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Ecuador: Infrastructure

### **Ecuador: Improvement of Roads and Infrastructure**

Ecuador is a country located in South America with a population of around 16,787,793 people (Ecuador Population). Roughly 63% of that population is considered urban (3) and about 37% is considered rural (2). That population is spread over 283,561 sq km. The percentage of land that is agricultural land is 29.7%. Of that agricultural land, 4.7% is arable, 5.6% is permanent crops, and 19.4% is permanent pasture. The arable land is used for crops that are seasonal or rotated such as rice, potatoes, sugarcane, and cassava. The permanent crops would be things like bananas and cocoa (World Factbook). Although it seems that the percent of the agricultural land would be enough to comfortably sustain a country the size of Ecuador, there are challenges and problems that stand in the way of that comfort.

Not all of the agricultural land is the same in terms of shape and structure. The terrain of the land can be divided into three categories. The first is the Sierra also known as the central highlands (Diverse....Ecuador). The wet season for the Sierra is October through May (Climate in Ecuador). The next category is the Coastal Plains which can be abbreviated as the Costa. They consist of large cliffs and ridges closer to the border that is shared with Peru (Diverse... Ecuador). The wet season for the Costa is January through April (Climate in Ecuador). The last region is the Oriente, which is made up of the jungle (Diverse...Ecuador). The wet season for the Oriente is April through November. As a country, they enjoy 12 hours of daylight because they are so close to the equator. Typically the weather on the coast runs about 80 to 90 degrees Fahrenheit. The mountain weather is slightly colder with an average of about 50 to 76 degrees Fahrenheit (Climate in Ecuador). The housing is generally the same with small adjustments made depending on the which of the three categories they are built on. The common materials used are brick and cement block. Older homes are sometimes made with mud and straw. On the coast, bamboo is sometimes used (Ecuador Housing).

Children are generally entering school at age 6. The primary school runs from ages 6 to 11. The lower secondary school runs from ages 12 to 14 for a total of 3 years. Upper secondary runs from ages 15 to 17. School starts in April and ends in January (National Education Profile). The unemployment rate is 5.8%. The average monthly wage in U.S. dollars is \$437.44. The job sector can be loosely divided into three sections. About 56% of employees are in the service industry. Employees in the mechanical/construction industry make up 19%, and the agriculture industry has 25% of employees (Jobs Data).

The typical family size is 4.6. The health of the families varies by age. Twenty-three percent of

children under the age of five are stunted and six percent are underweight. Fifty percent of children 15 and above are overweight. As children get older, they have more access to food, but many of it is empty calories. The nutritional access isn't always good (Nutrition at a Glance). Ecuador is prone to floods, earthquakes, droughts, and volcanic eruptions. These natural disasters can sometimes negatively impact food safety and security (Food Assistance).

Renewable water resources per capita have been declining since 1967. The 2014 number was 27,403 cubic meters per year (Renewable Water Resources). The amount of the public with access to improved sanitation facilities has been on an upward trend with an ending number in 2015 of 64.7% (Sanitation Facilities). As far as electricity goes, about 98.976% of the population has access to it, this number has been on a general upward trend since 1996 (Access to Electricity). Ecuador ranks 61 out of 113 countries on the Global Food Security Index with a score of 55.2. Fifty percent of the population is dependent on chronic food aid. That is 7.1% lower than the mean score.

The Ecuadorian health care system has been broken into two sectors, private and public. The Ministry of Public Health, The Ministry of Economic and Social Inclusion, the Instituto Ecuatoriano de Seguridad Social, and the Instituto de Social Security are part of the public sector. The Ministry of Public Health provides health care to everyone. The Ministry of Economic and Social Inclusion offer health care to the uninsured within the scope of their resources. The private sector is comprised of for-profit organizations such as hospitals and clinics (Sistema De Salud De Ecuador). The current constitution was passed and put into place in 2008. The current President is Lenín Moreno (Ecuador).

Ecuador is nestled, or pinched, between Colombia and Peru. That particular area is prone to all kinds of natural disasters. Floods contribute about 32.2% of all economic losses, drought contributes 27.5%, volcanic eruption contributes 21.7%, and landslides contribute 7.8%. Floods also contribute 22.1% of the mortality rate, landslides contribute 42.2%, and fires contribute 15.7%. Viewed objectively as a whole, natural disasters contribute 97% of economic losses and 93.2% of the mortality rate. Mortality and economic loss is not the only thing that natural disasters impact. The natural disasters can wreak havoc on the infrastructure of a country, and with Ecuador being so prone to them, they have an influx of problems centering on infrastructure. According to the INFORM 2017 risk index, Ecuador has a medium risk score, bordering on high (Disaster and Risk Profile).

The most recent earthquake in Ecuador of significant severity occurred on April 16, 2016. It was a 7.8 magnitude earthquake that hit in northern Ecuador around 6:58 pm local time. It killed 668 people, 8 were proclaimed missing, and 6,274 people sustained injuries that were incredibly severe. More than one million people were affected by the earthquake, directly or indirectly. Aftershocks of that earthquake took place on May 19 and July 10. Another earthquake with a magnitude of 5.8 hit the northwest region of Ecuador on December 19. It damaged 145 buildings and 4,000 people were affected (Ecuador Earthquake).

Although the Ecuadorian government has started to invest heavily in infrastructure

improvements, not all of the areas have been improving at the same rate as the others. Domestic flights are often used to get from one place to another because the road conditions are often bad. Another common mode of transportation is a bus, many buses run from city to city along the major highways and roads. The railroad is mainly used for freight transport and not passenger transport, so it isn't a viable transport method for the citizens of Ecuador. The dramatic changes in altitude and many types of terrain can make road travel very difficult, especially in the dark. A multitude of rural roads are maintained badly and are often not marked. Landslides, mudslides, and heavy rains can wash out or damage the road conditions or destroy a road altogether. Crash barriers and guardrails are a helpful aid, but they are very rarely in place. The practice of herding livestock along the poorly maintained country roads can also damage them (Infrastructure in Ecuador).

Not all dangerous roads are rural roads only used by those in the area. The Cotopaxi Volcan road is a 25 mile road winding toward the Cotopaxi National Park. It connects the Pan American Highway with the National Park. It is a dirt track dotted with potholes and crosses many streams. Some of those streams are prone to flash flooding that can hit at a moments notice. To make matters worse, the Cotopaxi volcano is one of the most active volcanoes in the world, each eruption further damages the integrity of the road (Cotopaxi Volcan Road).

The road system has certain classes that each road can be sorted into. Class A roads are considered primary roads such as roads linking international boundaries, ports, or provincial capitals. Class B roads are secondary roads and they direct traffic from the areas surrounding the primary roads and direct them toward the primary roads. Class C roads are tertiary roads are connected parishes and areas of production to the National Road Network. Class A, B, and C roads are under the purview of the Agencia Nacional de Tránsito. Class D roads make up the Provincial Road network and are controlled by each individual Provincial Council. Class E roads make up the Cantonal Road network and are controlled by each individual Municipal Council. In order to put the roads in perspective, only 19% of roads are paved, 53% or roads are gravel, and 28% are dirt (Ecuador Road Network).

The lack of reliable, safe roads inhibits the efficiency of food transportation. Most of the producers are located around those rural roads that are so poorly maintained. The producers of livestock often use those rural roads as an avenue to herd their livestock, further damaging them. If the roads are not stable enough to transport the farmers and their goods to wherever they need to be, the food is not distributed. Some may be lucky and use the air system to transport their crops, but that would be ten times as difficult with livestock. The same could be said the other way around. The rural families that don't grow enough to sustain their families must use those roads to travel to markets and urban areas where they can purchase their food. The road infrastructure must be improved because the population is only growing and the need for nutritional food will not be appeased.

If a road is unstable, the general cause is the soil and the structure it is built on or with. There are many ways that societies have used to improve road infrastructure over the years. The first being mechanical soil stabilization. This entails physically changing the properties of the soil to

affect the characteristics, such as dynamic compaction. Dynamic compaction is simply dropping a heavy weight upon the ground to literally smooth and compact the soil so that there are no deformities in the road. This doesn't usually last as long as a chemical method. As you can tell, this a very primitive way to solve a much larger problem so, they have evolved the mechanical method into one of vibration. The vibration takes the place of the heavyweight. They call it vibro compaction. Chemical soil stabilization can also be used. These methods require adding something else to the soil to change the properties of it. An example would be mixing in some cement. Some of the chemical methods can be harmful to the environment in some areas. Another method of soil stabilization would be a polymer alternative. They function much like chemical soil stabilization but, they are less harmful to the environment and in some cases, much cheaper (Soil Stabilization Techniques).

In a country like Ecuador, where they have already spent so much on the after effects of the earthquakes and floods, polymer alternative soil stabilization would be much needed support to the road infrastructure. Although the road infrastructure may seem like an easy fix, the amount of time and money required alone is the challenge. The producers need access to efficient transportation to distribute food to the markets. There are a handful of companies that have products suited to this endeavor. The first step would be to determine which roads are candidates and which roads are beyond help and need to be completely redone. Some roads may have been neglected for so long that they need to be rethought out and redone. The audit of the roads would have to be carried out by the government and communication between the providences and municipal bodies would have to be paramount.

Once the roads are audited and chosen, there are some things that must be done before the polymer is added. The area that is being stabilized should have most of the rich topsoil removed and all vegetation and tree roots removed. The topsoil could be relocated and used in farming and the trees replanted in an area that has a low number of trees. Before taking any of these measures, the soil should be tested using a standard sieve test. The sieve test indicates soil particle sizes and classification. The ground below the road must be free of underground streams (How to Stabilize Soil Roads).

When the polymer is mixed with the soil, it decreases the brittleness of the road. This improves the road because it prevents the cracking and breaking that can occur during constant use. It is also harder to impress grooves and rutting on the surface of the road. The use of polymer and not cement increases elasticity while also increasing strength (Polymers Help Make Roads Stronger). The polymer can protect the soil from the impact of chemical compounds such as sulfate. The effects of moisture migration can also be reduced.

Funding for this project could be drawn from the current plan with a few changes. The country spends about 1.3 billion dollars on infrastructure improvements each year. They could eliminate some of the costs of building new roads by restoring old ones using the polymer technique. The government could also lower imports if they could distribute the food grown in-house more efficiently using the newly renovated roads. The natural disasters that harm the roads and other structure cannot be halted but, with the roads in better condition, they would be more resistant

to damage because of the elasticity of the polymer and the increased strength. The polymer is also water resistant so, in the event of a flood or flash flood, the aftermath would look drastically different. The road would not be washed away or deformed.

The repair of the infrastructure system is not an overnight project. As well as the fact that it is not the sole issue that Ecuador is facing. The high prevalence of earthquakes, floods, and fires is something that will also have to be dealt with. Otherwise, they are fighting a losing battle. With this innovative, realistic, and cost effective solution, the steps can be made towards a better infrastructure.

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