#impacts world2017

Mapping vulnerability to dengue in Mekong Delta region, Vietnam from 2002 to 2014 using a water-associated disease index approach and geospatial data

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Nguyen Tien Cong*, Pham Thi Thanh Nga*, Vu Duoc**

* Vietnam Space Center, Vietnamese Academy of Science and Technology

** National Institute of Hygiene and Epidemiology

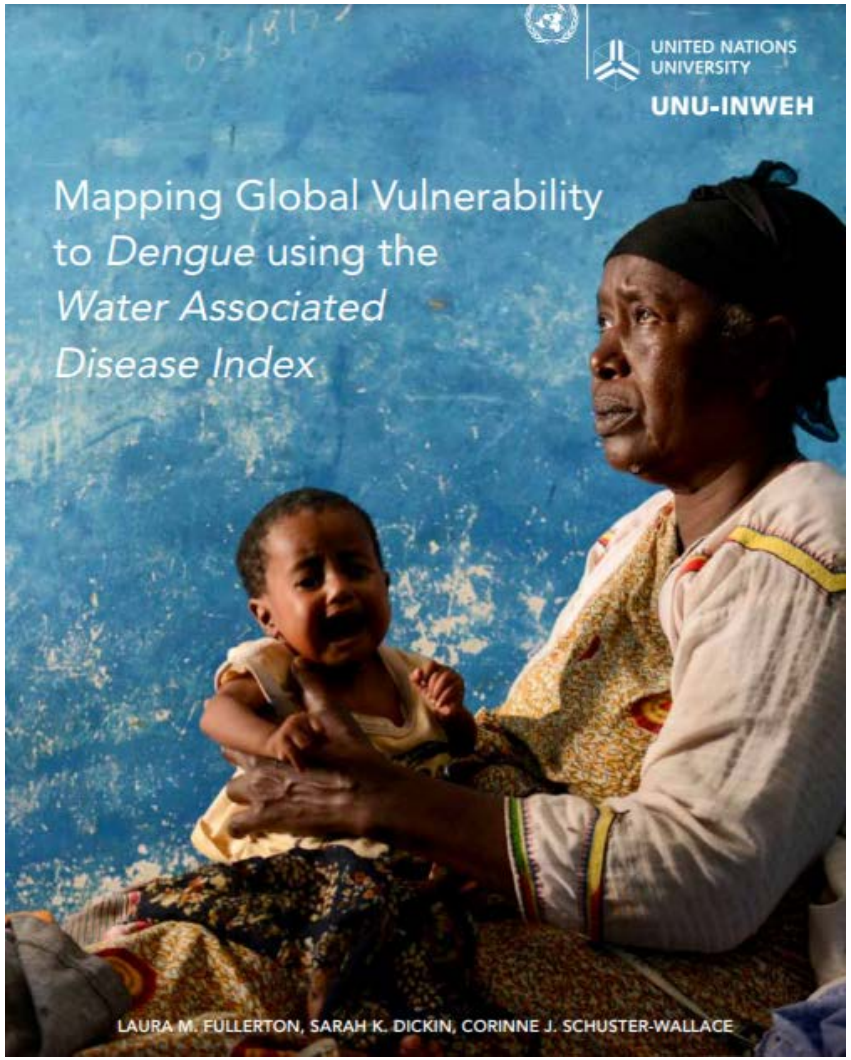
Introduction

The research's objective is to utilize geospatial data and technique and the WADI index approach, which developed by Dickin et al. (2013) in order to map change of vulnerability to dengue for provinces in Mekong delta region (MDR) from 2002 to 2014.

Select the WADI index approach because of following reasons:

- The index approach that is likely simpler than statistical and mathematical approach, however, it describes clearly the geographic integration of factors associating with dengue transmission. The flexibility framework adapts multi-dimensional data at different scales and geographic places, such as at global (Fullerton, 2015), and local level in Malaysia and in Brazil as well as to both urban and rural area (Dickin et al., 2013, 2014, Louis, 2014).
- Moreover, its validated result was applied in Malaysia, a nation in South East Asia has climate conditions similar to Southern Vietnam. The index approach is completely built on geospatial technology that process, assess and visualize rapidly the vulnerability index to dengue with available data, adaptable factors and thresholds (Dickin et al., 2014).

Vulnerability is the degree to which a population is unable to anticipate, cope with, resist and recover from dengue outbreak under the impacts of climate change.

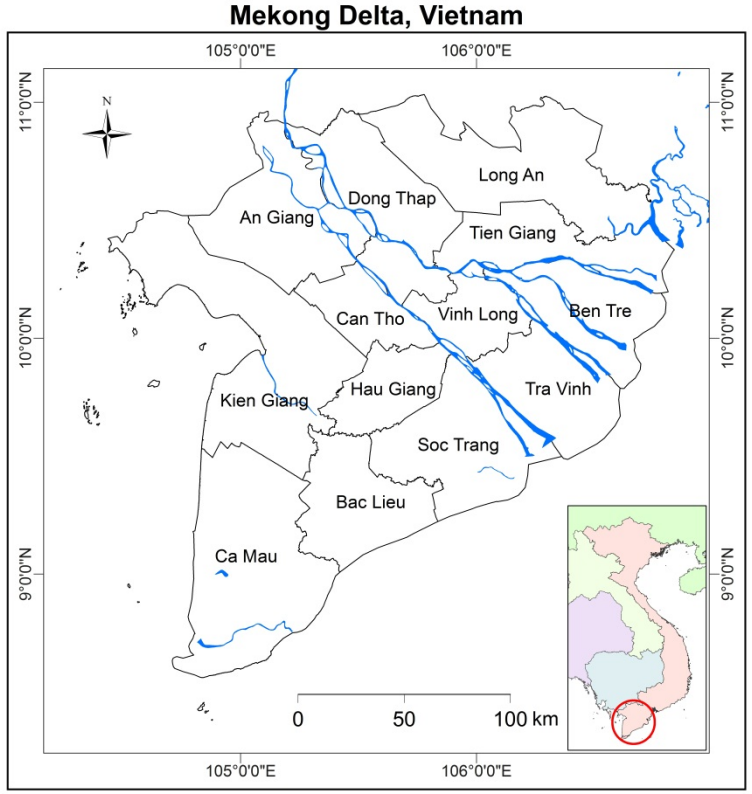


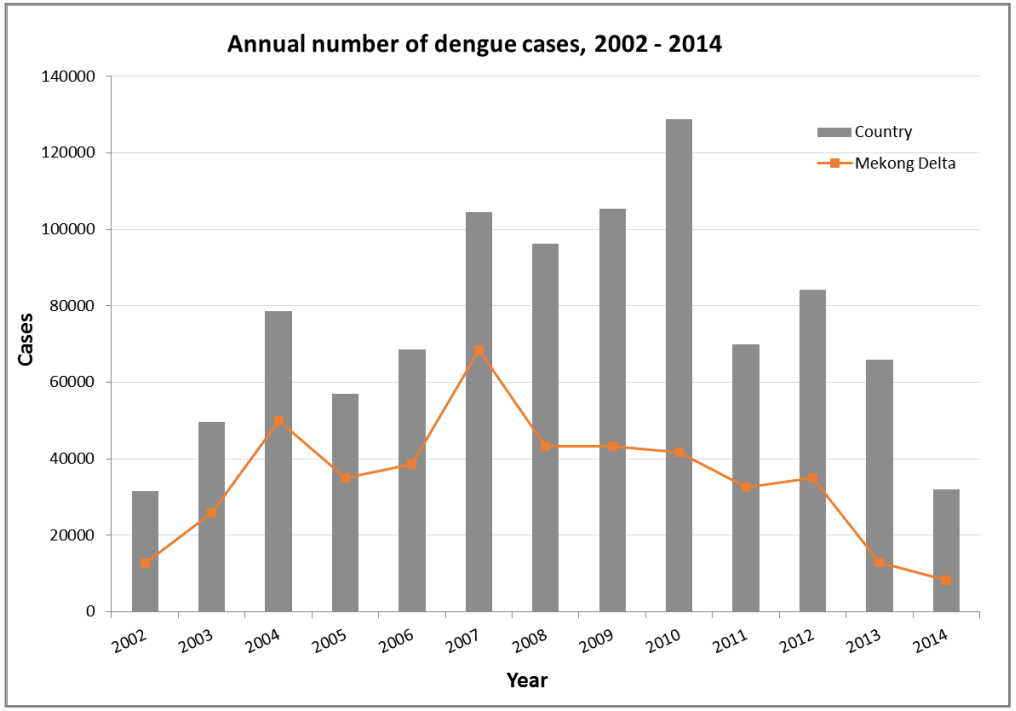
http://journals.plos.org/plosone/article?id=10.1371/journal.pone.0063584

- Dickin Sarah K., Corinne J. Schuster-Wallace, Assessing changing vulnerability to dengue in northeastern Brazil using a water-associated disease index approach. Global Environmental Change, Volume 29, November 2014, p.155-164, ISSN 0959-3780
- Dickin SK, Schuster-Wallace CJ, Elliott SJ (2013) Developing a Vulnerability Mapping Methodology: Applying the Water-Associated Disease Index to Dengue in Malaysia. PLoS ONE 8(5): e63584. doi:10.1371/journal.pone.0063584
- Fullerton, L.M., Dickin, S.K., Schuster-Wallace, C.J. (2014). Mapping Global Vulnerability to Dengue using the Water Associated Disease Index. United Nations University
- Louis Valérie R, Revati Phalkey, Olaf Horstick, Pitcha Ratanawong, Annelies Wilder-Smith, Yesim Tozan and Peter Dambach, Modeling tools for dengue risk mapping - a systematic review. International Journal of Health Geographics 2014. DOI: 10.1186/1476-072X-13-50

Study area

The Mekong Delta region or Lower Mekong Basin situates in the Southern of Vietnam and includes 13 provinces. Geographic features are plain and a complex network of streams. The region has the largest agricultural area and the biggest rice crops per acre in the Vietnam.

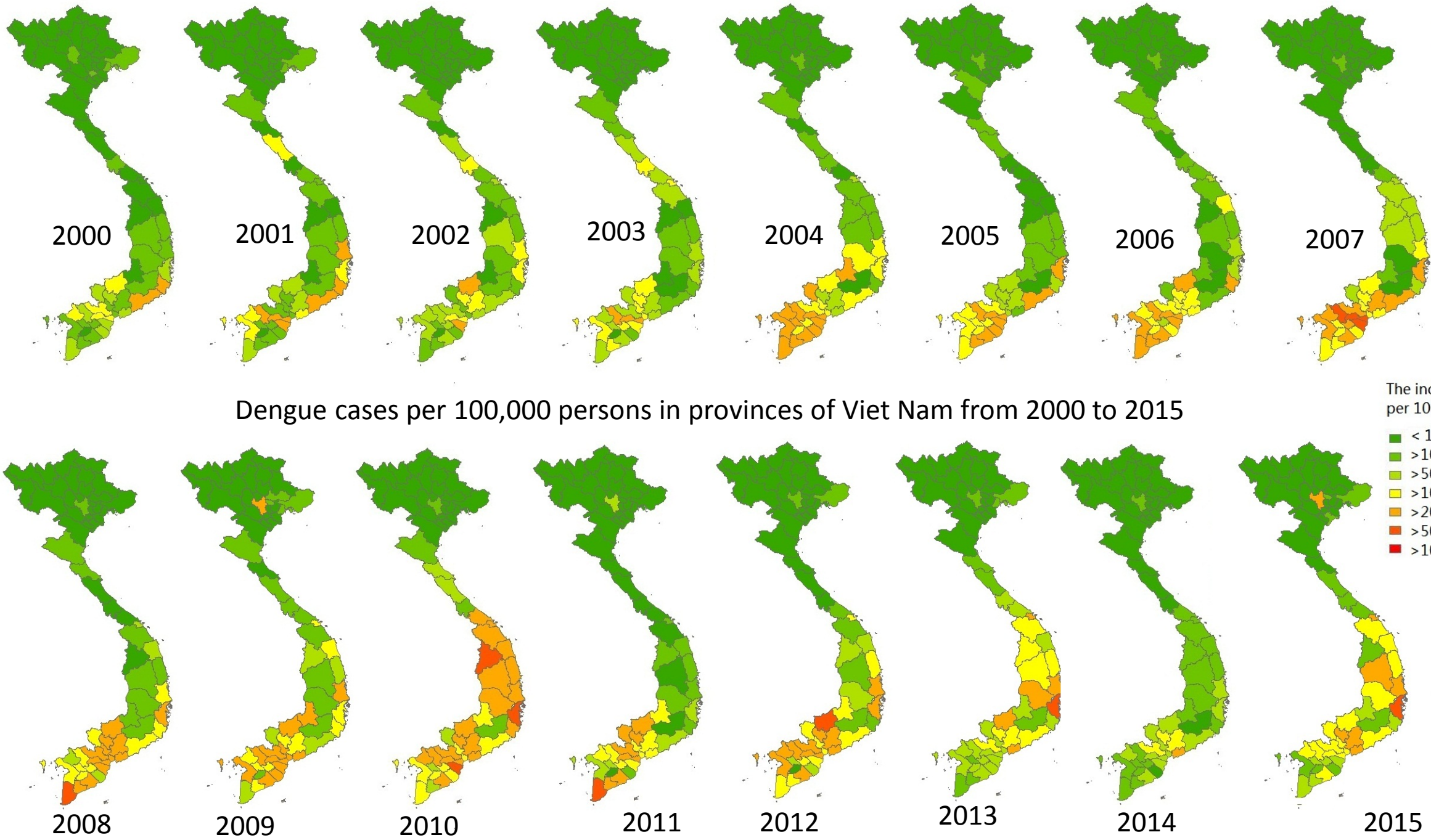




Dengue cases of Mekong Delta and Viet Nam

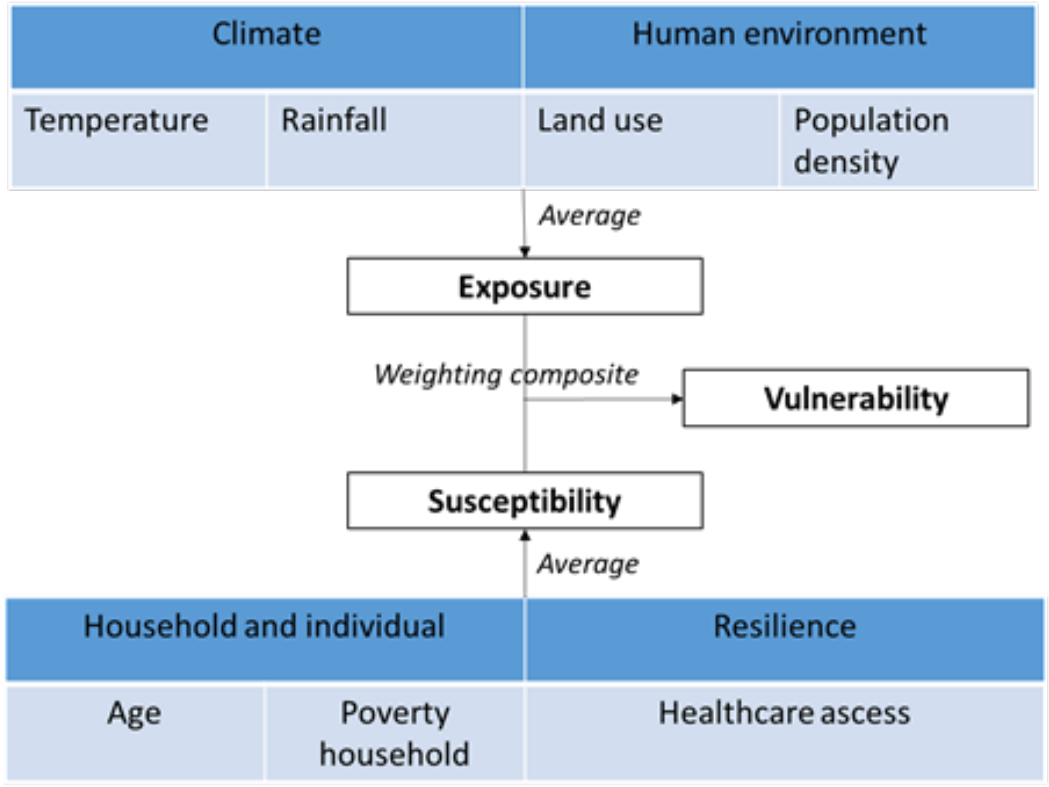
Dengue transmission occurs throughout the year and increases toward a peak between July and September which coincides with the rainy season in the Southern of Vietnam (Cuong, 2013, Thuy 2015, Toan 2015). Aedes aegypti is principal vector responsible to dengue transmission in ở Mekong delta provinces (Yukiko et al., 2010, Thuy, 2015), especially during wet season in rural and transition areas of the Southern region of Vietnam the number of aedes aegypti was higher than that in urban as well as other regions of Vietnam (Yukiko et al., 2010). Thi et al. (2001), Toan (2015) recognized that the majority of dengue cases and deaths came from rural areas of the Mekong Delta.

- Cuong, H., Vu, N., Cazelles, B., Boni, M. F., Thai, K., Rabaa, M. A., Anders, K. L. (2013). Spatiotemporal Dynamics of Dengue Epidemics, Southern Vietnam. Emerging Infectious Diseases, 19(6), 945-953. https://dx.doi.org/10.3201/eid1906.121323.
- Thuy NTT, Peter Horby et. al., The Atlas of Communicable Diseases In Vietnam From 2000 To 2011, National Institute of Hygiene and Epidemiology & Oxford University Clinical Research Unit, 2015
- Toan Do Thi Thanh, Climate change and dengue transmission in Vietnam: an integrated assessment, Doctoral Thesis, Maastricht University, Dec. 2015
- Yukiko Higa, Nguyen Thi Yen, Hitoshi Kawada, Tran Hai Son, Nguyen Thuy Hoa, and Masahiro Takagi, Geographic Distribution of Aedes aegypti and Aedes albopictus Collected from Used Tires in Vietnam. Journal of the American Mosquito Control Association Mar 2010 : Vol. 26, Issue 1, pg(s) 1-9 doi: 10.2987/09-5945.1
- Thi Kim Tien, N., Tuan, A., Ngoc, N., Tuan, K. M., Trong Toan, N., & Quang, L. C. (2001). Epidemiological Analysis of Deaths Associated with Dengue Haemorrhagic Fever in Southern Viet Nam in 1999-2000.


2000
2001
2002
2003
2004
2005
2006
2007
Dengue cases per 100,000 persons in provinces of Viet Nam from 2000 to 2015
The incidence of dengue per 100,000 persons
< 10
>10-50
>50-100
>100-200
>200-500
>500-1000
>1000
2008
2009
2010
2011
2012
2013
2014
2015

Methodology

Vulnerability index = 3*Exposure Indicator + Susceptibility Indicator



the conceptual framework to assess vulnerability to dengue

Susceptibility indicator

Component	*Data sources*	*Threshold*	*Threshold Source*
Age under 15 years	The General Statistic Office of Vietnam (2009 census dataset)	% population under 15 years by state	Dickin, 2013
Health care access	Annual report from the General Statistic Office of Vietnam	Density health facilities per square km area	Hagenlocher, 2013
Poverty	Annual report from the General Statistic Office of Vietnam	% poverty household	Hagenlocher, 2013

$$\text{Susceptibility component}_x = (x - x_{\min})/(x_{\max} - x_{\min})$$

- Dickin SK, Schuster-Wallace CJ, Elliott SJ (2013) Developing a Vulnerability Mapping Methodology: Applying the Water-Associated Disease Index to Dengue in Malaysia. PLoS ONE 8(5): e63584. doi:10.1371/journal.pone.0063584
- Hagenlocher Michael, Eric Delmelle, Irene Casas and Stefan Kienberger, Assessing socioeconomic vulnerability to dengue fever in Cali, Colombia: statistical vs expert-based modeling. International Journal of Health Geographics 2013; 12:36. DOI: 10.1186/1476-072X-12-36

Exposure indicator

Component	*Data sources*	*Threshold*	*Value*	*Threshold source*
Landcover	MODIS Land Cover Type Yearly L3 Global 500m (MCD12Q1) using classification type 3	Forest	0	Cheong (2014), Dickin (2014)
		Bare soil	0.2	
		Shrubs	0.17	
		Mixed horticulture	0.25	
		Water	0.3	
		Cereal agriculture/ paddy field	0.45	
		Urban	1	
Population density (thousand per square km)	General statistic office	<0.1	0	Dickin, 2014
		>0.1-<0.25	0.25	
		>0.25-<0.5	0.5	
		>0.5-<1	0.75	
		>1	1	
Temperature	Hydro-meteorology stations	Maximum monthly temperature, lag of 1 months	>20^0C and <34^0C : linear increase in exposure up to 1; <20^0C or >34^0C : 0 exposure	Dickin, 2014
Rainfall	GSMaP data	Monthly cumulative precipitation, lag of 1 months	<300 mm precipitation: linear increase in exposure up to 1; >300 mm monthly precipitation: 0 exposure	Dickin, 2014

- Cheong YL, Leitão PJ, Lakes T., Assessment of land use factors associated with dengue cases in Malaysia using Boosted Regression Trees. Spat Spatiotemporal Epidemiol. 2014 Jul, p.75-84. doi: 10.1016/j.sste.2014.05.002. Epub 2014 Jun 11
- Dickin Sarah K., Corinne J. Schuster-Wallace, Assessing changing vulnerability to dengue in northeastern Brazil using a water-associated disease index approach. Global Environmental Change, Volume 29, November 2014, p.155-164, ISSN 0959-3780

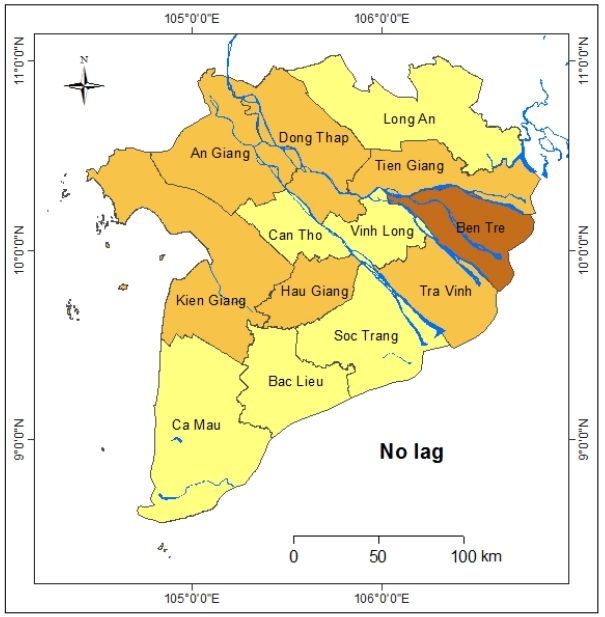
Correlation between Vulnerability and Dengue rate in different lags of Rain and Temperature

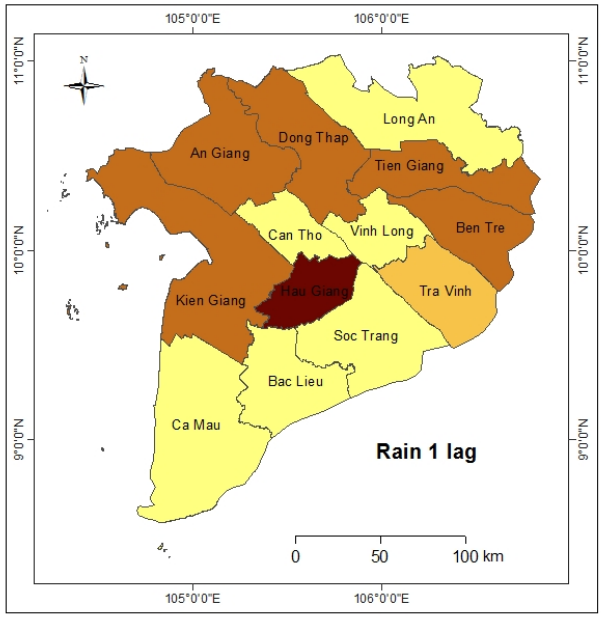
Correlation coefficient

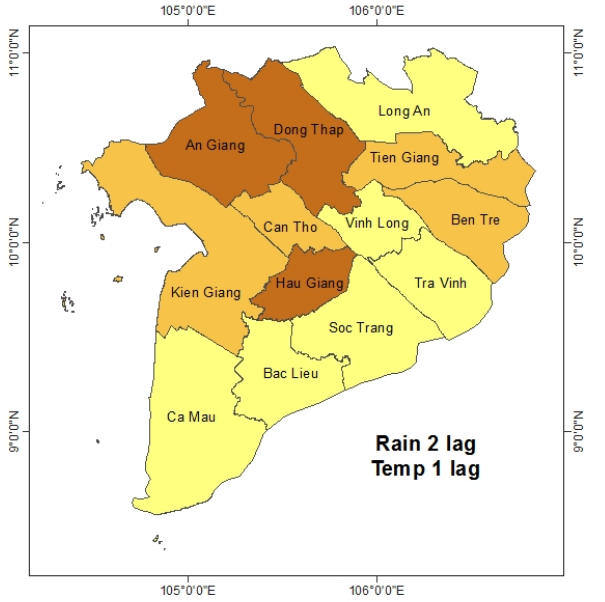
- < 0.3
- 0.3 - 0.4
- 0.4 - 0.5
- > 0.5

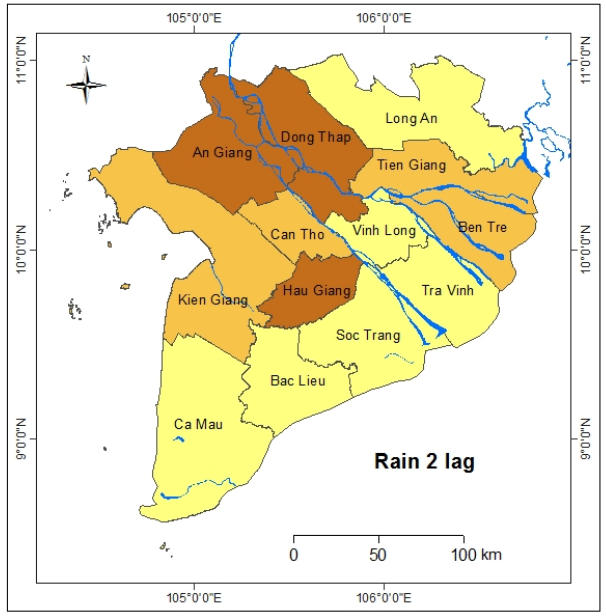
Correlation was calculated using the time series of Vulnerability and Dengue rate from 2002 to 2014 (the whole study period).

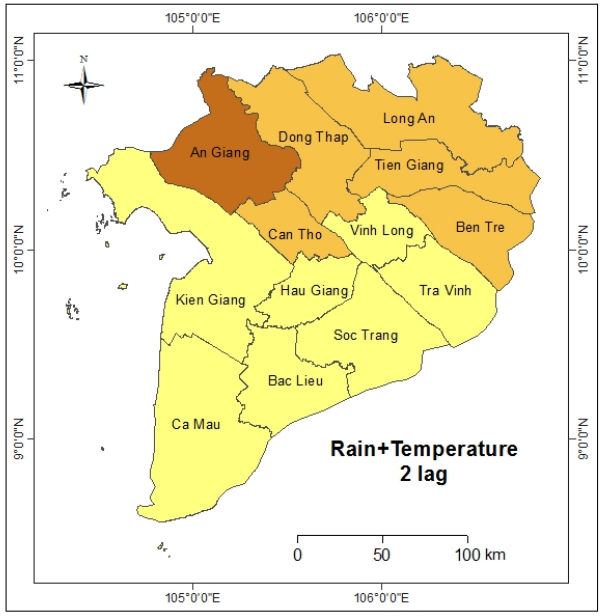
Different lags were taken into account in order to see role of climate variables in different areas which were then divided into groups.

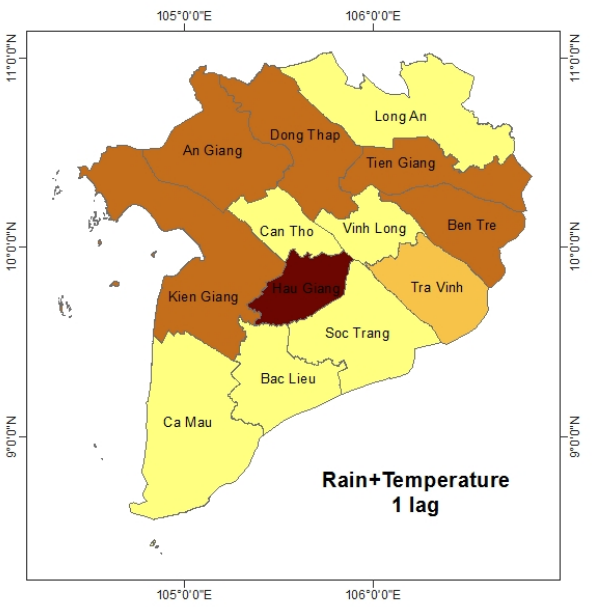










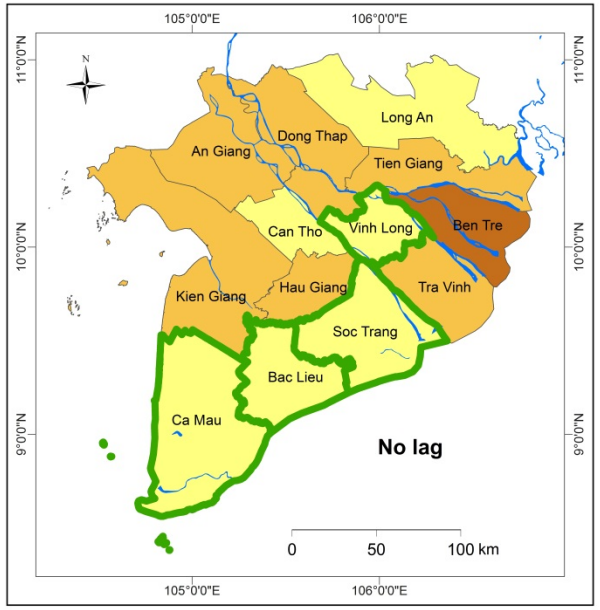


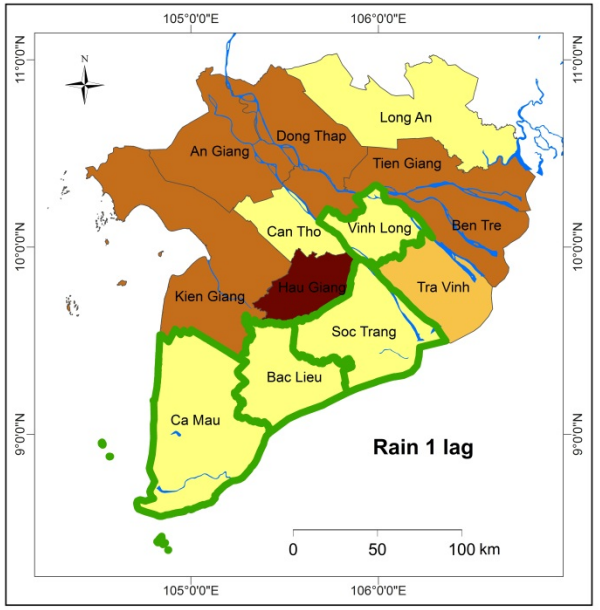
Correlation between Vulnerability and Dengue rate in different lag of Rain and Temperature

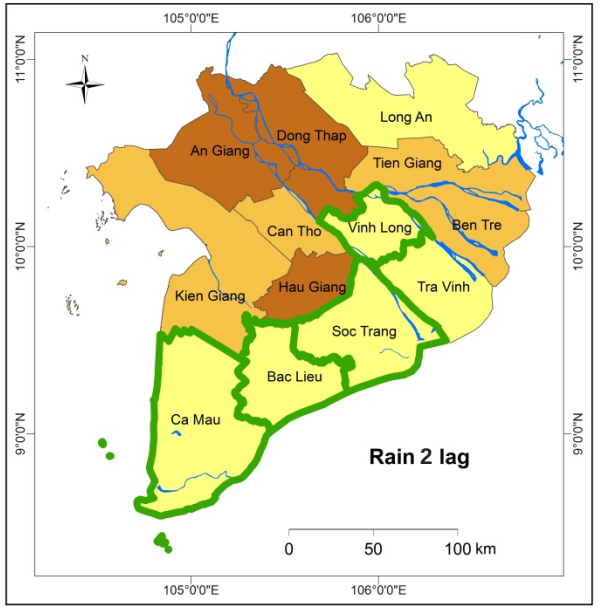
Correlation coefficient

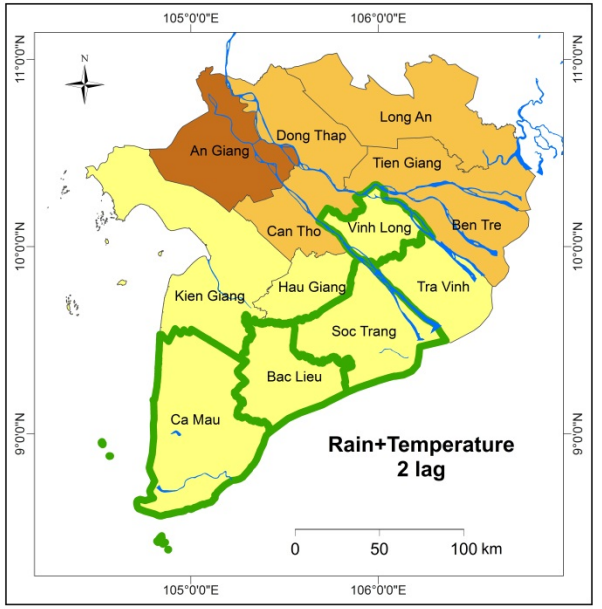
- < 0.3
- 0.3 - 0.4
- 0.4 - 0.5
- > 0.5

Group A: Correlation is **NOT AFFECTED** by climate variables









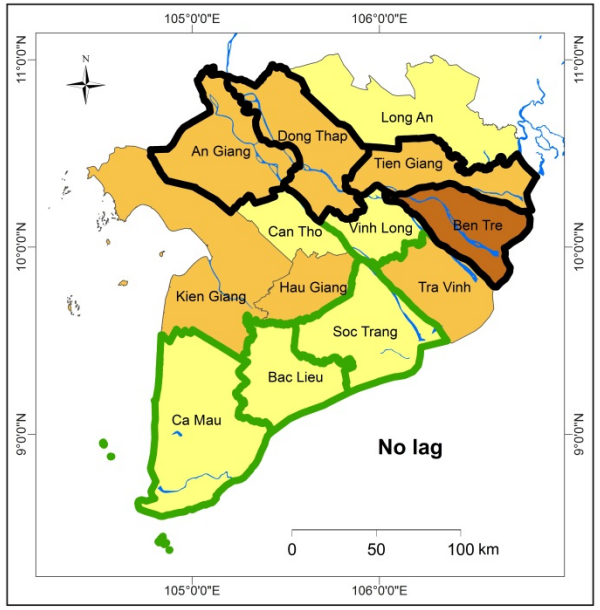
Correlation between Vulnerability and Dengue rate in different lag of Rain and Temperature

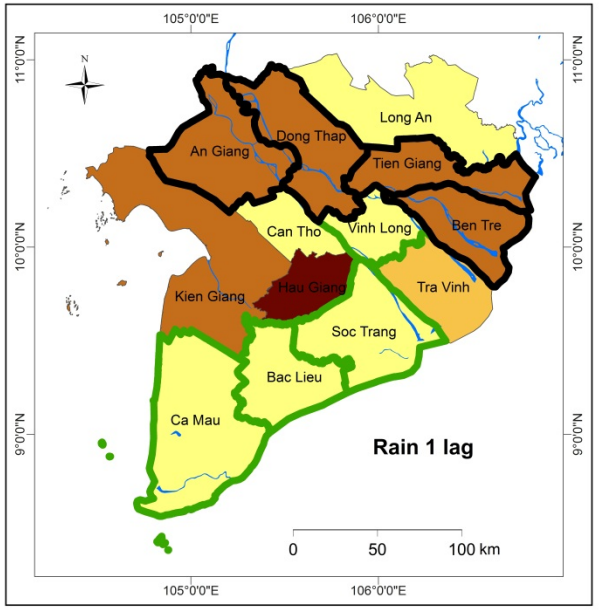
Correlation coefficient

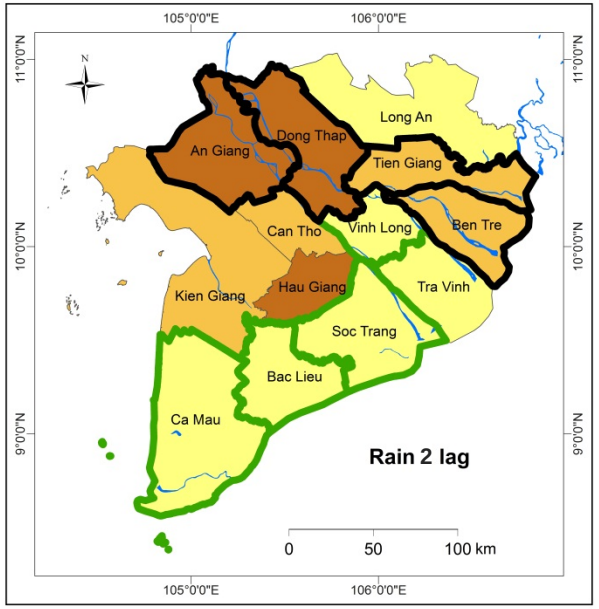
- < 0.3
- 0.3 - 0.4
- 0.4 - 0.5
- > 0.5

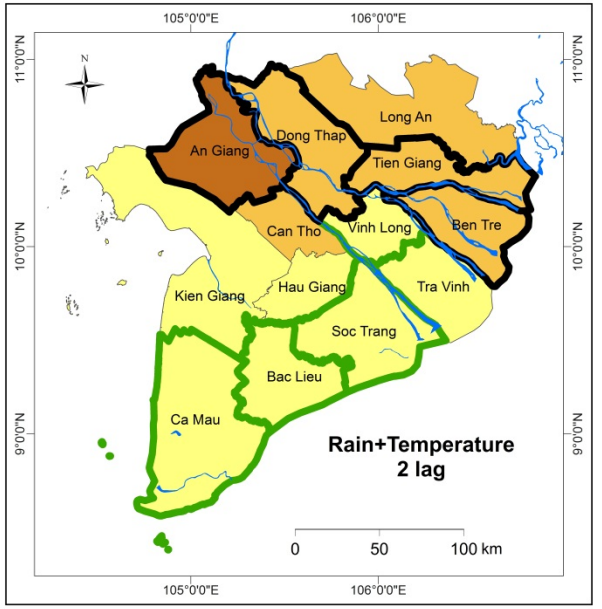
Group A: Correlation is **NOT AFFECTED** by climate variables

Group B: Correlation is **AFFECTED** by climate variables









Correlation between Vulnerability and Dengue rate in different lag of Rain and Temperature

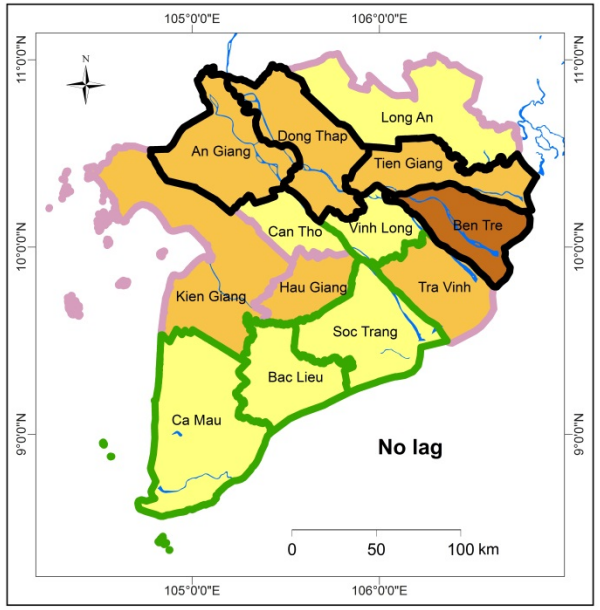
Correlation coefficient

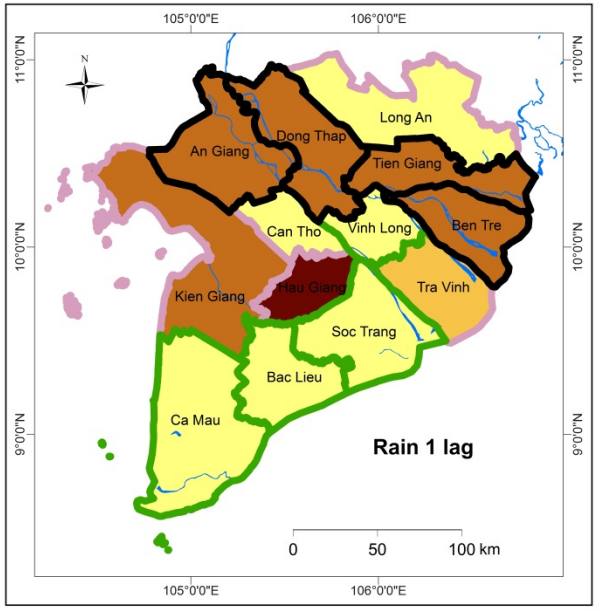
- < 0.3
- 0.3 - 0.4
- 0.4 - 0.5
- > 0.5

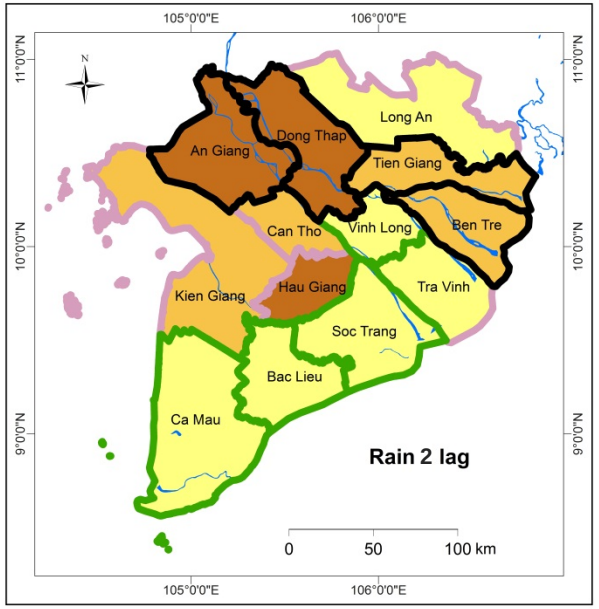
Group A: Correlation is **NOT AFFECTED** by climate variables

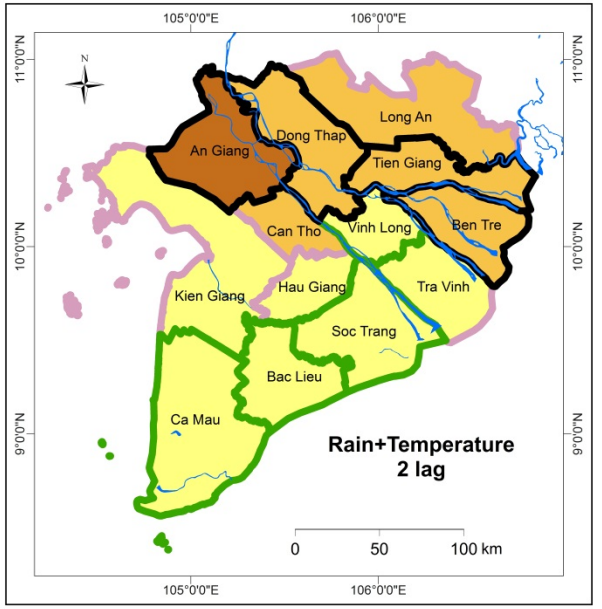
Group B: Correlation is **AFFECTED** by climate variables

Group C: Correlation is **PARTLY AFFECTED** by climate variables







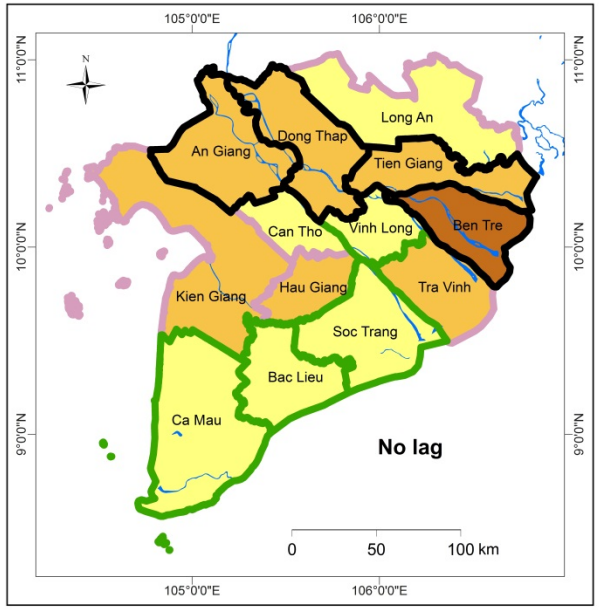


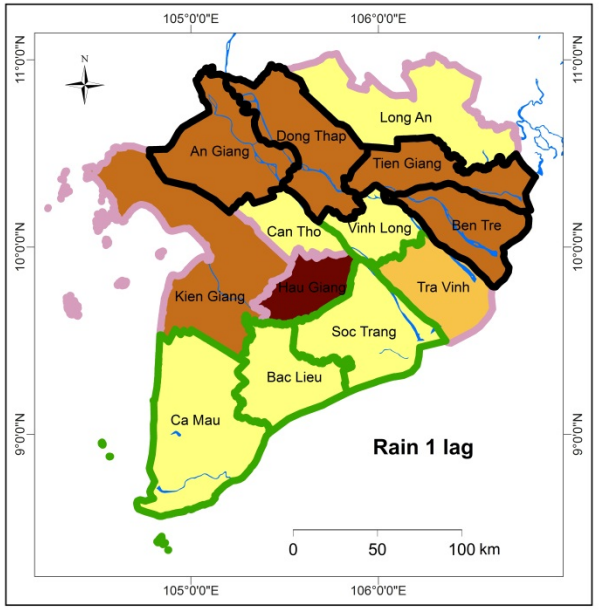
Correlation between Vulnerability and Dengue rate in different lag of Rain and Temperature

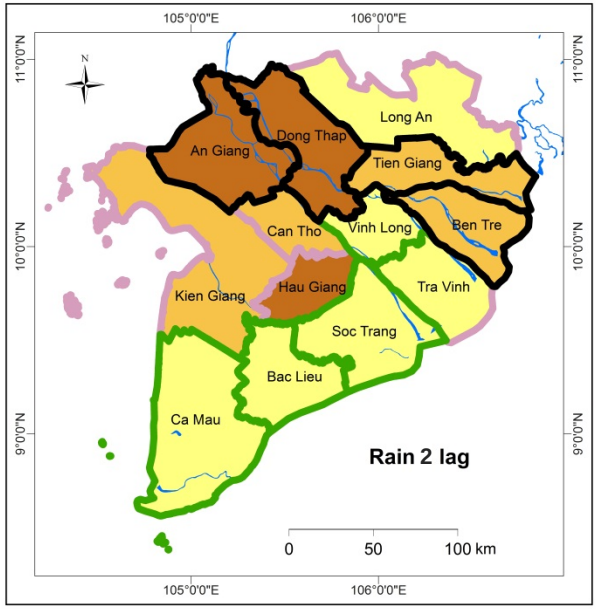
Correlation coefficient

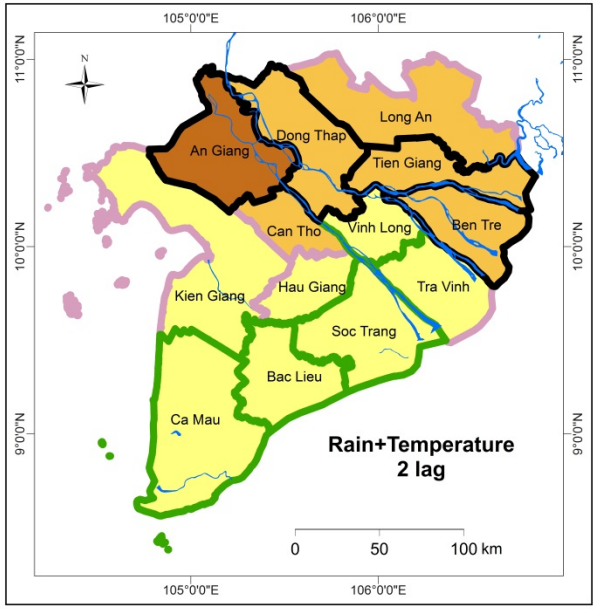
- < 0.3
- 0.3 - 0.4
- 0.4 - 0.5
- > 0.5

- Generally, in the provinces bordering the sea, climate variables play *less important* roles than in other ones.
- Again, The provinces, except Vinh Long where the Tien river through shows stronger correlation.



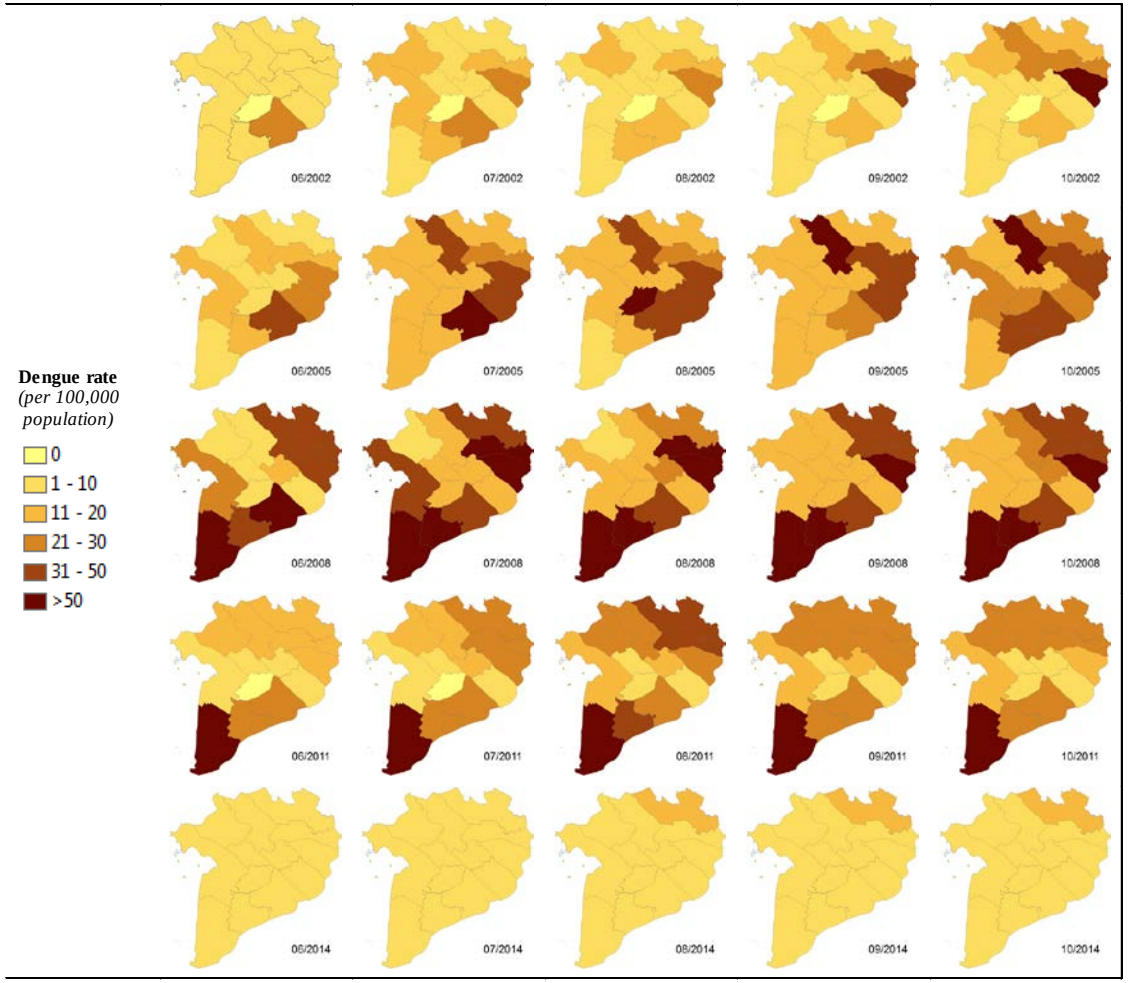




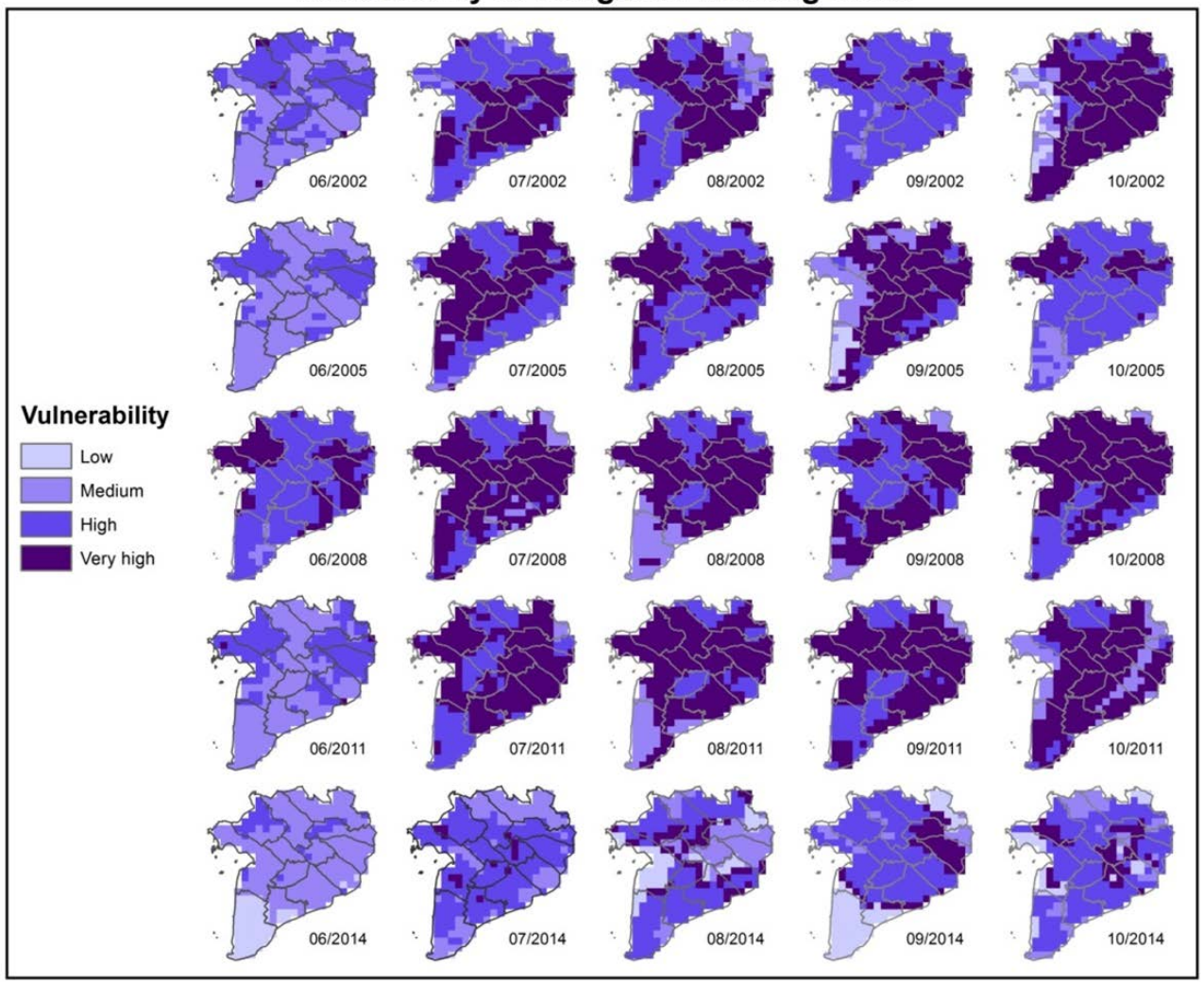


Results

Dengue Rate in Mekong Delta



Vulnerability to Dengue in Mekong Delta



Validation

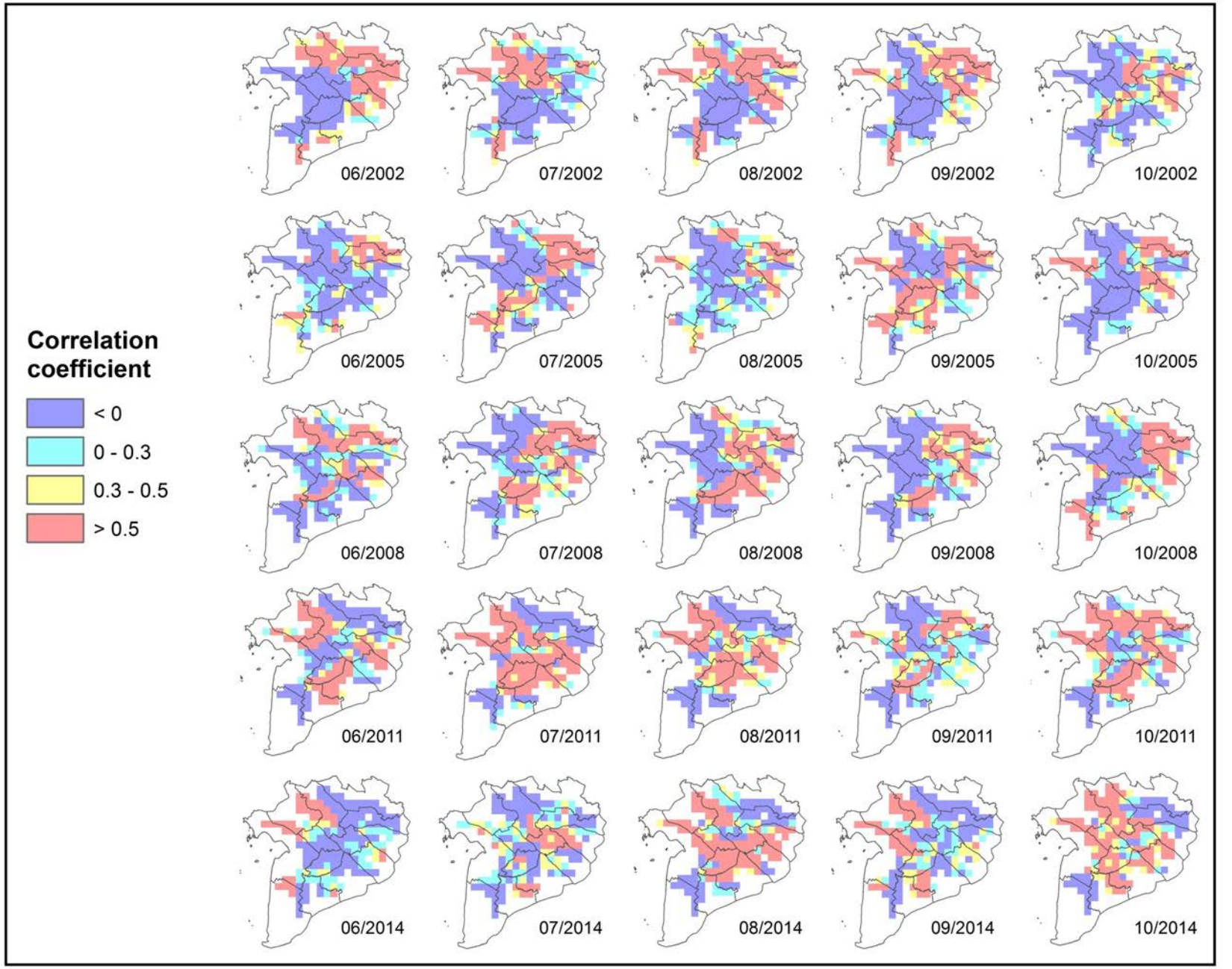
The vulnerability outputs were validated using monthly dengue rate obtained from database of the Vietnamese Ministry of Health. Correlation coefficients were used to evaluate the associations between dengue rates and vulnerability values that aggregated at the province level. The Pearson correlation coefficient, which represents the linear relationship, between dengue rate and vulnerability within each year since 2002 to 2014 are calculated for each province.

Province	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	*No. of years >0.5*	*No. of years >0.7*
Vinh Long	0.48	*0.03	0.75	0.86	0.67	*0.21	0.82	*-0.11	0.90	0.80	0.44	*-0.20	0.53	*7*	*5*
Long An	0.90	0.72	0.73	0.81	0.70	0.88	0.92	0.54	0.57	0.83	0.54	0.84	0.87	*13*	*10*
Tien Giang	0.94	0.55	0.92	0.84	0.77	0.29	0.93	0.49	0.58	0.97	0.64	0.48	0.69	*10*	*6*
Ben Tre	0.90	0.49	0.25	0.92	0.57	0.51	0.92	0.40	0.72	0.71	0.63	0.58	0.46	*10*	*5*
Dong Thap	0.74	0.77	0.59	0.82	0.72	0.72	0.72	0.85	0.92	0.81	0.66	*0.06	0.58	*13*	*10*
Ca Mau	0.89	0.63	0.72	0.82	0.35	0.78	0.65	*0.08	0.56	0.79	0.26	0.38	0.42	*8*	*5*
Bac Lieu	0.53	0.79	*0.11	0.64	0.29	0.76	0.83	0.38	0.63	0.84	0.77	0.56	-0.07	*9*	*5*
Can Tho	0.52	0.73	0.64	0.71	0.87	0.47	0.73	0.66	0.64	0.84	0.70	0.38	0.63	*12*	*7*
Hau Giang			0.89	0.40	0.66	0.88	0.94	0.58	0.63	0.52	0.43	0.61	0.54	*9*	*3*
Tra Vinh	0.85	0.88	0.68	0.80	*0.16	0.71	0.90	0.50	0.72	0.62	0.72	0.23	0.57	*11*	*7*
An Giang	0.86	0.50	0.85	0.75	0.32	0.62	0.71	0.68	0.79	0.88	0.53	0.30	0.76	*11*	*7*
Kien Giang	0.68	0.76	0.68	0.81	0.51	0.54	0.87	*0.14	0.89	0.82	*0.10	*0.18	*-0.54	*9*	*5*
Soc Trang	0.59	*-0.37	*-0.12	0.50	0.38	0.60	0.67	0.28	0.80	0.79	0.72	*0.13	0.49	*6*	*3*
No. of provinces >0.5	*11*	*8*	*10*	*11*	*8*	*10*	*13*	*6*	*13*	*13*	*9*	*4*	*8*		
No. of provinces >0.7	*7*	*6*	*6*	*10*	*4*	*6*	*11*	*1*	*7*	*11*	*4*	*1*	*2*		

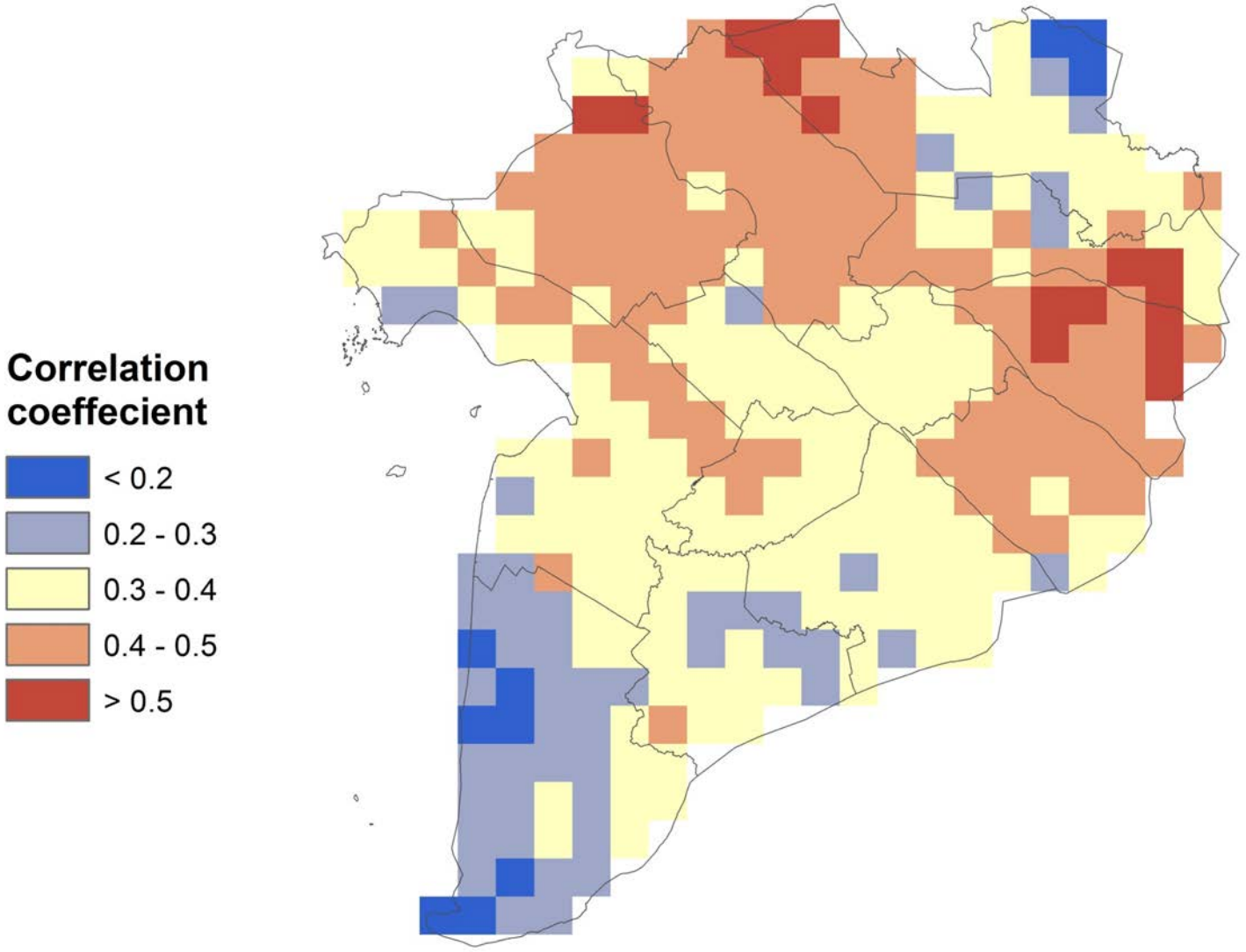
(*) $\rho > 0.05$

Pearson correlation coefficient between dengue rate and vulnerability index for each year ($\rho \leq 0.05$)

Spatially localized Correlation between Vulnerability and Dengue Rate using a 3x3 window sliding



Spatially localized correlation between Vulnerability index and Dengue rate from 2002 to 2014



Summary

- The maps of vulnerability to dengue for MDR seem to be effective evidence to utilize geospatial technology to support public health authorizes in disease control and intervention.
- Under climate change impacts the provinces along the Tien river are more vulnerable to dengue that others in Mekong delta.
- Mapping vulnerability to dengue with 1 months lag of rainfall and temperature contributes to warn early and to identify areas where a population is high vulnerable if dengue fever outbreaks.
- The most essential challenge of existing approaches in mapping dengue risk is to improve accuracy in describing spatially localized dengue distribution.

http://apn-climateandhealth.com/DetailNews.aspx?id=1224

Thank you