running speed of the horses (Ecker and Lindinger 1995a). The current, very limited database would suggest an upper index temperature of 32.5°C for present planning purposes. Below this value, properly acclimatised, fit, top-class horses would probably be capable of top level performance provided that: i) the going was optimal and ii) sufficient cooling was achieved during scheduled stops. Unacclimatised, horses should not be allowed to compete at this level. They should be stopped when the index reaches a lower, as yet unidentified, temperature. Because riders are exercising at a sub maximal level, an index of 32.5°C would be a reasonable limit for them also, provided that: i) they are sensibly clothed in a way that protects from direct radiation but allows excellent internal ventilation and the evaporation of sweat and ii) they are fully acclimatised to the conditions and are maintained well hydrated during the competition. For this, or any other index, to become of real value. It is essential to collect further data on both local climatic conditions and the thermal load on competing horses. (Schroter and Marlin, 1995). It must be stressed that even following acclimatisation, care still has to be taken to avoid long periods of exercise without recourse to cooling and rehydration in order to avoid undue heat stress (Marlin, D.J. et al, 2001).

In addition to the notes above about exercising during periods of heat, it should be noted that competition horses are usually transported to attend competitions. Given that Australians have a general cultural acceptance for travelling long distances, horses may be inside enclosed trailers for several hours at a time, with limited air movement that they require to cool themselves. Horse 'floats' and trucks in Australia have limited ventilation that has not been rigorously tested, and which may unintentionally increase the amount of dangerous gases drawn into horse floats from towing vehicles. Where competitions or riding club rallies end earlier on hot days as part of their 'hot weather' policies (for example, rallies cancelled after lunch but occurring beforehand), many horses are transported during the hottest part of the day.

Moreover, horses are transported by humans who also have to tolerate heat. Heat affected drivers may pose road safety hazards, affecting the lives of horses and other human road users.

Gap:

Differences between hot and cold blooded horses, fast/slow twitch muscles. More research on horse transport.

Gaps: There are apparently many more publications on horse transport and climate.

5b. Effects on tests of cognitive function

Cognitive function can be affected by temperature and thus climate change. Extreme heat can cause horses to suffer from the extreme levels of water loss that accompanies severe diarrhoea or from clinical heat illness have impaired consciousness that may progress to complete loss. Likewise, it is not unusual for marathon runners with hyperthermia and dehydration, which may amount to 5-8% of body mass, to show signs of confusion. The available data, however, suggest that there may be negative influences of even rather modest levels of hypohydration and hyperthermia on some measures of cognitive function in horses. Gopinathan et al. (1988) used a variety of tests of mental function. (Maughan and Lindinger, 1995)

Gap:

Competition related heat stress, heart failure, heart disorders and related fields

6. Track Maintenance

6a Turf Tracks

In colder climates there could be an increase in the length of the growing season for turf tracks. Increased atmospheric CO₂ levels have been predicted to improve plant growth, at least in the short term. However, water shortages in warmer climates may decrease the suitability of turf tracks, and encourage a shift to synthetic surfaces. Such a shift would be associated with increased costs, and decrease the viability of smaller tracks; a change that could result in socio economic impacts (Knight, and Muscatello,2006)

6b. Synthetic tracks

A correlation was found between temperature of the synthetic track and speed of horse. Wax separated from the track showed that the temperatures experienced in the surface during normal operation exceed the temperatures at which the wax begins to experience thermal transformation. It is therefore hypothesised that the wax may be a cause of the observed changes in the track performance. Average air, surface and subsurface temperatures changed significantly throughout the day. Temperatures were higher during the afternoon race sessions and race times were significantly slower compared to morning work times. Temperatures at which some of the components of the wax began to soften were found to be within the range of temperature measured during track operation. (Peterson et al, 2010).

7. The Carbon Farming Scheme

In light of government driven climate change mitigation strategies aimed at minimising Carbon emission through carbon trading and tax schemes, it is important that the racing Industries and other horse industries carbon footprint is evaluated promptly. For example, emissions related to stud farms, breeding and transport, racing stables and racing meetings need to be evaluated. Activities such as international horse travel by air for both breeding and racing purposes may be contributing significantly to the industry's carbon emission and may attract attention from government and public climate change lobbyists, given that modifications may result in immediate climate change mitigation benefits. Industries need to be prepared to tackle, modify or justify activities which may be seen as significantly contributors to carbon emission. They will also need assistance to develop and initiate changes. For example, allowing artificial insemination would require reliable means of testing parentage and the participation of the global racing community. Evaluating the industry's carbon footprint and the activities within that contribute to it is an important step in facilitating industry justified rather than public preserved climate change mitigation strategies. (Muscatello and Knight, 2006).

Other Gaps:

Gaps

Impact on the human participants in the industry such as jockeys, farriers, transporters, riders, competitors, dentists, physios, vets etc. All of these people have to work long days out in the heat to attend horses.

8. Conclusions

The horse industry is under threat by climate change. Disease seems to be the biggest threat to long term horse health. While much of the literature review relates to disease, it is difficult to predict what insect vectors will increase and decreased due to temperature and humidity changes.

Furthermore cyclones and storms that carry these vectors are also difficult to predict. Other things to consider will be maintenance feeding as pasture is likely to be available for less time due to shorter growing seasons across Australia. Careful planning and track design will be important to both reduce heat stress on horses and heat impact on synthetic tracks. So while some strategic planning for the long term viability of horse industries will be important, so will tactical responses to outbreaks of diseases, caterpillars (causing abortions), worms and more.

9. Recommendations

It is recommended that a peer reviewed vulnerability assessment be carried out on the horse industry. A vulnerability analyses would add to the assessment of the impact of climate change on horses and horse industries as well as look at climate stressors, adaptation and score the overall vulnerability of the horses and industry as described by Allan Consulting Group (2005). This assessment would consider in isolation specific horse industries and aspects of horses and management such as veterinary, public health, natural resources, carbon trading, events and infrastructure, occupational health, water and pasture management in peri-urban properties and more. The vulnerability assessment will help recognise sectors in the horse industry that are more vulnerable than others and will need priority support and research.

The horse industry also needs support to mitigate climate change and little work has been done as to how much carbon horses and industry are emitting into the atmosphere. There may be funding available through the carbon farming scheme funded by the Department of Agriculture Fisheries and Forestry to support the horse industry.

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