Influence of Climate Change on Prevalence of Livestock Diseases in Cagayan Valley

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ABSTRACT

The study was conducted to determine the influence of climate change on prevalence of livestock diseases in Cagayan Valley from 2009 to 2012. Four provinces - Cagayan, Isabela, Quirino and Nueva Vizcaya - were selected as study sites. Batanes was not included because of its remote location and being a low risk area. Sources of data were the Regional Animal Disease Diagnostic Laboratory, Provincial Veterinary Offices, Bureau of Agricultural Statistics and ISU-PAGASA Agromet Station.

Prevalent livestock diseases were Hemorrhagic septicemia, Ephemeral fever, Surra, Fascioliasis and Swine enzootic pneumonia. Fascioliasis was the most prevalent with an annual average prevalence of 8.82 per 10,000 animal population.

Diseases common during the rainy season were Hemorrhagic septicemia, Ephemeral fever, Surra, Fascioliasis and Swine enzootic pneumonia. Surra, Fascioliasis and Swine enzootic pneumonia were commonly observed during the dry season. Disease cases during dry season were far lower compared to rainy season. There was a significant (0.05 level) correlation between temperature and Fascioliasis prevalence, and a highly significant (0.01 level) correlation between rainfall and Surra prevalence

No new disease emerged during the conduct of study. All of the diseases identified in Cagayan Valley were endemic or constantly occurring.

INTRODUCTION

Diseases play important roles in how all life on earth evolve and develop. They have influenced the social and economic structure and the very existence of past and present civilizations. Many diseases, and the organisms that cause them, are integral components of intricate natural ecosystems.

Climate interacts in complex and dynamic ways with the biophysical and social environment in shaping individual and population health (de la Rocque *et al.*, 2008). Climate change is a result of global increase in average air and ocean temperatures, and rising average sea levels. It has become the main issue affecting global and regional natural ecosystems. Based on predictions of the 2007 Intergovernmental Panel on Climate Change (IPCC) report, global changes in temperature and precipitation patterns in different regions may affect the incidence and range of several infectious diseases (Pinto *et al.*, 2008). Climate change strongly affects agriculture and livestock production and influences animal diseases, vectors and pathogens, and their habitat. Changes in mean climatic conditions and climate variability also can affect health via indirect pathways, particularly via changes in biological and ecological processes that influence infectious disease transmission and food yields (Patz *et al.*, 2001).

The threat of climate change and global warming is now recognized worldwide and some alarming manifestations of change has occurred. Animal health may be affected by climate change in four ways: heat-related diseases and stress, extreme weather events, adaptation of animal production systems to new environments, and emergence or re-emergence of infectious diseases dependent on environmental and climatic conditions (Hungerford *et al.*, 2008). The Asian continent, because of its size and diversity, may be affected significantly by consequences of climate change, and its new status as a "hub" of livestock production gives it an important role in mitigating possible impacts of climate variability on animal health.

Livestock production, animal diseases and climate change are closely related and influence each other through different mechanisms. Livestock contribute to global warming but land use modifies their context and the environmental load or exposure to animal pathogens. Distribution and incidence of vector-borne diseases are directly influenced by climate because the geographical distribution of vectors is predetermined by temperature and humidity. A set of global factors is believed to drive a worldwide redistribution of hosts, vectors, and pathogens. Climate change clearly plays a role in this regard, enhancing or decreasing the introduction and invasions of disease agents.

Knowledge and technology generation on climate change vulnerability and impacts on animal agriculture include assessing the impact of climate change on the prevalence of pathogenic organisms on livestock. The effects of climate change on animal diseases, and emergence and re-emergence of infectious diseases in the Philippines have not been thoroughly studied. Trend analysis of occurrence of climate sensitive animal diseases in the country is therefore necessary. This study was therefore conducted to give an insight into improved disease surveillance initiatives for prevention activities in animal health, and determine the influence of climate change on the prevalence and emergence of livestock diseases in Cagayan Valley. Specifically, it aimed to: 1) determine the most prevalent and emergent diseases and parasites from 2009-2012; 2) find out which of the diseases and parasites are commonly occurring during the rainy and dry season; and 3) to determine the correlation between prevalence of diseases and temperature and rainfall in the region.

LITERATURE REVIEW

Climate change, manifested by global changes in temperature and rainfall patterns in different regions, may affect the incidence and range of several infectious diseases. Recent global researches provide evidence of climate change-related disease outbreaks already occurring through the spread of different types of pathogens like viruses, bacteria, and parasites. Changes in temperature and humidity affect the distribution or ecological range of infectious diseases, hence, the frequency and magnitude of outbreaks of disease change with weather extremes (Epstein, 2001).

Climate change may affect certain pathogens directly. Many pathogens must spend a period of time in the environment to be able to get from one host to another. During this transit, they are exposed to weather extremes. Emergence or re-emergence of some diseases appears to be driven by climatic, habitat and population factors that affect hosts, pathogens or vectors, frequently causing natural increases and decreases in disease activity in different geographical areas and periods of time (Baylis, 2006).

Many pathogens use vectors or intermediate hosts to facilitate transmission between animal hosts, like snails in the case of Fascioliasis. Fascioliasis is associated with environmental conditions favoring the snail intermediate hosts like low lying, wet pasture areas subject to periodic flooding, and in temporary or permanent bodies of water. Snails prevail during the rainy season, which is why incidence of Fascioliasis is relatively higher during wet than dry season. Trematodes such as *Fasciola* are easily affected by climate change; the impact appears to be more pronounced in these parasites (Mas-Coma *et al.*, 2009).

Climate often plays a dominant role in determining distribution of vectors so that vector-borne diseases are often climatically restricted in both time and space. Climate change can directly influence the ability of pathogens and vectors to survive, replicate, or attack hosts. For example, free-living stages of some parasites like *Fasciola* concentrate in high numbers in stagnant pools or bodies of water during the rainy season. This influences ecology which in turn influences pathogen or vector availability. Excessive rainfall leads to ground saturation resulting in increased hatching of vectors and outbreaks of vector-borne diseases. In addition, dormant spores of some bacteria, such asanthrax, may be stirred up by heavy rainfall (Baylis, 2007).

Climate change influences animal behavior. More intense cold weather during the wet season leads to closer contact and higher transmission of bacterial, parasitic and viral infection. Moreover, extreme weather events may lead to population displacement and disruption of sanitation and water and food supplies, a pre-disposition for pathogen spread (Mas-Coma *et al.*, 2009).

Incidence of parasitic and viral diseases are among the most sensitive to climate change. Moisture-sensitive diseases, including anthrax, blackleg, dermatophilosis, haemonchosis, fascioliasis and vector–borne diseases, are affected by climate change. More intense weather events during rainy season create conditions conducive to outbreaks of infectious diseases. Outbreaks of some diseases are often associated with alternating heavy rainfall and drought and high temperatures (Baylis, 2006). These diseases may decline in some areas and spread to others. Moreover, heavy rains cause insects to leave breeding sites, drive rodents from burrows, and contaminate clean water systems (Bezirtzoglou et al, 2011).

METHODOLOGY

Site Selection

A preliminary survey was conducted to identify high risk areas for the study. Based from the survey, four provinces in Cagayan Valley Region - Cagayan, Isabela, Quirino and Nueva Vizcaya - were selected as study areas. Batanes was not included in the study because of its remote location and it is a low risk area. From each province, at least one municipality was considered as the study site. The municipalities randomly selected were Solana and Alcala in Cagayan, San Agustin and Ilagan City in Isabela, Maddela in Quirino and Bayombong in Nueva Vizcaya

Sources of Data

Pertinent records needed for the study were obtained from ISU-PAGASA Agromet Station, Bureau of Agricultural Statistics (BAS), Regional Animal Disease Diagnostic Laboratory (RADDL 02) and the different Provincial Veterinary Offices (PVOs) from year 2009 to 2012.

Gathering and Evaluation of Data

Data necessary for the study were procured from the different offices mentioned using a prepared form. Four-year prevalence reports of various livestock diseases from the different Provincial Veterinary Offices and Regional Animal Disease Diagnostic Laboratory of Cagayan Valley region were analyzed with the aid of Geographical Information System.

Parameters collected included number of disease cases, incidence rate of diseases, number of examined samples or animals, number of positive animals or samples, total animal population per municipality/province, annual rainfall and annual air temperature.

The data obtained were verified

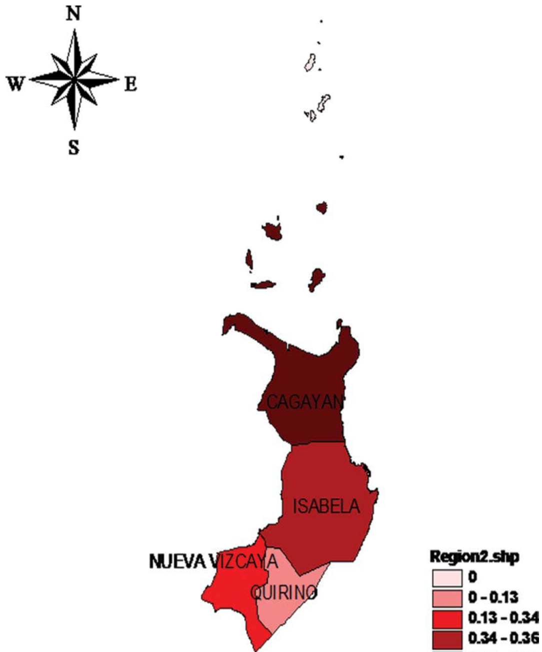

Fig. 1. Ave. Hemorrhagic Septicemia prevalence (2009-2012)

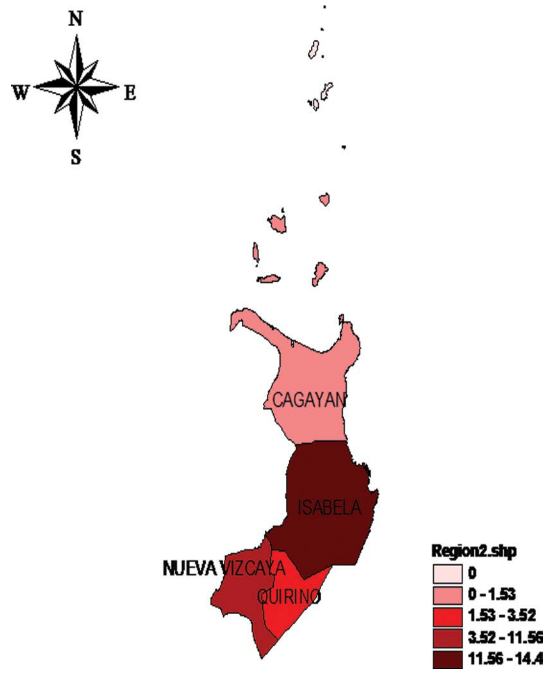

Fig. 2. Ave. Ephemeral Fever prevalence (2009-2012)

through interviews of key persons and audited reports. The secondary data were then verified through survey from the selected study sites in each province.

Analysis and Interpretation of Data

Correlation analysis between disease prevalence and temperature or rainfall was done using Statistical Package for the Social Sciences (SPSS) Version 18 to determine influence of climate change on prevalence of diseases. Data gathered from the survey, compiled records and key person interviews were analyzed by simple descriptive analysis and presented using Geographical Information System (GIS) maps, tables, and charts for interpretation. GIS was used as a tool to assist in interpreting and assessing which province had the highest prevalence among the diseases identified.

Determination of Prevalence of Diseases

Prevalence of diseases identified during the conduct of study was computed using the formula:

$$\text{Prevalence} = \frac{\text{Number of disease cases}}{\text{Total population of animals}}$$

RESULTS AND DISCUSSION

Prevalence of Livestock Diseases in Cagayan Valley

From 2009 to 2012, Cagayan had the highest prevalence of hemorrhagic septicemia (5.52/10,000 population) and Surra (0.42/10,000 population) (Figure 1 and Figure 3, respectively). Isabela had the highest prevalence of Ephemeral fever (Figure 2) with 14.4/10,000 population. Nueva Vizcaya had the highest prevalence of both Fascioliasis (Figure 4) and Swine Enzootic Pneumonia (Figure 5) with 34.49/10,000 population and 8.4/10,000 population, respectively.

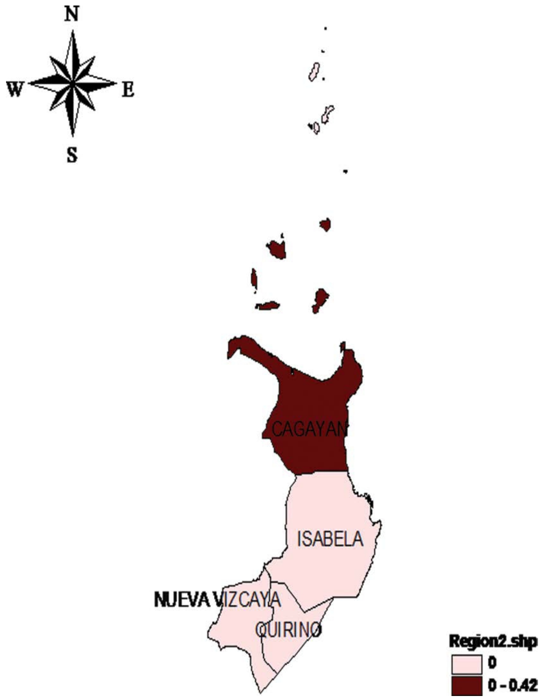

Fig. 3. Ave. Surra prevalence from 2009-2012

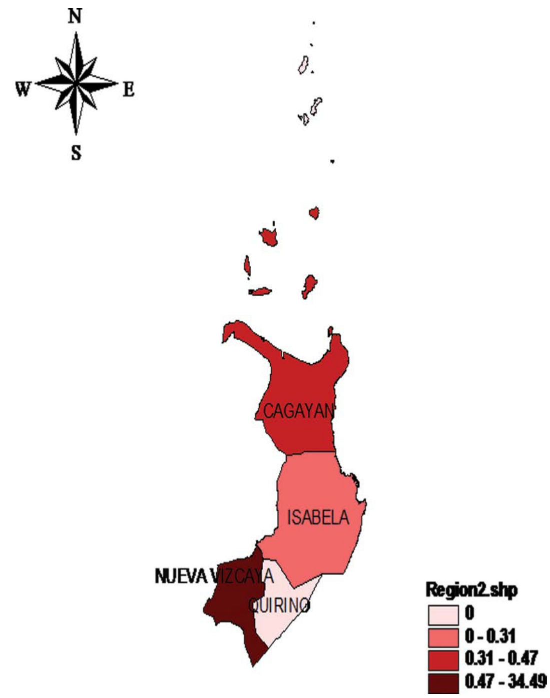

Fig. 4. Ave. Fascioliasis prevalence from 2009-2012

Figure 6 shows that the average annual prevalence of Hemorrhagic septicemia in 2009, 2010, 2011 and 2012 were 2.46, 2.20, 1.63 and 0.07, respectively, per 10,000 population showing a declining trend. The average prevalence of Hemorrhagic septicemia for the four-year period was 1.59 per 10,000 population. This finding suggests that this disease is inversely correlated with increase in temperature or rainfall in the study area.

Figure 7 presents the yearly prevalence of Ephemeral fever from 2009 to 2012 (19.37, 4.77, 2.12 and 4.71, respectively, per 10,000 population), showing a rapid decline for the first three years and a slight increase in 2012 approaching that of 2010. The average prevalence of Ephemeral fever for the four-year period was 7.74 per 10,000 population.

Figure 8 shows the annual prevalence of Surra from year 2009 to 2012 (0.17, 0.0, 0.22 and 0.02, respectively). Prevalence of Surra for the said period had no definite trend. This result suggests this is not affected by increase in temperature in the study area. However, the analysis revealed a highly significant correlation between rainfall and Surra prevalence.

Figure 9 presents the yearly prevalence of Fascioliasis from 2009 to 2012 (9.68, 5.90, 10.74 and 8.95, respectively) showing a relatively high prevalence averaging 8.82 per 10,000 population, making it the most prevalent disease in the entire region. This finding indicates that prevalence of Fascioliasis might be affected by temperature and rainfall. Based on correlation analysis, there was significant correlation noted between temperature and Fascioliasis prevalence.

Figure 10 shows that the prevalence of Swine enzootic pneumonia in 2009 to 2012 were 2.85, 5.37, 2.12 and 1.57, respectively. From 2009 to 2010, there was an increase in prevalence, but a marked decreasing trend from 2010 to 2012. The average yearly prevalence of Swine enzootic pneumonia for the four-year period was 2.98 per 10,000 animals.

Table 1 revealed that incidence of livestock disease throughout the region was relatively higher during the rainy than dry season. This indicates that prevalence of diseases in the study area is strongly affected by seasonal variations in rainfall or temperature. This is in accord with the study of Bezirtzoglou *et al.* (2011) that more intense weather events during rainy season create conditions conducive to outbreaks of infectious diseases. In most cases, change in climate affects the ability of pathogenic agents to survive or reach and enter a new animal host, resulting in seasonality of certain diseases.

Diseases of livestock that are common during the wet or rainy season were Hemorrhagic septicemia, Ephemeral fever, Surra, Fascioliasis and Swine enzootic pneumonia. Among these, Fascioliasis has the most significant number of disease cases. On the other hand, only Surra, Fascioliasis and Swine enzootic pneumonia were commonly observed during the dry season

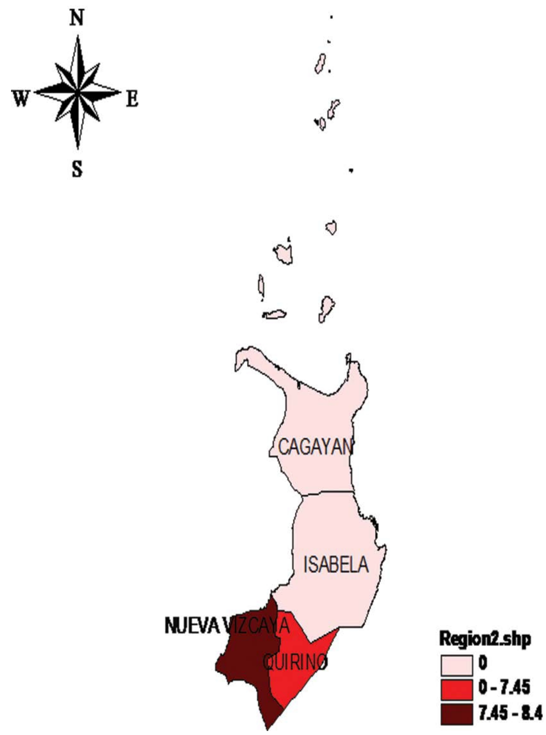

Fig. 5. Ave. Swine Enzootic Pneumonia prevalence from 2009-2012

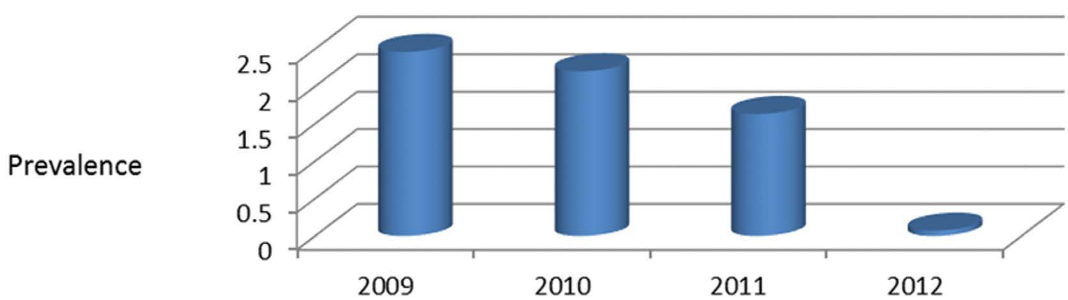

Figure 6. Prevalence of Hemorrhagic Septicemia in Cagayan Valley from 2009 to 2012

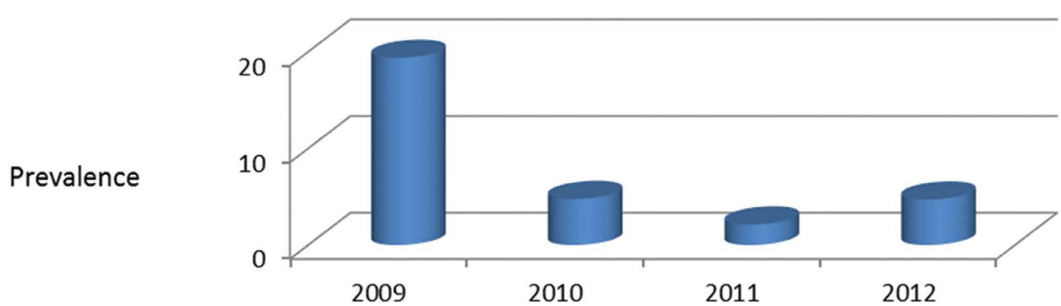

Figure 7. Prevalence of Ephemeral Fever in Cagayan Valley from 2009 to 2012

namely. However, the number of disease cases during the dry season was far lower compared to the rainy season.

Effect of Climate Change on Prevalence of Livestock Diseases in Cagayan Valley

Climate change is manifested by global increase in temperature and rainfall (Pinto *et al.*, 2008). In Cagayan Valley, the annual average rainfall from 1977 to 2003 was 1,611 mm. However in 2009 to 2012, data from ISU-PAGASA Agromet Station showed that annual average rainfall increased to 2,304.2 mm (Figure 11). Moreover, annual average

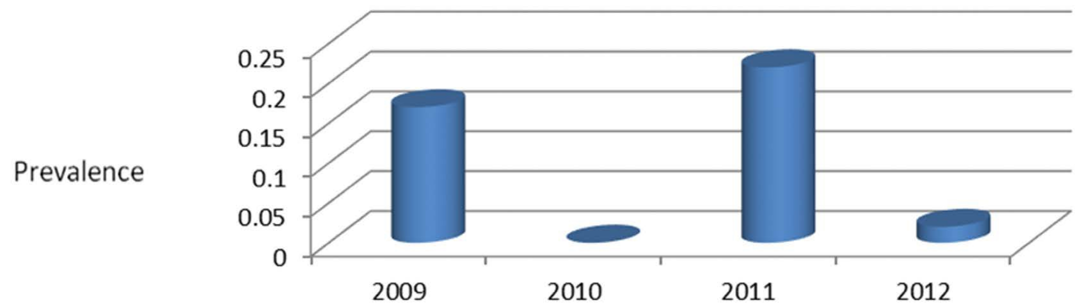

Figure 8. Prevalence of Surra in Cagayan Valley from 2009 to 2012

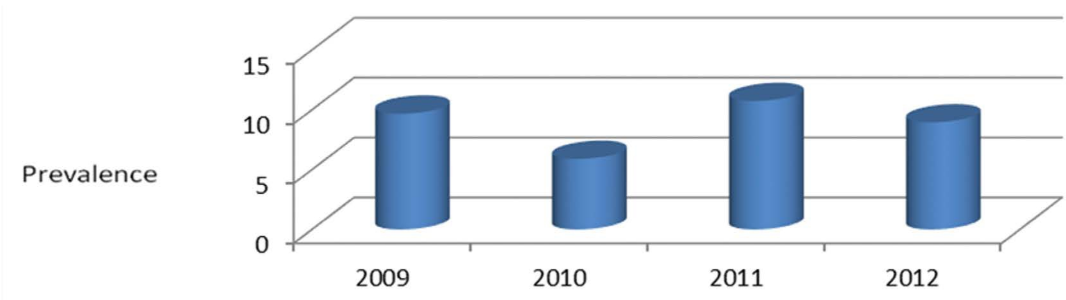

Figure 9. Prevalence of Fascioliasis in Cagayan Valley from 2009 to 2012

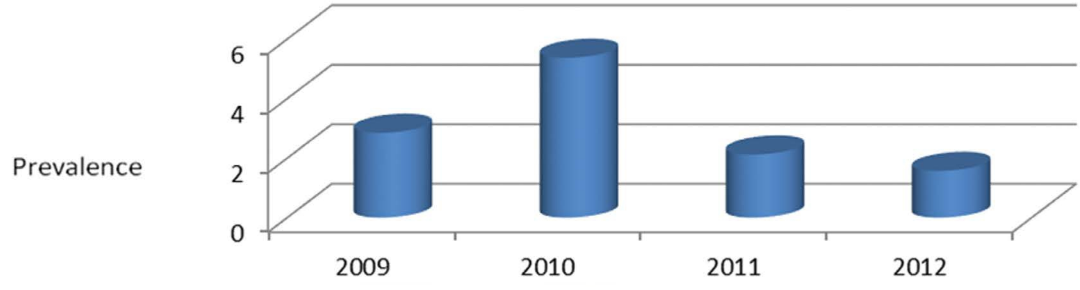

Figure 10. Prevalence of Swine Enzootic Pneumonia in Cagayan Valley from 2009-2012

Table 1. Diseases of Livestock Based on Survey (Rainy and Dry Season)

Selected Site	Hemorrhagic Septicemia		Ephemeral Fever		Surra		Fascioliasis		Swine Enzootic Pneumonia	
	Rainy	Dry	Rainy	Dry	Rainy	Dry	Rainy	Dry	Rainy	Dry
Solana, Cagayan	1	0	0	0	0	0	9	0	3	0
Alcala, Cagayan	0	0	0	0	0	0	4	0	1	1
San Agustin, Isabela	3	0	5	0	2	2	2	0	0	0
Ilagan, Isabela	3	0	0	0	3	0	0	0	2	0
Maddela, Quirino	0	0	0	0	0	0	3	2	2	0
Bayombong, NuevaVizcaya	1	0	0	0	0	0	4	0	0	0
TOTAL	**8**	**0**	**5**	**0**	**5**	**2**	**22**	**2**	**8**	**1**

temperature in Cagayan Valley from 1977 to 2003 was 26.90°Celsius. This increased to 26.93°Celsius (Figure 12) in 2009 to 2012. The figures suggest that Cagayan Valley had experienced climate change as described by Pinto *et al.* (2008).

Climate change as manifested by global increase in temperature and rainfall may affect prevalence of infectious diseases. To determine the influence of climate change on livestock diseases, correlation analysis between prevalence of different diseases and temperature or rainfall was done (Table 2).

There was no significant correlation between temperature and prevalence of Hemorrhagic septicemia, Ephemeral fever, Surra and Swine enzootic pneumonia. However, there was significant correlation between temperature and Fascioliasis prevalence. This conforms to the study of Mas-Coma *et al.* (2009) and Baylis (2006). Mas-Coma *et al.* (2009) affirmed that trematodes such as Fasciola are easily affected by climate change; the impact appears to be more pronounced in these parasites. According to Baylis (2006), diseases affected by climate change include Fascioliasis and other vector–borne diseases; outbreaks of these diseases are often associated with extreme environmental temperatures.

There was no significant correlation between rainfall and prevalence of Hemorrhagic septicemia, Ephemeral fever, Fascioliasis and Swine enzootic pneumonia. However, there was a highly significant correlation between rainfall and Surra prevalence. This is in accord with the study of Baylis (2006) and Bezirtzoglou *et al.* (2011). Baylis (2006) explained that climate change influences ecology which in turn influences pathogen or vector availability. Excessive rainfall leads to ground saturation resulting in increased hatching of vectors and outbreaks of vector-borne diseases. In addition, pathogens maybe stirred up by heavy rainfall.

Bezirtzoglou *et al.* (2011) pointed out that more intense weather events like heavy rainfall create conditions conducive to outbreaks of infectious diseases. Heavy rains drive insects from breeding sites, and rodents from burrows, and contaminate clean water systems. The incidence of parasitic diseases are among those diseases most sensitive to climate change. Surra is a parasitic disease caused by protozoa.

During the conduct of the study, no new disease was found to emerge brought about by climate change. All of the livestock diseases identified in Cagayan Valley were endemic or

Table 2. Correlation of Prevalence of Livestock Diseases with Temperature and Rainfall

		Hemorrhagic Septicemia Prevalence	Ephemeral Fever Prevalence	Surra Prevalence	Fascioliasis Prevalence	Swine Enzootic Pneumonia Prevalence
Temperature (°Celsius)	Pearson Correlation	.022	-.301	-.892	-.985*	.777
	Sig. (2-tailed)	.978	.699	.108	.015	.223
Rainfall (mm)	Pearson Correlation	.260	.150	.992**	.874	-.498
	Sig. (2-tailed)	.740	.850	.008	.126	.502

** Correlation is significant at the 0.05 level (2-tailed)*
*** Correlation is significant at the 0.01 level (2-tailed)*

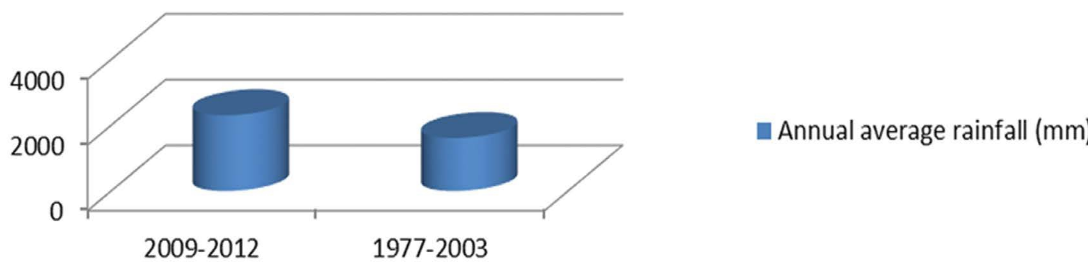

Figure 11. Comparison of Annual Average Rainfall in 1977-2003 and 2009-2012 in Region 2

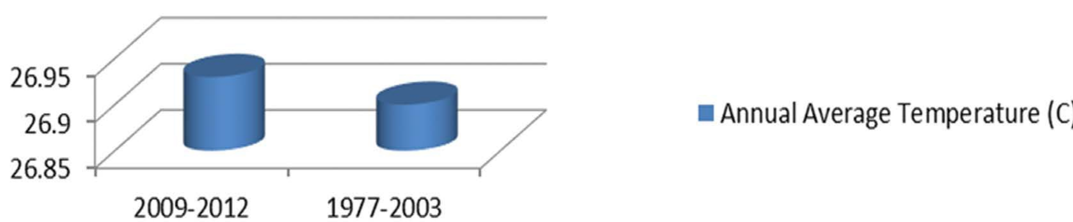

Figure 12. Comparison of Annual Average Temperature in 1977-2003 and 2009-2012 in Region 2

constantly occurring.

Findings of the study revealed that some and possibly many livestock diseases will be affected by climate change. This is in accord to the assessment of Karyonen *et al.* (2010) that climate change increases the risk of some, but not all diseases.

CONCLUSION

The prevalent livestock diseases in Cagayan Valley region are Hemorrhagic septicemia, Ephemeral fever, Surra, Fascioliasis and Swine enzootic pneumonia. Among these infectious diseases, Fascioliasis was the most prevalent during the conduct of the study.

Diseases of livestock that are common during the rainy season are Hemorrhagic septicemia, Ephemeral fever, Surra, Fascioliasis and Swine enzootic pneumonia. During the dry season, only Surra, Fascioliasis and Swine enzootic pneumonia are common. . Moreover, incidence of diseases during the dry season was far lower compared to the rainy season.

There was no significant correlation between temperature and prevalence of Hemorrhagic septicemia, Ephemeral fever, Surra and Swine enzootic pneumonia. However, there was a significant correlation noted between temperature and Fascioliasis prevalence. There was no significant correlation between rainfall and prevalence of Hemorrhagic septicemia, Ephemeral fever, Fascioliasis and Swine enzootic pneumonia, but not with prevalence of Surra.

No new disease emerged brought about by climate change during the conduct of study. All of the livestock diseases identified in Cagayan Valley were endemic or constantly occurring.

Results of the study indicate that some and possibly many diseases of livestock will be affected by climate change. Therefore, it can be concluded that climate change increases the prevalence of some, but not all livestock diseases.

RECOMMENDATION

There is a need for closer collaboration between veterinary, medical and environmental sciences to improve disease surveillance and control relating to climate change, as this is lacking in many countries. This underscores the concept or movement for "one nation, one health."

It is recommended that further studies be conducted on the effect of climate change on livestock diseases for at least 10 years in order to understand more fully its possible consequences. Such studies can provide important information on animals affected and spatio-temporal distribution of diseases prevalent in the country. Data that will be obtained can help to effectively focus on disease control programs in different provinces.

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