# Climate, Yams and Precolonial Centralization in Africa - Preliminary Version - Please do not cite

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**Abstract**

Recent studies have highlighted the importance of precolonial political centralization in Africa for current economic outcomes. The factors that promoted or hindered centralization in Africa are also being researched. In this paper I examine the relationship between potential agricultural output and centralization. Diamond (1997) argues that agricultural surpluses are essential for state formation. I however find that the within Africa, areas with the most potential for agricultural yields were less centralized than other areas. I examine court records on land disputes from Eastern Nigeria during the colonial era to explain this phenomenon.

**Keywords:**Africa; Agriculture; Precolonial Centralization

**Classification Numbers:** O1, N, Q1.

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# 1 Introduction

Various studies have highlighted the essential important of agriculture to the development of states as centralized political organizations. Although the rise of states cannot be attributed solely to agriculture and the domestication of plants and animals, it played a major role (Allen 1997; Maisels, 1990). It has argued that the rise of agriculture preceded the rise of political organization almost everywhere. According to Putterman (2008) and Wright (1977), research has yet to discover a prehistoric society with centralized political organization without agricultural food production. Based on the work of Diamond, 1997, agricultural production provides the foundations through which organized states emerge. Johnson and Earle (2000) argue that agriculture induces population growth. The increased population growth creates opportunities for life outside subsistence agriculture. In the presence of increased population growth and food surpluses, opportunities exist for soldiers, artisans, and so on. These opportunities outside agriculture would not exist in early societies without the agricultural members of society growing enough food to feed the rest. In essence Diamond argues that state formation in some way depends on the ability of to produce excess food. This idea is supported by Ashraf and Galor (2011) establish a link between the Malthusian ideas of technological progress leading to population growth. Easterly and Gong (2010) also show that the timing of historical technological adoption shaped by the timing of agriculture has a significant impact on the contemporary economic performance.

The distribution of potential for agriculture is however not completely random. Diamond argues that early civilization arose in the Middle East first partly because of the existence of plants and animals suitable for domestication. Early states then sprung up in areas most suitable for agriculture and surplus food production. In that context more fertile areas stood a better chance of discovering or implementing agriculture leading to more sedentary communities and subsequent political organization than less fertile areas.

Agriculture in Sub Saharan Africa has followed a similar trajectory with regards to the movement from hunter-gatherers to sedentary settlements. Some early communities domesticated animals and crops and became sedentary whereas others did not. In terms of crop domestication, perhaps the most important agricultural crop in sub Saharan Africa is the yam, Dioscorea. Various authors argue that certain species of yams were originally domesticated in Africa (Watt, 1890; Chevalier, 1909; Burkill, 1921; Davies, 1968; Coursey, 1976). Although there are dissenting voices (Dumont, 1966; Murdock, 1959), the importance of yams in African agriculture cannot be disputed.

However not all parts of Africa are endowed with the same yam growing potential. Some areas have more suitable temperature, soil types and climate for yam production. In essence some areas have the potential for much higher yields per acre of yams than other areas. In the context of state formation through the food surplus hypothesis, areas with a higher probability of food surpluses from yam cultivation should be able to support a larger non-farming fraction of the population and maybe have a higher probability of state formation.

Various studies have already documented the importance of climate and climate shock on various measures economic development and social structure in Africa and beyond. Ashraf and Michalopolous (2013) show that climate and climatic disturbances influenced the timing of the diffusion of agriculture and the adoption of farming. They argue that climatic shocks that did not lead to the collapse of the resource base influenced the rate at which hunter gatherers transitioned to agriculture. Fenske and Kala (2014) for instance show that African economies responded to climate shocks during period of the Atlantic slave trades. They show that African societies exported more slave during colder years with areas least resilient to climate shocks responding the most. The implication in both cases isnt just that climate shocks matter, but that the normal climatic conditions matter as well.

In this paper I examine the relationship between suitability for yam production and pre-colonial political centralization in Africa. I find that .. I also find that increased suitability is associated with inheritance practices for land and other movable property.

# 2 Data

## 2.1 Precolonial Political Centralization

Data on political centralization is taken from the Ethnographic Atlas (Murdock 1967, World Cultures 1986). This is a database of characteristics of various ethnic groups around the world including ethnic groups in Africa. The data in the case of Africa was compiled by George p. Murdock with care taken to describe African societies before European colonization.

The major variable of interest is the jurisdictional hierarchy beyond the local community. This variable measures the degree of centralization of precolonial institutions. Ethnic groups are ranked on a scale from 0 to 4. A score of 0 describes groups with no instances of centralization beyond the local community. A score of 1 describes petty chiefdoms. A score of 2 describes larger paramount chiefdoms or small states. A score of 3 or 4 describes large states. I use this classification as my measure of political centralization. Figure 1 shows the distribution of ethnic groups based on their level of precolonial centralization.

As an alternative I groups ethnic groups into fragmented or centralized states as in Gennaioli and Rainer (2007). Ethnic groups with a score of 0 or 1 are categorizes as fragmented and lacking any political integration above the local level. Ethnic groups with a score of 2 and above are categorized as centralized with political integration above the local level. The results are qualitatively identical using both specifications.

## 2.2 Suitability for Yam cultivation.

Data on the suitability for cultivation of yams is taken from the Food and Agriculture Organizations Global Agro-Ecological Zones Project (GAEZ). The GAEZ project estimates the land suitability for various crops around the world. Since yams were the key domesticated crop in sub-Saharan Africa I use the crop suitability index for low input rain-fed yams. This index uses data on soil resources, terrain resources, land cover, temperature, humidity, and rainfall to estimate the suitability of an area for yam cultivation. Mean climatic variables between 1961 and 1990 are used. The low input category assumes traditional farming systems, subsistence level farming and no application of nutrients or chemicals and minimum conservation measures. In essence this index estimates the suitability of land for cultivating yams assuming farmers have little almost no adoption of modern farming techniques.

The GAEZ project provides this suitability index at a 0.0833 degree resolution for all areas across the globe with a range of 0 to 100. I combine this with Murdocks map of ethnic groups in Africa to compute an average suitability index for all ethnic groups. Figure 2 shows the distribution of suitability across Africa. As can be seen from the map, almost all of tropical sub-Saharan African has some yam growing potential with a lot of variation across and within specific regions.

## 3 Results

The categorical nature of the precolonial centralization variable makes it difficult to see the relationships in scatter plot. However the distribution of ethnic groups across yam growing areas may perhaps shed some light on the relationship between suitability and centralization. Figure 3 shows the distribution of suitability for fragmented groups while figure 4 shows a distribution of suitability for centralized groups. The distributions for the two broad groups appears to be different. Whereas fragmented groups seem randomly dispersed across both very suitable and not very suitable areas, with the bulk in the middle, centralized groups seem to be skewed towards the areas less suitable for yam cultivation.

To examine this relationship further I run of basic regression of the form:

$$p_i = \alpha_1 + \beta_0 y_i + \beta_1 c_i + \epsilon_i \tag{1}$$

where $p_i$ is precolonial centralization of ethnic group i, $y_i$ is the average suitability index for yam cultivation for the area occupied by ethnic group i, $c_i$ are various control variables that could influence the relationship between suitability and precolonial centralization, and $\epsilon_i$ is the error term. The parameter b is the coefficient of interest.

The results from the baseline specification using the full measures of precolonial centralization and the suitability index is contained in column 1 of table 1. The baseline results show a negative relationship between suitability and centralization. The higher the suitability for yam cultivation the lower the level of centralization of ethnic groups in that area. In column two I include other climatic variable which may influence centralization outside the influence on yam suitability. I include average temperature, average humidity and average rainfall. Column 3 includes geographic variables which may also influence centralization. I include longitude, latitude, altitude, ecological zone, fraction of the ethnic groups in the tropics, and forest cover. In column 4 I include trade influence control variables such as access to waterways, distance to the coast and distance to the trans-Saharan trade routes. Finally in column 5 I control for the malaria suitability index and the tsetse fly suitability index. In all cases the negative relationship observed in the baseline case with the result still significant as well.

Table 2 mimics table 1 but uses the binary categorization of centralization where groups are categorized as fragmented or centralized. Again the negative relationship remains and is significant. The results are replicated in tables 3 and 4 using ordered logit and probit estimators.

## 3.1 Robustness Tests

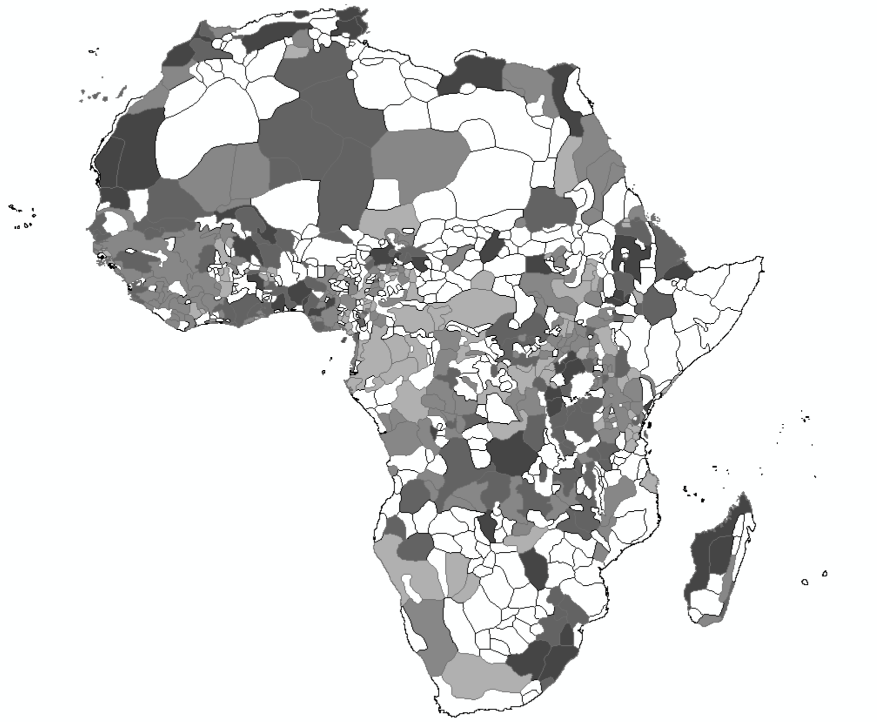
I carry out various robustness tests to support the validity of the relationships in the previous section. I exclude all ethnic groups in North Africa. I also exclude ethnic groups with a suitability index less than 5. This excludes groups whose locations do not support the cultivation of yams. The negative association between suitability for yam cultivation and centralization remains in both cases. I also substitute suitability for yam cultivation with suitability for agriculture in general. Perhaps yam cultivation serves as a proxy for any type of agriculture. However the negative relationship is not present if suitability for any type of agriculture is used.

# 4 Yams and Land disputes in Eastern Nigeria.

# 5 Conclusions

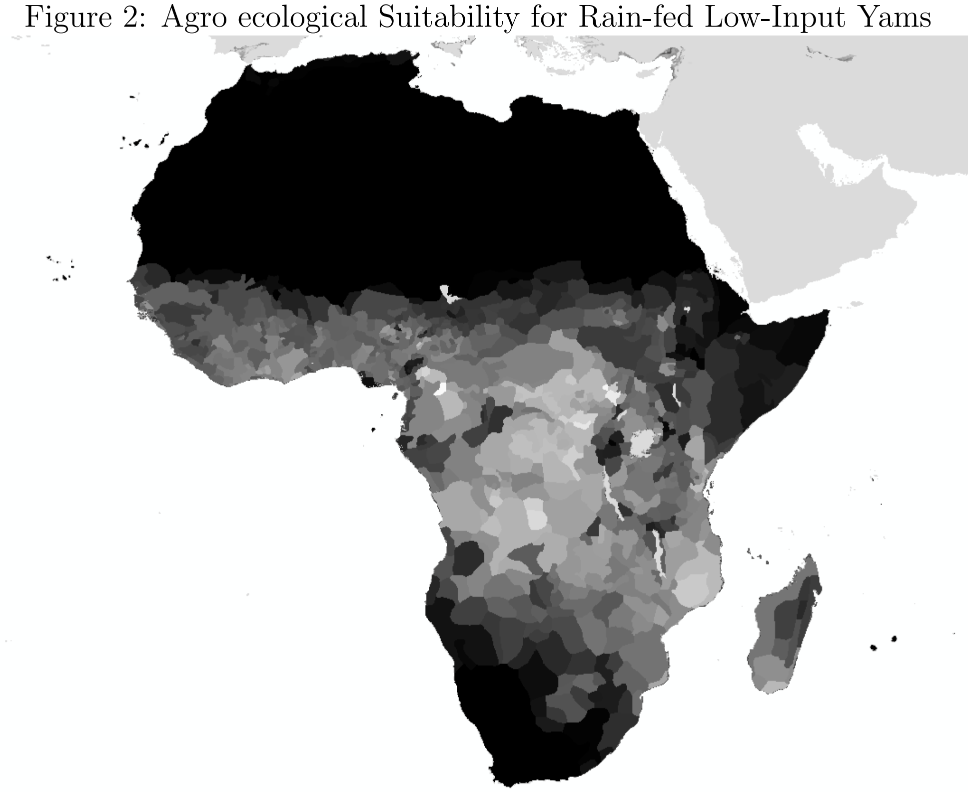
This paper tests the hypothesis of links between state formation and surplus agricultural production. I examine the relationship between the climatic variation in potential yam production and levels of political centralization in Africa prior to the colonial era. I find a rather puzzling negative relationship between suitability and potential yield for yams and centralizations. The results show that areas with the highest potential for yam production have a lower levels of centralization. This is contrary to the hypothesis of food surplus potential providing the platform for state formation and centralization. Further research on specific circumstances in yam growing areas might provide more information on why such a relationship is present.

Figure 1: Precolonial Centralization of Ethnic Groups



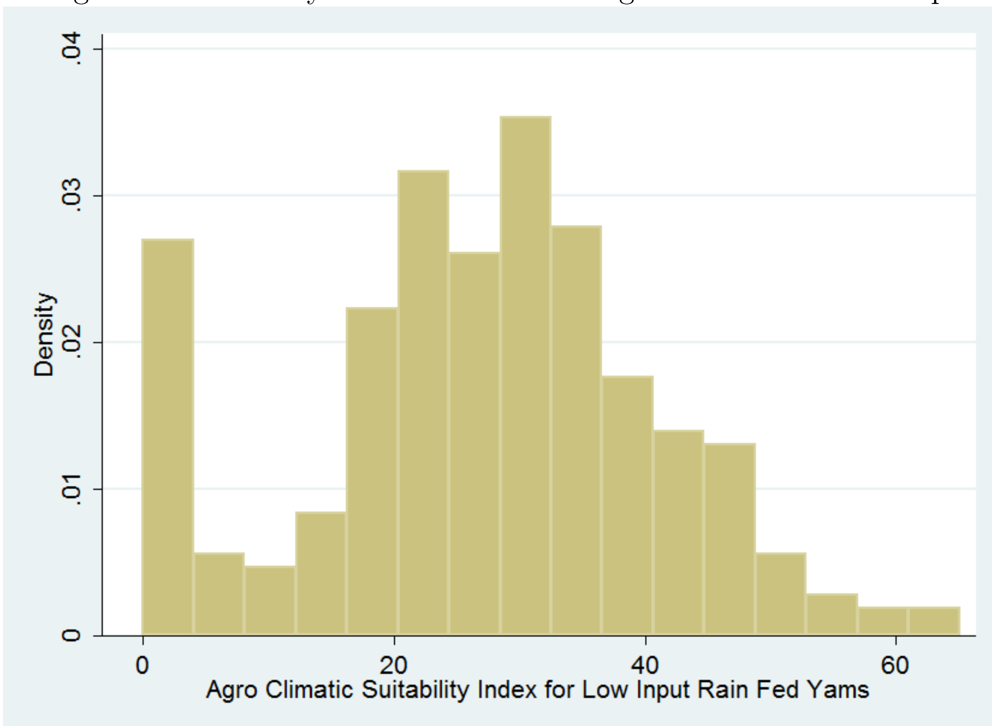
*Precolonial Centralization of Ethnic Groups*

Figure 2: Agro ecological Suitability for Rain-fed Low-Input Yams



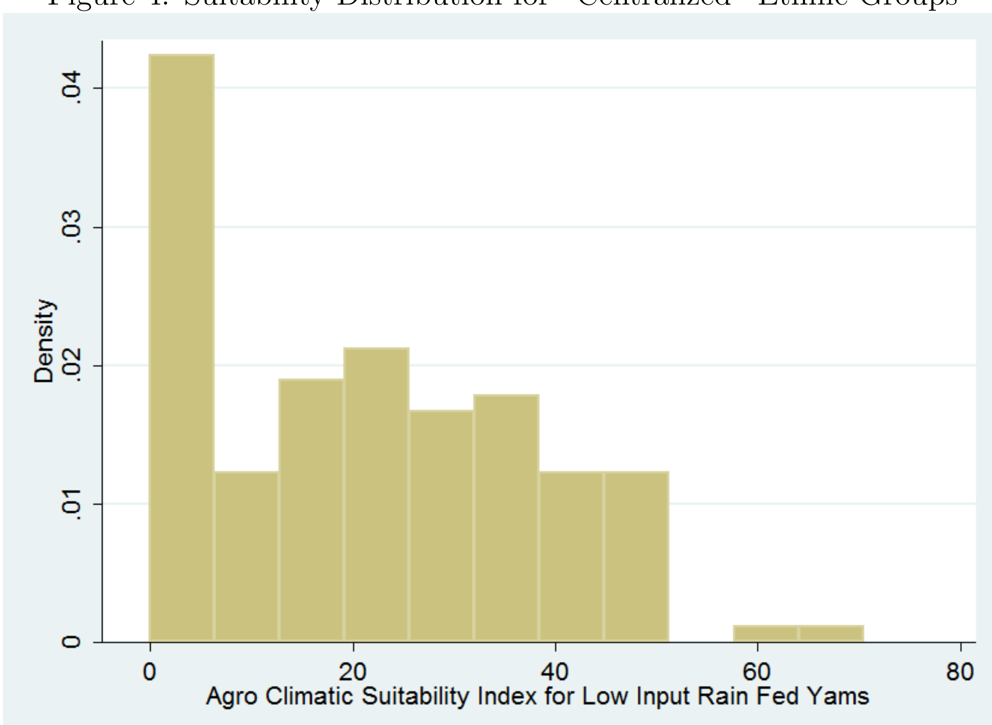
*Agro ecological Suitability for Rain-fed Low-Input Yams*

Figure 3: Suitability Distribution for "Fragmented" Ethnic Groups




*Suitability Distribution for "Fragmented" Ethnic Groups*

Figure 4: Suitability Distribution for "Centralized" Ethnic Groups




*Suitability Distribution for "Centralized" Ethnic Groups*

Table 1: Relationship between Centralization and Suitability

| Variable | Obs | Mean | Std. Dev. | Min | Max |
|---|---|---|---|---|---|
| Suitability | -0.013*** | -0.015*** | -0.010** | -0.009** | -0.012** |
| | (0.003) | (0.003) | (0.004) | (0.005) | (0.005) |
| Average Temperature | | 0.170 | 0.156 | 0.054 | 0.172 |
| | | (0.125) | (0.317) | (0.317) | (0.378) |
| Average Humidity | | 0.401 | -1.316 | -0.490 | -1.405 |
| | | (0.387) | (0.969) | (1.078) | (1.097) |
| Longitude | | | -0.003 | -0.006 | -0.005 |
| | | | (0.004) | (0.005) | (0.005) |
| Latitude | | | 0.002 | 0.032** | 0.017 |
| | | | (0.006) | (0.015) | (0.018) |
| Altitude | | | 0.511*** | 0.440** | 0.389* |
| | | | (0.185) | (0.187) | (0.209) |
| Ecological Zone | | | 0.110*** | 0.074* | 0.051 |
| | | | (0.038) | (0.042) | (0.048) |
| Forest Cover | | | -0.003 | -0.004 | -0.001 |
| | | | (0.003) | (0.003) | (0.004) |
| Waterways | | | | 0.219** | 0.295*** |
| | | | | (0.107) | (0.113) |
| Distance to Coast | | | | 0.002 | -0.006 |
| | | | | (0.017) | (0.020) |
| Distance to Saharan | | | | 0.039* | 0.024 |
| Trade Route | | | | (0.020) | (0.025) |
| Distance to Explorer | | | | 0.005 | 0.000 |
| Route | | | | (0.037) | 0.039 |
| Malaria Ecology | | | | | -0.006 |
| | | | | | (0.009) |
| Tsetse fly suitability | | | | | -0.032 |
| | | | | | (0.084) |
| R-Squared | 0.04 | 0.06 | 0.13 | 0.15 | 0.22 |
| No. of Obs. | 404 | 404 | 404 | 404 | 404 |

[1] Notes. Standard errors in brackets. ***, **, and * indicate significance at the 1%, 5% and 10% levels.

Table 2: Relationship between Centralization - Binary and Suitability

| Variable | Obs | Mean | Std. Dev. | Min | Max |
|---|---|---|---|---|---|
| Suitability | -0.006*** | -0.006*** | -0.006*** | -0.006*** | -0.006** |
| | (0.002) | (0.002) | (0.002) | (0.002) | (0.003) |
| | | | | | |
| Average Temperature | | 0.041 | 0.046 | -0.011 | 0.172 |
| | | (0.063) | (0.161) | (0.160) | (0.192) |
| Average Humidity | | 0.172 | -0.697 | -0.225 | -0.555 |
| | | (0.193) | (0.490) | (0.545) | (0.557) |
| Longitude | | | -0.000 | -0.002 | -0.001 |
| | | | (0.002) | (0.002) | (0.003) |
| Latitude | | | 0.002 | 0.014** | 0.005 |
| | | | (0.003) | (0.007) | (0.009) |
| Altitude | | | 0.200** | 0.157** | 0.104 |
| | | | (0.094) | (0.095) | (0.106) |
| Ecological Zone | | | 0.036* | 0.017 | 0.027 |
| | | | (0.019) | (0.021) | (0.024) |
| Forest Cover | | | -0.000 | -0.000 | 0.000 |
| | | | (0.002) | (0.002) | (0.002) |
| Waterways | | | | 0.124** | 0.164*** |
| | | | | (0.054) | (0.058) |
| Distance to Coast | | | | 0.004 | -0.006 |
| | | | | (0.009) | (0.010) |
| Distance to Saharan | | | | 0.021** | 0.008 |
| Trade Route | | | | (0.010) | (0.020) |
| Distance to Explorer | | | | 0.003 | 0.006 |
| Route | | | | (0.019) | 0.020 |
| Malaria Ecology | | | | | -0.002 |
| | | | | | (0.005) |
| Tsetse fly suitability | | | | | -0.070 |
| | | | | | (0.042) |
| R-Squared | 0.03 | 0.04 | 0.10 | 0.13 | 0.19 |
| No. of Obs. | 404 | 404 | 404 | 404 | 404 |

[1] Notes. Standard errors in brackets. ***, **, and * indicate significance at the 1%, 5% and 10% levels.

Table 3: Relationship between Centralization and Suitability - Ordered Logit

| Variable | Obs | Mean | Std. Dev. | Min | Max |
|---|---|---|---|---|---|
| Suitability | -0.024*** | -0.027*** | -0.019** | -0.019** | -0.026** |
| | (0.006) | (0.007) | (0.009) | (0.010) | (0.011) |
| Average Temperature | | 0.256 | 0.225 | 0.013 | 0.200 |
| | | (0.267) | (0.665) | (0.670) | (0.781) |
| Average Humidity | | 0.863 | -2.749 | -0.559 | -2.532 |
| | | (0.749) | (0.666) | (2.245) | (2.555) |
| Longitude | | | -0.009 | -0.016 | -0.014 |
| | | | (0.008) | (0.010) | (0.012) |
| Latitude | | | 0.005 | 0.066** | 0.035 |
| | | | (0.012) | (0.032) | (0.041) |
| Altitude | | | 1.077*** | 0.872** | 0.750 |
| | | | (0.394) | (0.401) | (0.475) |
| Ecological Zone | | | 0.227*** | 0.157* | 0.094 |
| | | | (0.083) | (0.090) | (0.106) |
| Forest Cover | | | -0.009 | -0.011 | -0.004 |
| | | | (0.006) | (0.007) | (0.008) |
| Waterways | | | | 0.484** | 0.750*** |
| | | | | (0.223) | (0.253) |
| Distance to Coast | | | | 0.012 | -0.003 |
| | | | | (0.035) | (0.043) |
| Distance to Saharan | | | | 0.090** | 0.053 |
| Trade Route | | | | (0.042) | (0.055) |
| Distance to Explorer | | | | 0.002 | -0.019 |
| Route | | | | (0.076) | (0.083) |
| Malaria Ecology | | | | | -0.019 |
| | | | | | (0.020) |
| Tsetse fly suitability | | | | | -0.057 |
| | | | | | (0.185) |
| R-Squared | 0.01 | 0.02 | 0.05 | 0.06 | 0.09 |
| No. of Obs. | 404 | 404 | 404 | 404 | 404 |

[1] Notes. Standard errors in brackets. ***, **, and * indicate significance at the 1%, 5% and 10% levels.

Table 4: Relationship between Centralization - Binary and Suitability - Probit

| Variable | Obs | Mean | Std. Dev. | Min | Max |
|---|---|---|---|---|---|
| Suitability | -0.016*** | -0.018*** | -0.018** | -0.018*** | -0.018** |
| | (0.004) | (0.005) | (0.007) | (0.007) | (0.009) |
| Average Temperature | | 0.106 | 0.130 | -0.020 | 0.589 |
| | | (0.176) | (0.459) | (0.470) | (0.598) |
| Average Humidity | | 0.479 | -2.020 | -0.645 | -1.777 |
| | | (0.566) | (1.481) | (1.616) | (1.774) |
| Longitude | | | -0.001 | -0.005 | -0.004 |
| | | | (0.006) | (0.007) | (0.009) |
| Latitude | | | 0.005 | 0.038* | 0.014 |
| | | | (0.008) | (0.022) | (0.031) |
| Altitude | | | 0.558** | 0.038 | 0.302 |
| | | | (0.267) | (0.276) | (0.331) |
| Ecological Zone | | | 0.094* | 0.051 | 0.090 |
| | | | (0.056) | (0.063) | (0.079) |
| Forest Cover | | | -0.000 | -0.001 | -0.001 |
| | | | (0.005) | (0.005) | (0.006) |
| Waterways | | | | 0.382** | 0.540*** |
| | | | | (0.163) | (0.190) |
| Distance to Coast | | | | 0.010 | -0.021 |
| | | | | (0.025) | (0.031) |
| Distance to Saharan Trade Route | | | | 0.058** | 0.028 |
| | | | | (0.029) | (0.042) |
| Distance to Explorer Route | | | | 0.009 | 0.026 |
| | | | | (0.056) | (0.066) |
| Malaria Ecology | | | | | -0.008 |
| | | | | | (0.015) |
| Tsetse fly suitability | | | | | -0.227* |
| | | | | | (0.137) |
| R-Squared | 0.03 | 0.03 | 0.07 | 0.10 | 0.16 |
| No. of Obs. | 404 | 404 | 404 | 404 | 404 |

[1] Notes. Standard errors in brackets. ***, **, and * indicate significance at the 1%, 5% and 10% levels.