Climate-driven Spatio-temporal Disease Pattern of *Uromycladium falcatarium* (Doungsa-ard, McTaggart & R.G. Shivas) to Falcata Tree Plantations in Mindanao, Philippines

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INTRODUCTION

In the Southern Philippines, *F. moluccana* timber industry is a promising forest economic activity that provides livelihood and employment to locals. In the 1.1 million m^3 of national total log production, 75% contributed by *F. moluccana* (Gevaña *et al.,* 2015).

In 1988 and 1989, gall rust disease caused by *Uromycladium falcatarium* provoked severe damage to Falcata plantation in Mindanao, Philippines (Eusebio, 1990). To date, gall rust disease is still prevalent in the area.

The changing climatic condition affects rust fungus survival, disease incidence (Helfer, 2014), and geographic expansion (Garett, 2006).

Like any other pathogen, changes in temperature, relative humidity, and precipitation (Moore and Allard, 2008) are observed influencing the rust fungus biological behavior.

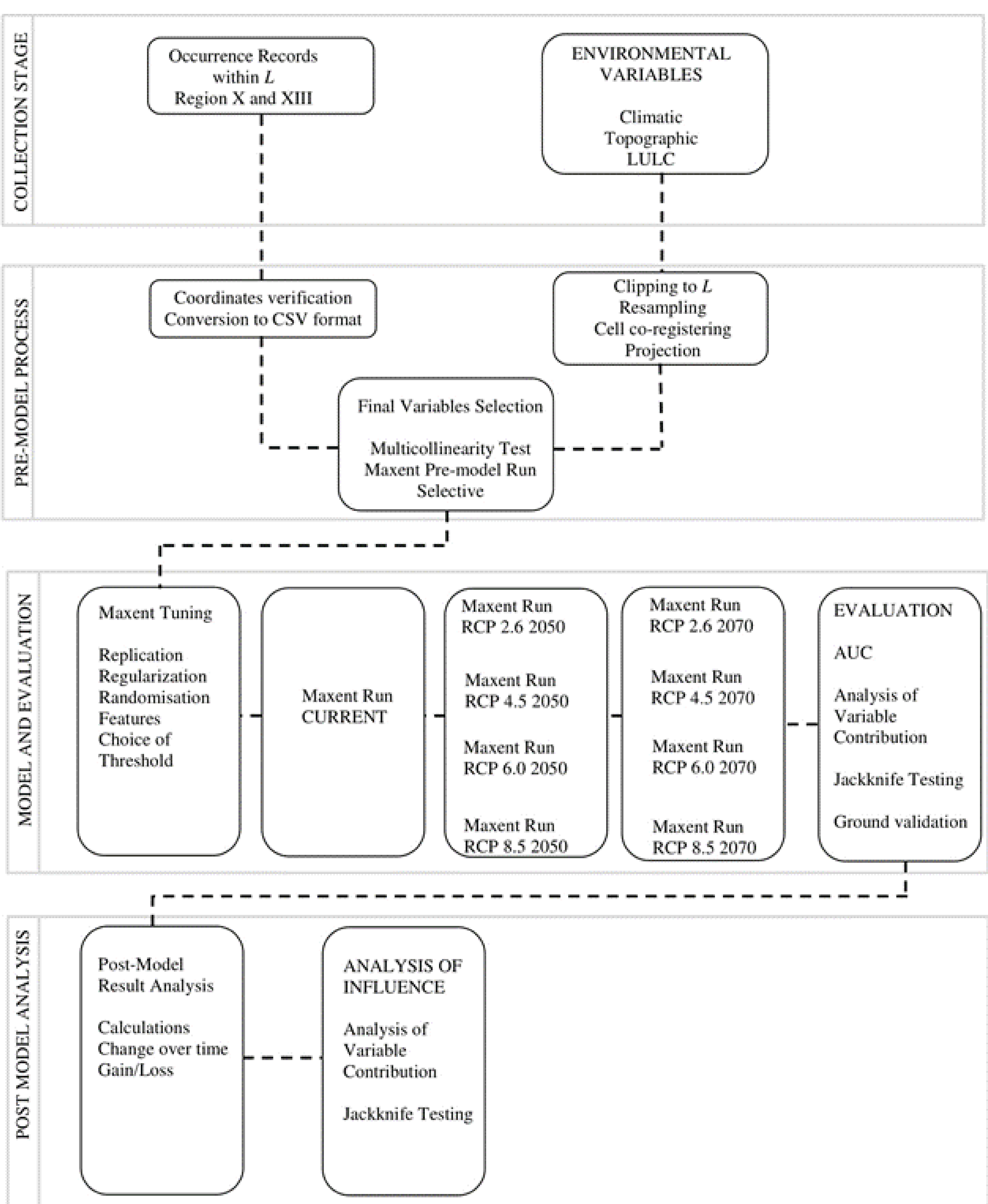
With reference to the situation, it is a growing concern for the forest managers the predictability of the spread of the disease as well as the deeper understanding of the environmental factors that influences the disease proliferation.

OBJECTIVES

(1) Determine the spatio-temporal disease pattern of gall-rust as influenced by climate in Northern Mindanao and CARAGA regions in Mindanao.

(2) Determine the influence of the environmental factors to the biological and reproductive cycle of the pathogenic rust fungus.

MATERIALS AND METHODS



RCP 2.6 is an emission scenario that leads to very low greenhouse gas concentration levels (Van Vuuren *et al.,* 2009).
RCP 4.5 was another stabilization scenario in which total radiative forcing is stabilized shortly after 2100, without overshooting the long-run radiative forcing target level (Clarke *et al.,* 2007).
RCP 6.0 is a stabilization scenario where radiative forcing is stabilized shortly after 2100, without overshoot, by the application of a range of technologies and strategies for reducing greenhouse gas emissions (Fujino et al., 2006; Hijioka *et al.,* 2008).
RCP 8.5 is characterized by increasing greenhouse gas emissions over time, representative of scenarios in the literature that lead to high greenhouse gas concentration levels (Riahi *et al.,* 2007).

RESULTS AND DISCUSSION

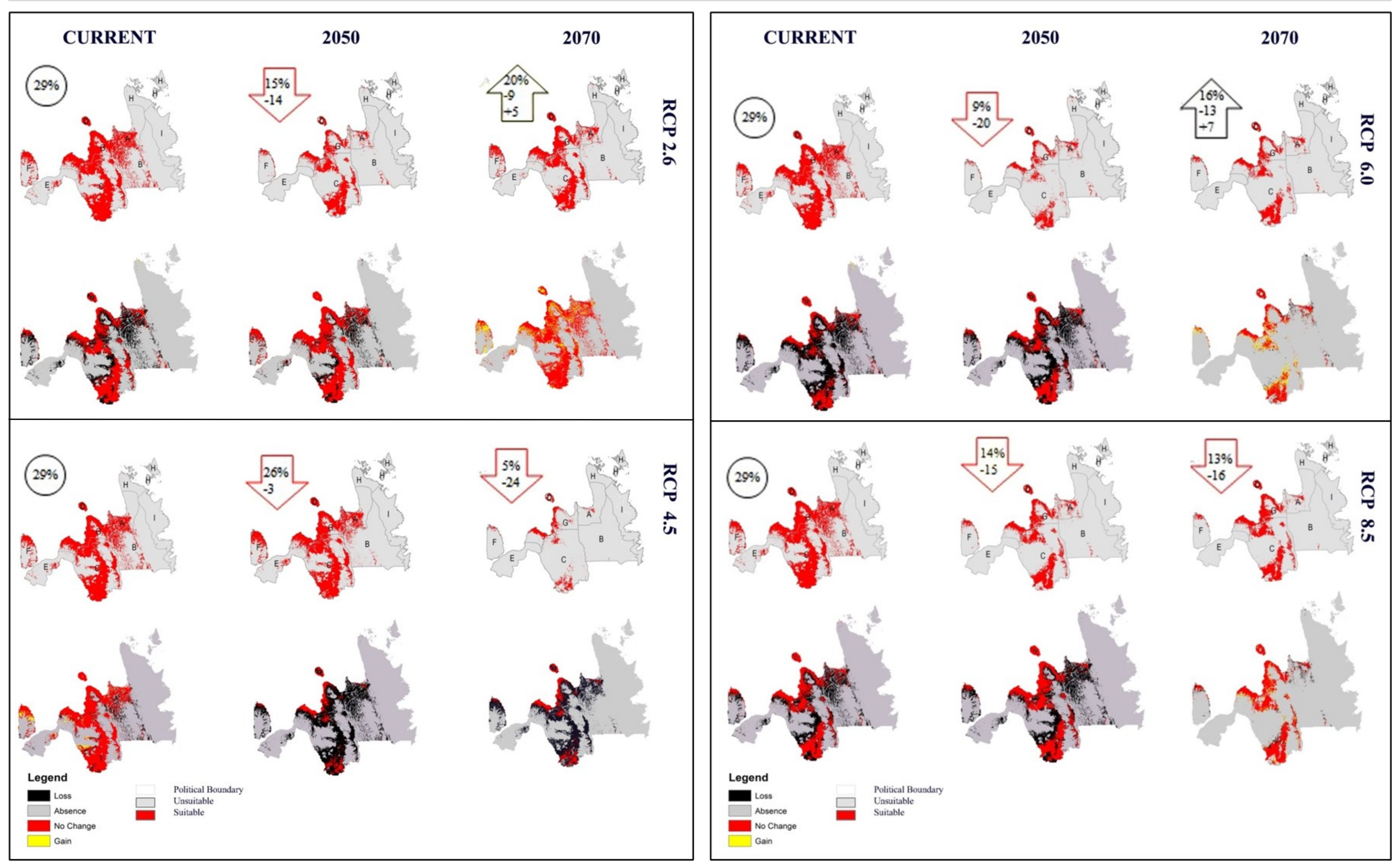


Figure 1. Spatial and temporal distribution of gall-rust disease

- Rust fungus thrives well in Northern Mindanao (Bukidnon and Misamis Oriental)
- CARAGA Region remains less suitable for the distribution of the rust fungus
- Distribution declines in all future climate scenario

Table 1. Mean percent variable contribution

VARIABLE CODE	MEAN PERCENT VARIABLE CONTRIBUTION									Mean % Contribution
	Current	RCP 2.6		RCP4.5		RCP 6.0		RCP 8.5		
		2050	2070	2050	2070	2050	2070	2050	2070	
ISO	5.2	8.6	8.6	9.2	9.1	10.4	11.1	8.8	6.8	**8.6**
TS	2.5	3	2.2	1.9	2.3	3	1.6	2.2	2.4	2.3
ATR	3.4	3.4	2.2	1.5	2.8	2	1.7	3.5	3.4	2.7
MTWQ	0.9	2.6	1.4	0.9	1.8	1.1	1	1.7	0.4	1.3
AP	19.8	18	19	19.3	21.6	20.9	21.9	19.9	20.7	**20.1**
PS	10	9.8	11.8	12.3	10.4	10.5	9.1	10.1	10.8	**10.5**
PDQ	16.9	11.9	12.5	16	14.6	12.3	11.4	9.5	14.9	**13.3**
PWQ	2.3	2.6	5.4	4.1	5.4	3.8	3.2	3.8	4.3	3.9
WS	0.5	0.6	1.3	2.1	0.9	0.3	0.9	0.7	0.6	0.9
WD	2.1	1.5	1.1	2.1	1.6	1.1	1.1	1.2	2.2	1.6
ELEV	2.6	2.7	2.5	1.7	2.3	2.6	2.2	2.3	4.2	2.6
ASPECT	4.1	2.5	2.4	2.9	1.5	2.4	1.6	2.6	1.5	2.4
SLOPE	0.5	0.8	0.7	0.6	0.6	0.5	0.5	0.5	0.4	0.6
LULC	29.2	33.3	28.9	26.9	25	28.9	32.7	33.1	27.4	**29.5**

* Highlighted are variables with highest contribution in the model

- Land cover (29.5%), annual precipitation (20.1%), precipitation at driest quarter (13.3%), precipitation seasonality (10.5%), and isothermality (8.6%) were found to influence the most in the cycle and the distribution of the rust fungus.

CONCLUSION

(1) The concentration of rust distribution in Northern Mindanao and lower distribution in CARAGA region correspond to the climatic differences of the two areas (Type III and Type II) respectively. Changes in the climatic condition drives the distribution of the disease as evident in the model for current and future climate scenarios.

(2) There are specific environmental factors that are required for the proliferation of the disease which also serve as limiting factors considering threshold limit and timing with reference to disease cycle.

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