Natural Resources and Conflict in LATAM

by Courtney Muro

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Will the interaction between Energy Nationalism and Climate Change cause Conflict in Latin America?

I. Introduction

Natural resources have been the cause of conflict among societies for both reasons of need and reasons of greed. Countries that don't have enough have waged war to on countries that have too much. This imbalance is often the true source of the conflict, and is exasperated by other factors, such as weak institutions, unstable income gap, and social unrest. With unpredictable climate changes on the horizon, we can expect pressure on natural resources to inflate, possibly causing shocks. In turn, existing competition over these resources may erupt into instability, and even violent conflict.[1]

I.I. Energy Nationalism in Latin America

A new type of nationalism is emerging in Latin America (LATAM). Reminiscent of the Import Substitution Model Industrialization (ISI) model of the 1950s, 60s and 70s, which advocates domestic production in place of imports,[2] this backlash against the 90s liberalization reforms uses measures such as tax reform and blocks non-LATAM economies from gaining access to LATAM resources. One result of these reforms has been a large increase in state revenue from hydrocarbon exports, with Venezuela, in particular, raising taxes on multinational companies' export revenues from 20% to 80%.[3]

These policies have been collectively termed Latin America's Energy Nationalism, and the extreme version of this story is the Bolivarian Alliance for the Peoples of Our America (ALBA). Based on socialist doctrine to counter to what its founders Hugo Chavez and Fidel Castro, among others, see as rampant external capitalism in the region, ALBA proclaims to take a stance against the imperialism of the Free Trade Area of the Americas (FTAA), proposed by the United States, which aims to create an open, integrated market across North, Central, and South America.[4] One of the ways in which ALBA is leading this fight is by using energy exports as a political weapon – in a spirit of energy nationalism[5] - against the imperial forces from the north.

Late Venezuelan president Hugo Chavez had a 5,000-mile, $20 billion project in mind to expand his country's natural gas exports to importers as far away as China – known as the Great Gas Pipeline of the South. Announcing plans to cut through the Amazon rainforest and river, displacing people and ecosystems, he made no effort to conceal the true motive behind the risky initiative as geopolitical: "Here in this South America, from the Caribbean to Patagonia, we'll build a great bloc of political, economic and social power to seek world equilibrium this century, where we don't have one policeman who wants to be the owner of the world."[6]

But conflict over LATAM's resources is not exclusively a North-South problem. There has also been a substantial amount of inner-continental skirmish, as neighboring countries jockey for rights to manage and use these resources; and this competition is exacerbated by the fact that LATAM has an uneven distribution of energy endowment, to an extent which can promote unhealthy competition. Summarily, Chile, Paraguay, Uruguay and the countries of Central America and the Caribbean are net importers of energy, while Venezuela, Bolivia, Ecuador, Colombia, Peru, Mexico, Brazil, and Argentina have the means to be net exporters. [7]

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[1] A New Climate for Peace
[2] Import Substitution
[3] Isbell, Paul. Energy and Geopolitics in Latin America
[4] Wikipedia. ALBA
[5] Isbell, Paul. Energy and Geopolitics in Latin America
[6] Gould, Jens Erik. *Plan for South American Pipeline Has Ambitions Beyond Gas*
[7] Isbell, Paul. Energy and Geopolitics in Latin America

In the face of climate change, environments in LATAM have become disturbed. Recent years have seen droughts and fires. Food security is on high alert, with some experts warning that the magnitude of humanitarian assistance that will be needed to alleviate these shocks will be as great as it was during 1998's Hurricane Mitch, when 100,000 refugees migrated to the United States.[8] If these projected shocks are to take place, will past experience indicate that places with more natural resources to experience more or less conflict? We could look at this question from 2 perspectives: either the presence of natural resources will alleviate the pressure caused by climate change, and countries with resources will feel secure enough not to fight over them, or the presence of resources will cause more conflict, as countries will compete over their use. My hypothesis is that natural resources in LATAM are associated with increased conflict. If this is the case, then conflict in the region will surely be intensified as climate change further disrupts the environment.

I.II. Literature Review on Natural Resources and Conflict in LATAM

LATAM's gas reserves are concentrated in the northern Andean region, particularly in Venezuela, Bolivia and Peru.[9] At the southern part of the mountain range, Chile is the region's most reliant on gas imports, with 2/3 of its consumption being dependent on Argentina.[10] Although Brazil has third-largest gas reserves in the region and considerable potential in the long run (with oil production doubling over the last decade)[11] it has yet to harness this potential at the rate at which its demand grows. It is still a net importer,[12] dependent mainly on Bolivia and Argentina. Venezuela imports gas from Colombia; 85% of which is used for extraction and production of oil, which in turn accounts for 75% of Venezuela's total exports, over 50% of government revenue and about 30% of its GDP.[13] Although inefficient, this oil production has continued because it is a vital part of Venezuela's political position in the region. Oil-diplomacy has been the basis of Venezuela's network coalition with Nicaragua, Cuba, Bolivia, Ecuador, and even Argentina.[14]

LATAM has become an epicenter of global mining,[15] and minerals in the region are no stranger to conflict. The 4-year War of the Pacific is the prime example. Fought between Chile, Peru, and Bolivia in 1879 over Bolivian taxes on a Chilean mining company in a shared mining zone, this conflict was exacerbated by unclear boundary lines in the desert.[16] Points of contention from this war have not yet been resolved. In particular, Bolivians are taught from an early age that their place as one of only two landlocked countries in the region is a direct result of Chile's acquisition of Atacam territories during the war, and that their economic hardships are a result of this.[17] As Bolivia is a member of ALBA, grudges have been stirred by flamboyant Huge Chavez, for example in his speech where he claimed to have had a dream in which he was swimming in a Bolivian sea[18] - a move that provoked Chile to recall its ambassador to Venezuela.[19] Conflict between the three countries regarding exact demarcation of borders has not been resolved, and other smaller conflicts have flared up since.[20]

Although we have not historically seen water wars, it is not an unrealistic concern for the future. Demand for water is growing, while climate change and pollution are decreasing supply. By some

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[8] National Public Radio. *Drought Conditions Wreak Havoc On Latin America*
[9] Isbell, Paul. Energy and Geopolitics in Latin America
[10] Isbell, Paul. Energy and Geopolitics in Latin America
[11] Isbell, Paul. Energy and Geopolitics in Latin America
[12] Isbell, Paul. Energy and Geopolitics in Latin America
[13] Isbell, Paul. Energy and Geopolitics in Latin America
[14] Isbell, Paul. Energy and Geopolitics in Latin America
[15] Entitle Blog. *Mining Conflicts in Latin America: Extraction, dispossession and violence. State of the art for 2014*
[16] Hudson, Rex A. *Chile: A Country Study: War of the Pacific, 1879-83*
[17] The Economist. Chile and Bolivia: The inalienable right to a beach
[18] The Economist. Chile and Bolivia: The inalienable right to a beach
[19] The Economist. Chile and Bolivia: The inalienable right to a beach
[20] Observatorio de ConflictosMineros de America Latina. *Mapa de conflictos mineros, proyectos y empresas mineras en América*

measures, 80% of the world's water security is already 'seriously threatened.'[21] And "for each 1°C of global warming, 7 percent of the global population will lose at least 20 percent of its renewable water resources."[22] Because this disconnect between supply and demand is occurring at unprecedented rates, past experience may not be a predictor of the future.[23] Over the past 30 years, international financial institutions such as the World Bank and the International Monetary Fund have attempted to remedy these issues by imposing neoliberal economic privatization policies on developing countries. Many of these policies have transferred the rights of water basins to multinational corporations, ultimately transforming water from a public good to a private good. Lower and middle-class groups are often negatively affected by these policies, and have protested them, defending their inalienable rights to water. Chile,[24] Bolivia,[25] and Argentina[26] have already seen such protests. Most recently, the Guatemalan government declared a state of emergency after the 2014 drought left 170,00 families experiencing total crop failure.[27] A hot topic right now is a Hong Kong based company's "inaugurated construction"[28] on the Nicaragua Canal. Protests highlight potentially catastrophic environmental impacts, the displacement of rural people from their land, as well as the overt influence this allows China, which has not been a model of human rights or environmental concern, over Latin American affairs.

Water scarcity can also cause conflict via other natural disasters, such fires caused by droughts. A recent study by Emily Foecke of UCSD found a 6% positive correlation between forest fires and criminal activity[29] in Indonesia, statistically significant at the 95% confidence level. If these results carried over to Bolivia, the 47,000 forest fires caused by the 2014 drought[30] could wreak havoc on the already fragile Bolivian civil harmony.

One indirect route through which natural resources can cause conflict in LATAM is via rising food prices. Venezuela and Brazil have both seen protests as a result of shocks in food security.[31] Although there are many potentially omitted variables for these incidents, LATAM's reliance on raw commodity exports does make it especially vulnerable to price shocks. In a region where much of its citizenry spends almost half of its total income on food, these shocks can carry disastrous consequences in the way of civil unrest.

II. Methods

I.I. Data Assembly

Data for the dependent variable, conflict, was downloaded in the form of a .csv file from the Peace Research Institute Oslo (PRIO), and covers all conflicts from 1989-2008, at the conflict-year level. For our purposes a 'conflict' is "a contested incompatibility that concerns government and/or territory where the use of armed force between two parties, of which at least one is the government of a state, results in at least 25 battle-related deaths."[32] The location is based on the center point of the conflict with a surrounding circular radius that extends to the farthest point of conflict, rounded upwards to the nearest 50 km, and ignoring outlying values. A caveat of this data is that more area is covered in the radius than

[21] A New Climate for Peace
[22] A New Climate for Peace
[23] A New Climate for Peace
[24] Coleman, Thomas. *Who Owns the Water? An Analysis of Water Conflicts in Latin American and Modern Water Law*
[25] Coleman, Thomas. *Who Owns the Water? An Analysis of Water Conflicts in Latin American and Modern Water Law*
[26] Coleman, Thomas. *Who Owns the Water? An Analysis of Water Conflicts in Latin American and Modern Water Law*
[27] National Public Radio. *Drought Conditions Wreak Havoc On Latin America*
[28] ECC Factbook. *A New Climate for Peace* Full Report
[29] Foecke, Emily. Working paper on forest fires and criminal activity in Indonesia.
[30] National Public Radio. *Drought Conditions Wreak Havoc On Latin America*
[31] Nett, Katharina and Lukas Rüttinger. *The Price of Climate Change: How Volatile Food Prices Spur Social Unrest*
[32] Centre for the Study of Civil Wars, International Peace Research Institute, Oslo (PRIO). *Uppsala Conflict Data Program*

was actually in the conflict. However, it would not be easy to obtain data on the exact location of the LATAM conflict sites, since they are predominately insurgencies carried out in guerilla warfare fashion. Because of this, the circular radius is a good way to set a uniform buffer shape from the center point of each conflict, assuming a standardized radius for each one.

Independent variables were acquired from PRIO, Environmental Systems Research Institute, Gordon McCord of UCSD, Diego Puga of CEMFI, and the World Bank, to be used for spatial integration and analysis. A comprehensive dataset of all known diamond deposits in the world, broken down by lootability and production yield, as well as a dataset on all known on- and offshore oil and gas deposits were obtained from PRIO, in the form of geocoded shapefiles. Shapefiles for rivers and minerals were obtained from the Environmental Systems Research Institute, and oceans, lakes, and land topography shapefiles were obtained from McCord's online database on Ted.ucsd.edu. A comprehensive composite indicator for ruggedness of terrain derived from slope, percentage desert, percent tropical, distance to the coast, gemstone extraction, and other relevant indicators was downloaded from Puga's website, in the form of a .csv file. It was projected onto the map using the *Display XY* tool, displayed on latitude and longitude. A country-level variable for income was downloaded from the World Bank, and joined to the, now projected, ruggedness of terrain indicator by iso code (country) to allow income to use ruggedness of terrain's latitude and longitude so that it could be mapped in ArcGIS 10.2™ (ESRI, 2013-2014). All files were then projected to the World Geodetic System WGS_1984 projection because this was the existing projection of my dependent variable and worked for my purposes.

I.II. Analysis

In preparation for analysis, a file was created using a national boundaries selection containing only LATAM countries, and a buffer 200 miles out from the coast to the sea, so as to capture the hydrocarbon rights of nations' exclusive economic activity zones.[33] The *processing extent* and *raster analysis* were set in environments to this buffer so that GIS would ignore all data outside of this area when doing calculations. An administrative boundaries shapefile was downloaded from NASA's Socioeconomic Data and Applications Center, clipped with the Latin American buffer boundaries file, and converted to a point file using *feature-to-point,* in order to be used as the new unit of analysis for my calculations. All other variables were converted to rasters using *polygon-to-raster* and *point-to-raster.* I then used *extract-multi-points-to-layer,* with the administrative boundaries point layer as the input point file to extract points from the dependent and independent raster files onto a single point file, which could be used to run Ordinary Least Squares (OLS) and Geographically Weighted Regression (GWR) analyses with an administrative-level unit of analysis.

I ran the OLS model to estimate the relationship between conflict and natural resources within administrative boundaries:

$$Y = \beta_0 + \beta_1 + \beta_2 + \beta_3 + \beta_4 + \beta_5 + \beta_6 + \beta_7 + \beta_8 + \beta_9 + \beta_{10} + \beta_{11} + \beta_{12} + \varepsilon$$

With each given administrative boundary, Y is the number of conflict-years, β_1 is the number of petroleum reserves, β_2 is the number of lootable diamonds reserves yielding no production, β_3 is the number of lootable diamonds reserves yielding production, β_4 is the number of non-lootable diamonds reserves yielding no production, β_5 is the number of non-lootable diamonds reserves yielding no production, β_6 is the number of square kilometers of river within the boundary, β_7 is the number of mineral reserves, β_8 is square kilometers of ocean, β_9 is square kilometers of lakes, β_{10} is topography in meters, β_{11} is a ruggedness of terrain indicator, β_{12} is the World Bank GDP per capital indicator in 2012 USD.

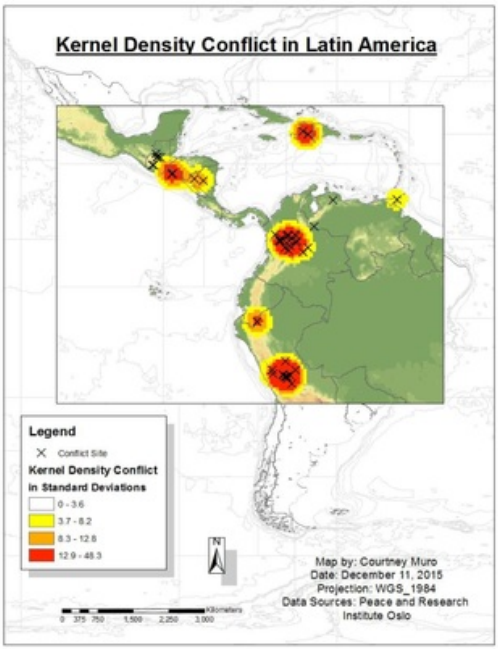
[33] National Oceanic and Atmospheric Administration. *What is the EEZ?*

After OLS, I projected the OLS output to Equidistant Conic and ran that in Moran I model to see if there was spatial autocorrelation in my OLS model. After Moran I, I put the OLS input into a GWR model. Below are the results.

III. Results

III.I. Kernel Density

As our conflict data is in conflict-year level, and conflicts in this region seem to be concentrated in a few geospatial areas, it is difficult to visualize the temporal aspect of our data on a map. To demonstrate the density of conflicts in these areas, I created a Kernel Density map. Using *point to raster*, I converted the conflict layer, and plugged it into the *Kernel Density* tool, leaving it in the default unit of 1-kilometer. The result is that we can see that there are four main geospatial areas of activity over time, and that zooming in on the conflict point layer may actually have been just as effective to visualize LATAM conflict over time and space.



III.II. OLS Model

The OLS results showed petroleum, non-lootable diamonds that haven't yielded production, rivers, minerals, lakes, and topography to be significant, all at the 99% confidence level. The positive association between conflict and petroleum and topography was in line with my hypothesis, but diamonds, rivers, minerals, and lakes all showed negative correlation with conflict, which was the opposite of my expectation, and the expectation of the literature. Furthermore, diamonds and lakes had an incredibly large correlation in terms of magnitude.

Summary of OLS Results				
Variable	Coefficient	Standard Error	T-Statistic	Probablility
intercept	0.3914	2.2164	0.1766	0.8599
petroleum	91.6763	31.5558	2.9052	0.003856*
dDIAL	5.5967	4.2453	1.3183	0.1881
dDIALyp	-11.8828	6.4090	-1.8541	0.0644
dDIANL	-2336.7795	715.7854	-3.2646	0.001193*
dDIANLyp	1376.6976	1814.8945	0.7586	0.4485
river	4.6160	1.5217	3.0334	0.002567*
minerals	-15.3636	5.0277	-3.0558	0.002388*
ocean	4.8241	3.6057	1.3379	0.1816
lakes	-123.8060	28.8060	-4.2979	0.000025*
land topography	0.0013	0.0003	3.6955	0.000258*
ruggedness	0.0071	0.0092	0.7751	0.4387
income	0.0061	0.0110	0.5547	0.5794

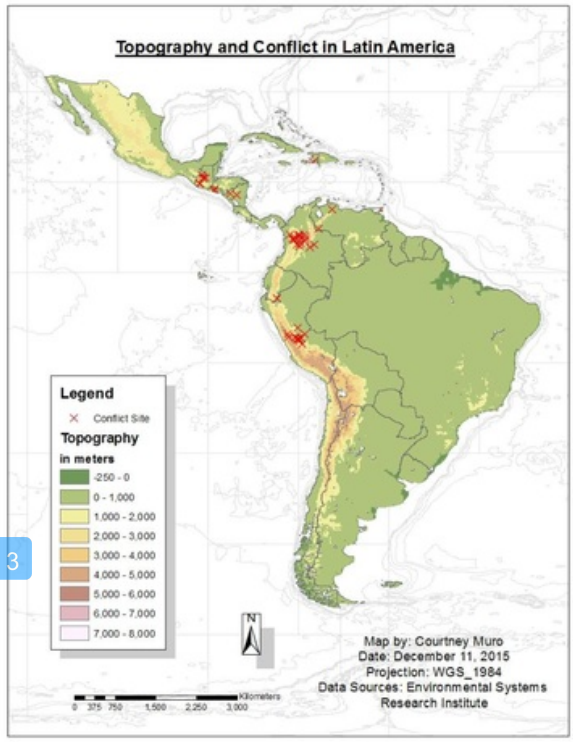
2

Petroleum: Oil and gas was found to increase conflict by 91.67 conflict-years for each deposit of petroleum present in the administrative boundary.

Diamonds: Of all four subsets of diamonds, only non-lootable (secondary) diamonds with no known production were significant. These deposits were exclusively in Venezuela, which is in line with the literature. However, the coefficient on this variable was extremely high, as well as negative, at -2,336.

Minerals: Minerals were found to have a significantly negative effect on conflict as well, with every mineral deposit resulting in -15.36 conflict-years for the administrative boundary.

Water: Rivers and lakes were both found to be significant, but rivers have a positive correlation with conflict, while lakes have a negative correlation. Another difference between the two basin types is that rivers were only associated with 4.6 conflict-years, while lakes were associated with a substantially larger magnitude, of -123.80 conflict-years.



3

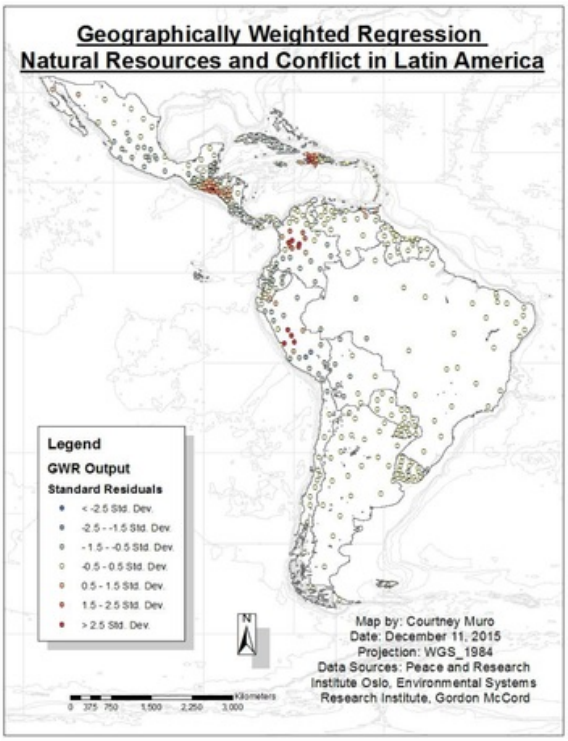
Topography: Although significant, topography was found to have very little impact on conflict in Latin America, in terms of magnitude, with a coefficient of only 0.0013. Furthermore, the ruggedness of terrain indicator was insignificant, with a low coefficient. This surprised me, given that one can visually see on the map that conflicts in this region occur almost exclusively in the Andes Mountain Range.

III.III. Spatial Moran's I Model

Next, I projected the output residuals from the OLS model to Equidistant Conic so that they would be in form for distance calculation. Then I could use the *Spatial Moran's I* model in order to see whether or not the residuals were spatially clustered. The result was a Moran's Index of 0.17, a Z-score of 19.43, and a P-value of 0.00. Being that my Moran is between 0 and 1, I can see that it is between being random and clustered, or that the residuals are spatially autocorrelated. Furthermore, my positive Z-score allows me to reject the null, which is that the errors are random, and my P-value of 0.00 gives me a model confidence level of 99%.

III.IV. GWR Model

To compensate for the Moran's I confirmed spatial autocorrelation, I ran the data in a GWR model, which allows for local, rather than global parameters, using *fixed kernel* and *AIC bandwidth* selections. In this model, observations are weighted according to their proximity point, determined by the kernel size. To see the extent to which this local relationship is significant throughout the region, I used the Fotheringham adjustment to calculate a new T-statistic that accounts for the large sample. The following map shows the varying degrees of statistically significant association between natural resources and conflict. It appears that the two variables are increasingly positively associated with each other as you get closer to the actual points of conflict.



4

IV. Conclusions and Limitations

IV.I. Conclusions

These negative results were disappointing and completely counterintuitive to me, but when conducted further research from this perspective, it appears that there are theories supporting a divergence between short-term and long-term effects of natural resources on conflict. In particular, Soyza and Neumayer contend that a "looting rebels model," which differs from a "civil war model," provides evidence that, although the presence of natural resources can cause conflict in the short-term, in the long term, it can provide large enough wealth to allow governments to constrain rebels.[34]

According to the model, the presence of petroleum and non-lootable diamonds without yielded production can cause conflict in LATAM and therefore can be expected to react as such if affected by climate change. Rivers, minerals, lakes, and topography, however, do not cause conflict in LATAM and, in fact, decrease conflict substantially. It is possible, then, that when faced with the trials and tribulations of climate change, resource-rich LATAM countries can use their endowments as a type of energy nationalism that mitigates potential conflict in the region.

IV.II. Limitations

Future studies should use a fishnet to decrease the size of the unit of observation, so that the model can capture subtle differences within variable values. Similarly, ruggedness of terrain should be analyzed in grid-level, as opposed to country-level, which will require a computer with the means to handle the exceptionally large file. Last, certain independent variables could be added to the model; particularly, sugar, crops, coffee, access to ports, rain forest, land suitable for drugs cultivation, and an institutional quality index.

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[34] De Soysa, Indra and Eric Neumayer. *Resource Wealth and the Risk of Civil War Onset: Results from a New Dataset of Natural Resource Rents, 1970–1999*

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Natural Resources and Conflict in LATAM

GRADEMARK REPORT

FINAL GRADE

85/100

GENERAL COMMENTS

Instructor

PAGE 1

PAGE 2

PAGE 3

Comment 1 | Interpret

It's unclear in the later regression what the dependent variable is measuring - an event or the duration of an event. Not clear why duration is appropriate since you can't use panel data in GIS appropriately this way.

PAGE 4

PAGE 5

Comment 2 | Visualization

Clean-up the regression table, hard to read variables

PAGE 6

PAGE 7

Comment 3 | Visualization

Too many label categories used; refer to Assignment #1

Comment 4 | Interpret

Unclear what the unit of analysis is in this image - Areas of conflict? Cities?

PAGE 8

Comment 5 | Take away

It's hard to make sense of the results when it's unclear how the variables are measured, especially since this is a time-series data forced into a single cut of the data

RUBRIC: FINAL PROJECT 0.85 / 1

GIS TOOLS - 1 (10%) 1 / 1

At least three GIS tools utilized appropriately

0
(0)

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1
(1)

GIS TOOLS - 2 (10%) 1 / 1

Tools used are clearly relevant and appropriate for the question, and clear justifications are provided.

0
(0)

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(1)

STEP-BY-STEP (10%) 1 / 1

Step by step walk-through of the procedures used are described in detail.

0
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(1)

VISUALIZATION (10%) 0.50 / 1

Map, table, or any other visualization are provided with proper format and aesthetics.

0
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RESEARCH Q (10%) 1 / 1

There is a clearly stated research question.

0
(0)

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MOTIVATION (10%) 1 / 1

Sufficient motivation is provided as to why this question is important.

0
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(1)

STRUCTURE (10%) 1 / 1

The paper has a full and complete structure appropriate for a proper research paper, i.e. introduction, conclusion, etc.

0
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0.5
(0.50)

1
(1)

INTERPRET (10%) 0.50 / 1

Full and proper interpretations of the findings are provided.

0
(0)

0.5
(0.50)

1
(1)

SIGNIFICANCE (10%) 1 / 1

Similar works are acknowledged with a proper literature review, or at least with a discussions of how this research question fits in a larger picture.

0
(0)

0.5
(0.50)

1
(1)

TAKE AWAY (10%) 0.50 / 1

Answer to "So, what do we learn from this project? What's the story?"

0
(0)

0.5
(0.50)

1
(1)