Sea Level Rise in Vietnam: Assessing the Geography of Poverty

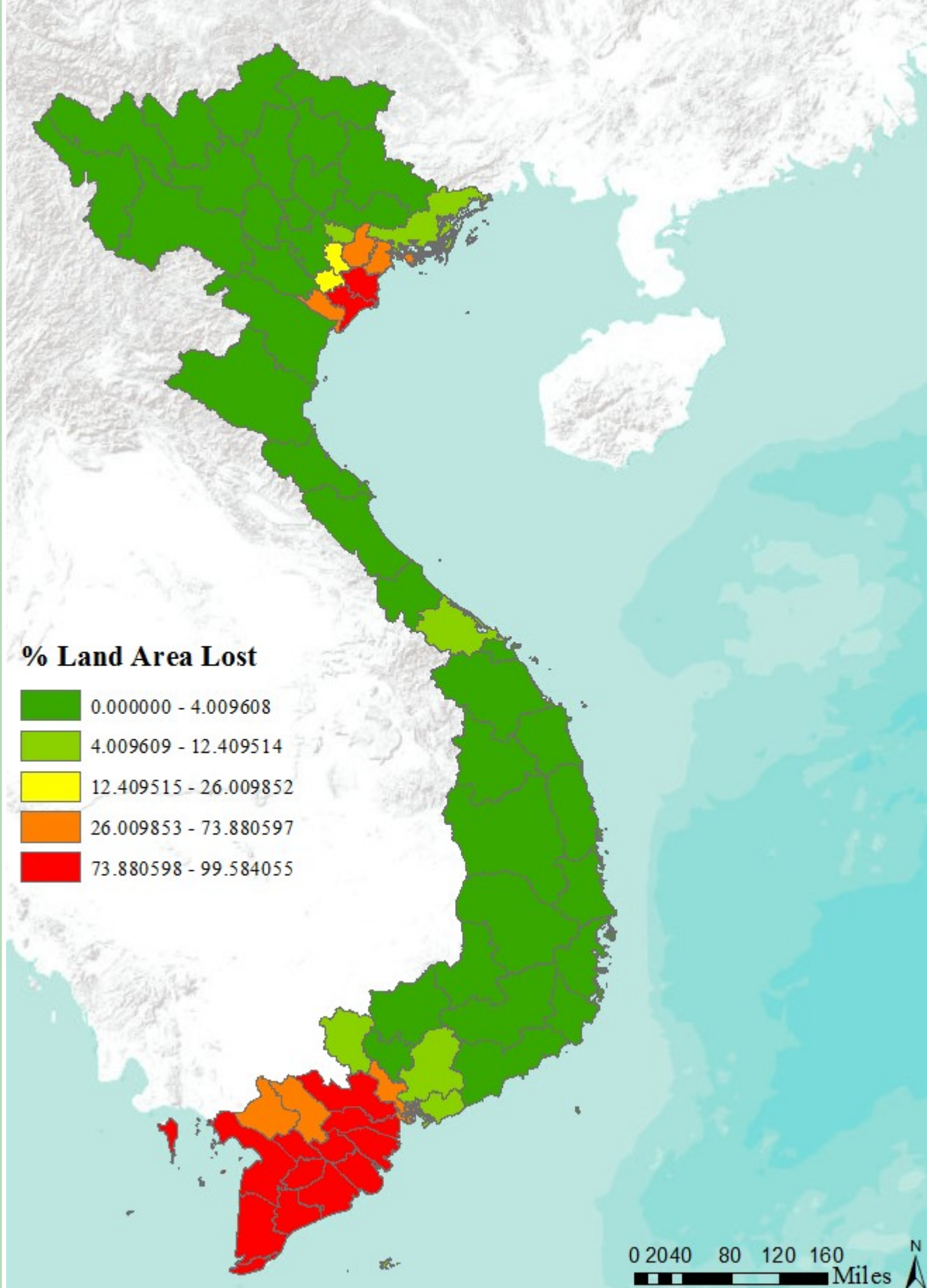Rachel Herman   UEP 236 Spatial Statistics   May 8, 2020

Introduction

Fig 1: Map of vulnerable land percentage in each province

Vietnam, a largely coastal country in southeastern Asia, has seen rapid economic growth in the past several decades. Considered a developing country, Vietnam has made remarkable progress in economic development in the short time . The economy has undergone a transition moving from agricultural dominance to service and manufacturing. However, agricultural still makes up the largest percentage of the workforce. Vietnam has seen a gradual transition to from a government-run command economy to a more mixed or market-influenced economic model in recent decades after economic reforms instituted by the government in the 1990s and early 2000s. This had aided in their continued economic growth (Vuong 2014).

Vietnam's geographic features of low elevation, prevailing wet weather conditions like floods and monsoons, and substantial coastline make it particularly susceptible to climate change via sea level rise. Sea level rise impacts have already been observed in Vietnam, and are likely to increase exponentially if global fossil fuel emissions do not abate.

Methods

Raster data on elevation was sourced from Diva-GIS. The raster was reclassified into two categories: elevation below 1 meter and elevation above 1 meter. Elevation data was then zoned to a province boundary shapefile also sourced from Diva-GIS. The pixels of the reclassified raster categories were summed by province and divided by the total number of pixels per province to determine the percentage of land area below one meter in elevation. Land below one meter in elevation would be underwater in a 1-meter sea level rise scenario, so this percentage is referred to as the percentage of vulnerable land area.

The 1-meter criteria was chosen based off of World Bank projections that 5.17% of the country would be impacted by a 1-meter sea level rise scenario. In terms of land loss, 5.17% represents a very serious impact. Of the 90 developing countries surveyed, Vietnam had the second highest percentage of impacted area for the 1-meter scenario, far above the average of 0.71% (Dasgupta 2006). Even this relatively modest sea level increase would have steep impacts on the country. A 1-meter rise in sea levels globally is considered a baseline, if not conservative, prediction for the end of this century, and is thus a critical starting point for assessing the impacts of sea level rise (Jones 2013).

Province-level economic and demographic data was sourced from the World Bank. This data originally included 23 variables for 63 provinces. For the analyses of this project, 3 variables were considered: percentage of population living in poverty (% poverty), percentage of population employed in agriculture (% agriculture), and percentage of population employed in wage work (% wage work). Agriculture and wage work were chosen because they represent a significant portion of the population and economy. They also both typically employee workers of low socioeconomic status. These variables where joined to the 10-meter sea level rise shapefile in ArcMap by province name. Three geographically weighted regressions were conducted in ArcMap for each of the three variables.
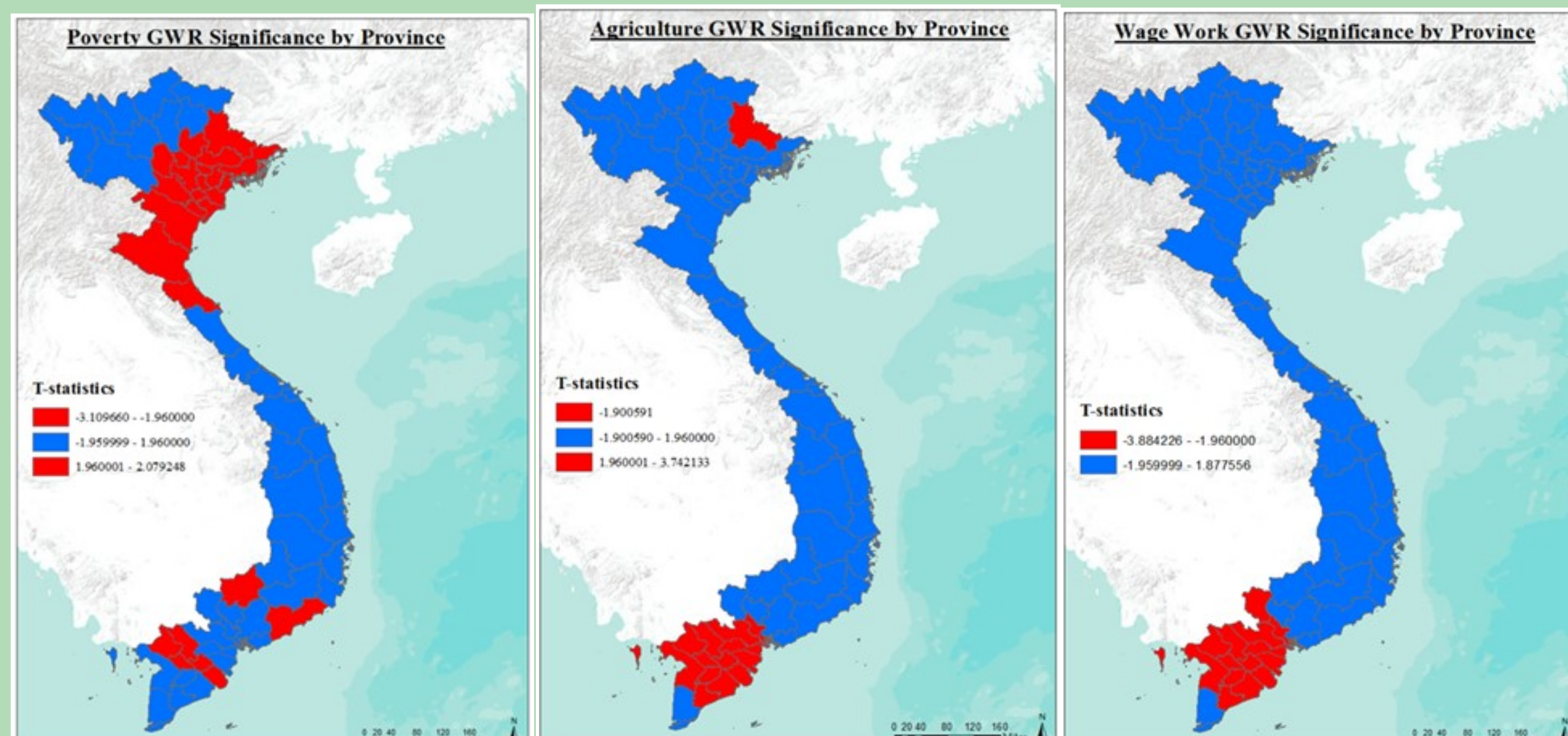

Fig 2, 3 & 4 (from left to right): T-statistics of geographically weighted regressions for % vulnerable land and % poverty, % vulnerable land and % agriculture, and % vulnerable land and % wage work.

Results

The provinces with the greatest land area lost due a 1-meter rise in sea level are concentrated in two primary regions. In the north, there is high vulnerability on the eastern coast around the nation's capital city of Hanoi. In the south, all the provinces south of Ho Chi Minh City, the nation's most populous urban area, have high vulnerability. This includes the city itself. Overall, the south has much more vulnerable land.

T-statistics for the GWRs were calculated to determine significance, with values below -1.96 or above 1.96 considered significant, as represented by the red provinces in figures 2-4. For the poverty GWR, the largest area of significance was concentrated in the north, although there were also several southern provinces with significance. The agriculture GWR had one significant province in the north and a larger group in the south that was very similar to the wage work GWR, which only had the southern cluster of significant provinces.

In the northern region where the poverty GWR showed the greatest significance, the coefficients in figure 5 indicate that a 1% increase in vulnerable land is associated with decreases between 0.1% and 1.9% of poverty. In the southern provinces that, there is a positive relationship, indicating that as vulnerable land increases, poverty also increases, up to 1.6% per 1% of land loss. For the agriculture GWR, the southern region where most of significant provinces are, there is also a positive relationship. As vulnerable land increases by 1%, agricultural work force increases by 0.66-1.17%. The north, though mostly not significant, showed a negative relationship as well. The coefficients for the wage work GWR deviated more from those of poverty and agriculture. The north was entirely not significant in figure 10 but showed a large cluster of positive coefficients. As vulnerable land increases by 1%, wage work increases by 0.64-1.38%. In the significant provinces in the south, a 1% increase in vulnerable land was associated with a 1.4%- 0.72% decrease in wage work.
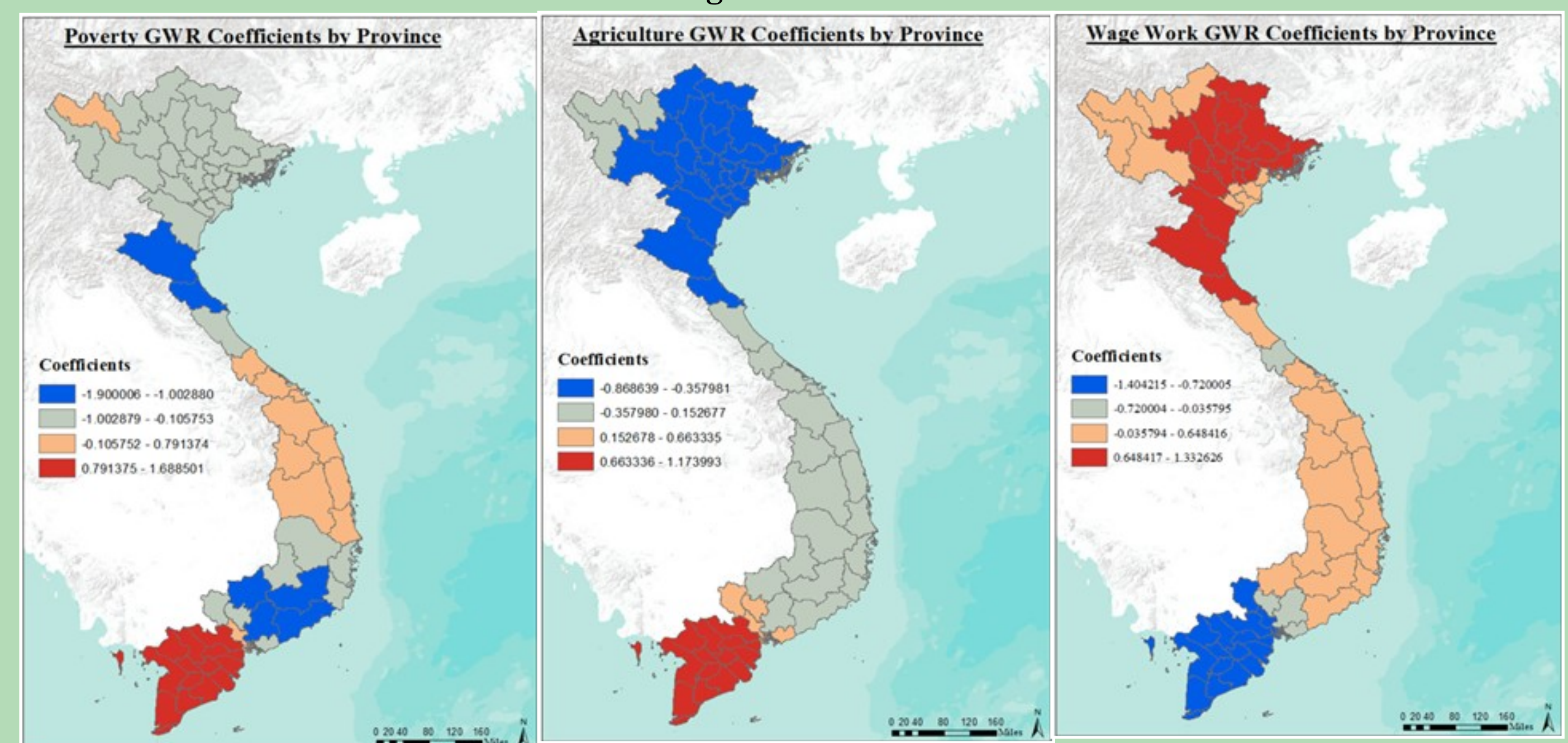

Fig 5, 6 & 7: (left to right): Coefficients by province for GWRs for % vulnerable land and % poverty, % vulnerable land and % agriculture, and % vulnerable land and % wage work.

Conclusions

The area of greatest significance in the GWRs was the southern tip of the country. Poverty tended to not be as strong for goodness of fit here, but for both wage work and agriculture it continually appeared as an area with a strong relationship to vulnerable land. This is likely driven by a particularly high land vulnerability in this area, since it is effecting both employment sectors so significantly. A more pronounced relationship with poverty was seen in the figure 2 where the coefficients showed increases in land loss associated with increases in poverty. However only a few of these provinces showed significance in the t-statistics. Still, this relationship is interesting because it closely aligns with the associations for agriculture, which do have more significance. The high overlap in these two variables' coefficients suggests that agricultural work and poverty could be linked in this area. This is also particularly interesting because when considering the wage work GWR results, it becomes clear that agricultural work is more closely associated with poverty, but wage work is more closely associated with the urban areas that see the greater impacts of land loss but also relatively less poverty. As figure 4 shows, increases in land loss are associated with decreases in wage work, and it is assumed that this is the result from job loss rather than job transition. Although the south seems to be dominant in wage work rather than agriculture, the agricultural work force in the south is at the highest risk. This could have implications for increasing the gap between the poor and the wealthy in Vietnam.

As sea level rise increases, economic well-being may change with it in unpredictable ways, creating new vulnerabilities where there currently are not significant ones. The wage work GWR indicated that wage workers would lose jobs as sea levels rise and land loss increases, so poverty would likely then increase as well as a result. . Despite its successful transition, the population is still largely employed in and dependent on agriculture, making threats to agriculture quite serious. If Vietnam hopes to continue its economic progress, sea level rise mitigation efforts must quickly be implemented. However, such measures are often a struggle for developing countries, who have contributed the least to climate change but with suffer the soonest and the most because of it. Global efforts to reduce climate change and sea level rise will be critical to preventing even further damage and helping the world's developing nations adapt for the damages that are already ensuing.