Effect of climate change on pastoral livestock health

E Vallee[1], M Wada[1], O Sagarasaerane[1], A Tait[2], J Benschop[1], N Cogger[1]
[1]School of Veterinary Science, Massey University, Palmerston North, [2]NIWA

Evidence of the effects of climate change on animal health

The effect of climate change on animal health in New Zealand is not reported yet climate change has likely played a role in the emergence of animal diseases on other continents (West Nile in North America, bluetongue in Europe), partly due to changeddistribution and competency of vectors. Extreme events (e.g. storms, flash floods, heat waves) can also have an impact on endemic diseases, as was seen in New Zealand with an increased prevalence of leptospirosis in lambs after the 2004 floods in the Manawatu (Dorjee *et al.* 2008). Previous work looking at laboratory submissions for ovine and bovine syndromes had failed to identify a relationship between an increase in submissions and extreme rainfall events in the Manawatu and Wairarapa districts (Moono 2011), suggesting that the relationship between animal health and climate is more complex and involves other climatic factors such as temperature and humidity in addition to rainfall. Moono (2011) also identified seasonality in the number of laboratory submissions for bovine and ovine syndromes, which could be associated with climate or with seasonal production.

Over the decade, the impact of climate change on the epidemiology and control of animal diseases is increasingly concerning for many countries. The OIE (2008) reviewed the issues and highlighted the need for:

- Appropriate research methodology suitable for the complexity of the problem; and
- Local studies relying on robust climate projections.

Climate change can affect animal health in different ways:

- **Improved survival conditions for infective agents outside of the host (e.g. leptospires, *Pithomyces chartarum* spores)**
  Mean annual rainfall and mean annual ambient temperatures >12°C were found to be positively associated with the sero-positivity of sheep, beef and deer farms to *Leptospira interrogans* Pomona in New Zealand (Sanhueza *et al.* 2016). Pomona can survive for at least 42 days in soil in simulated New Zealand winter conditions (Hellstrom and Marshall 1978). Optimal temperature and pH for Pomona survival was between 10 and 34°C and 6.0 and 8.4 respectively (Okazaki and Ringen 1957). Leptospira was isolated from environmental water samples from a dairy farm with a known history of Leptospira infection in both workers and livestock (the outbreak is described in Yupiana *et al.* 2015). An increase in temperature and rainfall is likely to increase the duration of survival and the regions where leptospires can survive in the environment in New Zealand.
- **Modified life cycle (e.g. better survival through winter), new distribution of vectors (e.g. *Theileria*), and higher vector competence (Lovejoy 2008)**
  In New Zealand, the introduction and spread of *Theileria orientalis* type Ikeda since 2012 has been responsible for more than 1,000 cattle farms experiencing losses through anaemia. The disease is transmitted by ticks, with only one species, *Haemaphysalis longicornis*, acting as vector in New Zealand. The tick distribution has spread from the north of the North Island to the north of the South Island since the 1920s. Recent modelling work (Lawrence *et al.* 2017) predicted that suitable habitat of ticks will likely expand further south by 2100. This type of information is crucial to implementing biosecurity measures and enhancing preparedness for the further spread of *T. orientalis* and the consequent new outbreaks of bovine anaemia.
- **Through change in pasture or modified land use (e.g. grass staggers)**
  Perennial ryegrass is known to be more resistant to drought and

thus could be used more commonly under climate projections showing an increase in dry spells. However, the frequent presence of the *Neotyphodium lolii* endophyte leads to an increase in the risk of adverse health events in livestock, such as grass staggers and heat stress (Bluett *et al.* 2001). This challenges farmer planning in the event of increased drought frequency, having to balance between drought-resistant pasture and the risk of impaired livestock health.

- **Impaired welfare (e.g. lower tolerance to heat of high-producing animals, increased incidence of heat stress)**
  European studies (Vitali *et al.* 2010, Wall *et al.* 2010) showed that high temperature and heat stress are associated with reduced fertility, reduced milk production and increased mortality of cattle. The mortality was maximum for dairy cows under intensive farming. A deeper understanding of this association in the New Zealand context will help New Zealand farmers prepare management plans in the face of heat waves.
- **Redistribution of reservoirs and intermediate hosts (e.g. wildlife reservoirs of leptospirosis, water snail reservoirs of liver fluke)**
  A recent study predicted that under current climate projections the risk of *Fasciola hepatica* infection in ruminants could increase by 29-186%, depending on the region, by 2090 (Haydock *et al.* 2016). These findings were attributed to the predicted change in the distribution of the lymneid snails linked with wet environment and in grazing habits of livestock in drier environments.

Climate projections in New Zealand

Climate change projections for New Zealand (Ministry for Environment 2016) are based on Global Climate Models (GCM) that have been dynamically and statistically downscaled for New Zealand to a country-wide 5km grid. They are presented as scenarios based on alternative future pathways of atmospheric greenhouse gas concentrations ("representative concentration pathways" or RCPs). The climate projections for each RCP contain uncertainty associated with the global and regional climate models used.

Depending on the RCP, mean temperature is expected to increase by 0.7 to 3.0°C by 2100, while the projections of precipitation vary depending on the region. The frequency of extreme weather events are also likely to be affected; for example frosts are expected to be less frequent, and hot days and dry or very wet days more common.

Models linking animal health and climate projections can be built on a selection of RCPs and should incorporate the uncertainty of the climate projections as well as the uncertainty around the association between health and climate variables.

Studying the effects of climate change on livestock health in New Zealand

The examples presented above show that the mechanisms of the effect of climate on livestock diseases can be complex. Knowing which livestock diseases are likely to be the most affected by climate change and variability, and prioritising them based on their importance for New Zealand's primary industry, would be useful for stakeholders to enhance preparedness for climate change. Case-studies for these diseases should account for the complexity in mechanisms described above and also for the consequent uncertainty.

Our current research project will include a systematic literature review and predictive modelling, and we will draw on information from experts within different farming industries and NZVA branches. The modelling is expected to be challenging, as typical modelling methods require long time series of climatic data (available through NIWA) but also of animal health events (Lancelot 2015) that are more difficult to source.

Facial eczema: a pilot case study

Facial eczema is a growing concern for New Zealand grazing farmers. It is caused by the ingestion of Pithomyces chartarum, a fungus that can grow in the environment under warm (grass temperature higher than 12 degree Celsius), cloudy and moist condition (humidity at grass level higher than 90%) (Brook 1969). The risk of facial eczema increases in warm and humid weather (Drew Smith *et al.* 1961) and areas at risk of outbreaks are expected to increase with climate change (Di Menna *et al.* 2009). Airborne transmission directly to animals or to nearby pasture is possible depending on the wind speed (Smith and Crawley 1964).

Spore count data can be used as a proxy for the risk of facial eczema. A previous study predicted an increased risk of facial eczema in North Island districts by 2040, by collating the spore count data and climate data (Dennis *et al.* 2014). We will model the risk of facial eczema in New Zealand, and predict economic impacts, which may help decision-making regarding prevention and control for facial eczema.

Acknowledgements

This project is funded by MPI's Sustainable Land Management and Climate Change fund.

References

Bluett SJ, Hodgson J, Kemp PD, Barry TN. Performance of lambs and the incidence of staggers and heat stress on two perennial ryegrass (Lolium perenne) cultivars using a leader-follower rotational grazing management system. *Journal of Agriculture Science* 136: 99-110, 2001
Brook PJ. Pithomyces chartarum in pasture, and measures for prevention of facial eczema. *Journal of Stored Products Research* 5: 203-6,IN5-IN6,7-9, 1969
Dennis NA, Amer PR, Meier S. Predicting the impact of climate change on the risk of facial eczema outbreaks throughout New Zealand. *Proceedings of the New Zealand Society of Animal Production* 74, 161-3, 2014
Di Menna ME, Smith BL, Miles CO. A history of facial eczema (pithomycotoxicosis) research. *New Zealand Journal of Agricultural Research* 52: 345-76, 2009
Dorjee S, Heuer C, Jackson R, West DM, Collins-Emerson JM, Midwinter AC, Ridler A. Prevalence of pathogenic Leptospira spp. in sheep in a sheep-only abattoir in New Zealand. *New Zealand Veterinary Journal* 56: 164-70, 2008
Drew Smith J, Crawley WE, Lees FT. Seasonal variation in spore numbers of Pithomyces chartarum in 1960 and 1961 in the Waikato. *New Zealand Journal of Agricultural Research* 4: 538-51, 1961
Haydock LAJ, Pomroy WE, Stevenson MA, Lawrence KE. A growing-degree day model for determination of Fasciola hepatica infection risk in New Zealand with future predictions using climate change models. *Veterinary Parasitology* 228: 52-9, 2016
Hellstrom JS, Marshall RB. Survival of Leptospira interrogans serovar pomona in an acidic soil under simulated New Zealand field conditions. *Research in Veterinary Science* 25: 29-33, 1978
Lawrence KE, Summers SR, Heath ACG, McFadden AMJ, Pulford DJ, Tait AB, Pomroy WE. Using a rule-based envelope model to predict the expansion of habitat suitability within New Zealand for the tick Haemaphysalis longicornis, with future projections based on two climate change scenarios. *Veterinary Parasitology* 243: 226-34, 2017
Lovejoy T. Climate change and biodiversity. *Revue Scientifique et Technique de l'Office Internationale des Epizooties* 27, 331-8, 2008
Ministry for Environment. *Climate Change Projections for New Zealand: Atmosphere Projections Based on Simulations from the IPCC Fifth Assessment.* ME 1247. Ministry for the Environment Wellington, 2016
Moono P. *Risk to animal health as a result of adverse natuarl events occurring in New Zealand. Dissertation thesis.* Massey University, Palmerston North, New Zealand, 2011
Okazaki W, Ringen LM. Some effects of various environmental conditions on the survival of Leptospira Pomona. *American Journal of Veterinary Research* 18: 219-23, 1957
Sanhueza JM, Stevenson MA, Benschop J, Phiri B, Wilson PR, Collins-Emerson JM, Dreyfus A, Heuer C. Spatial and geo-climatic distribution of Leptospira antibodies in cattle, sheep, and deer farms in New Zealand. In: *GEOVET.* Valdivia, Chile 2016
Smith JD, Crawley WE. Disturbance of pasture herbage and spore dispersal of Pithomyces chartarum (Berk. & Curt.) M. B. Ellis. *New Zealand Journal of Agricultural Research* 7: 281-98, 1964
Vitali A, Segnalini M, Bertocchi L, Bernabucci U, Nardone A, Lacetera N. Seasonal pattern of mortality and relationships between mortality and temperature-humidity index in dairy cows. *Journal of Dairy Science* 92: 3781-90, 2010
Wall E, Wreford A, Topp K, Moran D. Biological and economic consequences heat stress due to a changing climate on UK livestock. *Advances in Animal Biosciences* 1: 53, 2010