Sustainability of the Galapagos in Terms of Energy, Agriculture, and Waste Management:

Past and Present

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Abstract:

The Galapagos Islands are one of the most biologically diverse locations on planet Earth. The ecosystem that functions within the islands is unlike any in the world and the plant and animal species that call the islands their home are like no other as well. The biggest threat to the ecological integrity of this one of a kind archipelago is habitat destruction through human development. Whether it be through clearing of land or pollution through these developmental activities. As time has progressed the idea of sustainability has become an increasingly popular topic in which efforts are made to reduce the widespread impact that results from human development. The Galapagos Islands house a very fragile ecosystem that human activity has already started to make a significant impact on and in order to minimize the level of destruction and to prevent it from becoming much worse than it already is efforts have been identified and put into action through-out the islands. The three of the main sectors of operation through-out the island where sustainable development is apparent and making significant changes and contributions are Energy, Agriculture, and Waste Management. The history of prior efforts along with the efforts that are currently being made towards sustainable development will be highlighted and analyzed. The Galapagos Island are making a strong push towards sustainability and can be seen as a role model for many other locations throughout the world to show that it is possible and it does make a difference.

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Introduction:

Earth itself is an everchanging entity, no one day will be identical to another. However, each day can build towards progress, or stray away depending on the actions and influences made in the given time. As we have progressed through time the human race is making an increasing amount of contributions that lead us in the way of straying from overall progress in our day to day operations. Thus, change in the world is happening but happening in a negative sense. Our goal should be to make the change in the world happen for the good of human kind as well as the planet in which we live on, and make the change build towards a better future so that we can one day look back and say "it wasn't looking good for a while, but then there was a point where mankind came together and made the world a different and better place".

We currently live in the Anthropocene, which is a newly proposed epoch, or geological time period, defined by humans' effect on the environment (Museum of Natural History Pittsburgh). Every decision we make has the potential to leave lasting impacts on many different types of life and organisms. Humans need to become more aware of the impacts that we make and know that there are alternatives out there in which we can become more sustainable. By this I mean you can still operate in the same manner in which you are used to, however, there are other alternatives in the mode of which you accomplish your operations that have far less of an impact on other forms of life and the environment in general. The problem with this is that most people have limited awareness or knowledge about the sustainable, and progressive alternatives. The only way to perpetuate the knowledge to the general public is to act yourself and raise awareness. "Without action, the Earth will become much less hospitable for all of us. We must consider our impact on nature as we make development, economic, business, and lifestyle choices" (Museum of Natural History Pittsburgh)

Over the years the Galapagos Islands have started to do just that, take action towards sustainability by raising awareness and implementing new practices for existing systems in various sectors of day to day operations. The Galapagos archipelago is comprised of 19 volcanically formed islands about 1000 km off the coast of mainland Ecuador. Due to the isolation of the islands it has created an environment conducive to the life of unique species of all kinds. The Galapagos Islands are home to many endemic species that depend on the unique and highly complex ecosystem, "About 80% of the land birds you will see, 97% of the reptiles and land mammals, and more than 30% of the plants are endemic." (Galapagos conservancy). What makes this ecosystem so complex is the number of different habitats created by the varying environmental conditions which promotes the uniquely high levels of biodiversity. However, over the years development of the islands has increased significantly through general buildup of society in terms of development of cities, roads, housing, businesses, ports, agriculture, tourism, etc. In order to make all of this happen the islands rely on three key operations that make everything possible, Energy, Agriculture, and Waste Management. Without energy many people wouldn't be able to live in our current world, businesses would not be able to function, and the islands would not operate in the fashion in which they do now. Without agriculture a large portion of food would not be available and if it was the price would be very inflated due to the cost to import to the islands. And without a plan for waste management you may single handedly wipe out and entire valuable ecosystem. While when first implemented on the island, the methods and plans used to carry out these operations may have not been the most sustainable or smart, it gave innovators something to base change off of and make better. That is exactly what the islands started to do, as development increased, more shifts toward sustainability became apparent and this lead to positive change. The islands are now working toward progress instead of being part of the problem and straying away. Success in these efforts will only lead towards increased awareness and which may inspire more to make similar changes. Remember, "we are not separate from nature, *we are nature*, and our decisions

affect all life on Earth." Make the right decisions and follow in the footsteps of the Galapagos by shifting mindset and thought processes toward sustainability and minimizing our impact on all life on earth including our own.

Energy in the Galapagos:

The Galapagos Islands combined have about 27,000 inhabitants and those people heavily rely on the use of fossil fuels to make their everyday lives possible. Fossil fuels are needed for transportation such as cars, busses, motorcycles, boats, etc as well as energy. Most of the Galapagos' energy is generated by diesel powered generators that pump massive amounts of CO2 into the air every day. Oil is constantly being shipped to the islands each day and the inhabitants have became dependent on it. While the energy that the diesel fuel provides is a necessity there are many risks that come along with its use. First, the transportation of oil is a high environmental risk, especially when transporting to one of the most pristine ecosystems in the world. For example, in January 2001 an oil tanker by the name of "Jessica" ran aground off the coast of San Cristóbal and poured large amounts of oil into Wreck Bay. The tanker was carrying 600 tons (160,000 gallons) of diesel and 300 tons (80,000 gallons) of Intermediate Fuel Oil (IFO 200). Fisherman, park rangers, merchant marines, experts from Petroecuador and other all came together to retrieve as much oil from the water as possible, it was estimated that about 4,200 gallons of oil were retrieved from the water (EU Taskforce 2001). Due to the nature of the Islands and where they are located this spill had widespread implications, the wind and various prevailing currents moved the contaminated water throughout the archipelago. Beaches in Sant Cruz were polluted including the famous Tortuga Bay. Oil reached as far as off the southern coast of Isabela. This dispersion of oil had various ecological impacts, roughly 60% of Marine Iguanas were lost on Santa Fe island from eating algae that oil had settled on from the spill (Discovering Galapagos). Various other animals such as the Blue Footed Boobie and sea lions were affected by the spill as well and needed to be cleaned.

Another major risk and downside of the diesel-powered generators is the amount of exhausted produced and poured into the atmosphere daily.

Risks like the abundance of harmful emissions and disasters like the spill of the tanker Jessica are prime reasons why strides toward sustainability must be taken. The Galapagos has taken steps in the right direction and is currently addressing the problem by beginning to implement efforts and projects throughout the islands to have no fossil fuels used to generate energy by 2020. In order to accomplish this goal, they have set plans of what needs to happen and what needs to be implemented. This includes, San Cristobal's Wind Farm (1,800 KW), Baltra Island Wind Park (2.25 MW), Baltra Island Photovoltaic Plant (0.2 MW + energy storage), Puerto Ayora Photovoltaic Plant (1.5 MW) on Santa Cruz Island Bridges 8 (Spring 2014), Interconnection system Baltra with Santa Cruz, Isabela Island Hybrid System (1.0 MW + energy storage + thermal plant 1.320 MW), Substitution of inefficient appliances, Substitution of conventional street lighting system with energy efficient lights (Dove 2014). If successfully carried out it can be seen as major progress towards a sustainable future in which, especially in and ecosystem that is so special and so fragile, human development does not have major impacts of the surrounding ecosystem and environment.

San Cristobal Wind Project

More specifically the Island of San Cristóbal has taken steps toward sustainable development and as part of the zero fossil fuels initiative, in October 2007 they initiated a new renewable energy project under the direction of the Galapagos energy company, Elecgalapagos S.A. This project is comprised of three 51 meter tall turbines and two sets of solar panels. With this Elecgalapagos SA is capable of providing 30% of the total energy consumed through these renewable sources on the island. So, in other words 70% is still being provided by diesel generators. However, by making just 30% of the energy consumed come from a renewable resource the island was able to displace 8.7 million liters (2.3

million gallons) of diesel and has prevented 21,000 tons of CO2 from entering the atmosphere. The islands are currently working out plans that will move the percentage of energy provided by renewable sources to 70% for the Island of San Cristobal (Procopiou 2016).

This project was inspired by the oil spill that was previously mentioned on the tanker “Jessica”, The United States in partnership with the UN Development Programme, and the GSEP along with American Electric Power and RWE AG (German company) contributed $10 million to fund the startup of the San Cristobal Wind Project. The money was then placed into a trust which designated the money to a private company by the name of Eolica San Cristobal S.A.- EOLICSA. EOLICSA had the rights of ownership and controlled the operations of the project, however, passed it on to the public utility group Elecgalapagos S.A. In the eight-year span of 2007-2016 the turbines functioned properly 92% of the time and produced more than 26 million kilowatt-hours of energy. That is just for the turbines alone. The solar panels that were included in the project generated 136,000 kilowatt-hours of electricity, as well as control systems and transmissions lines that allow the renewable and diesel energy producers to work together in the most efficient way possible (Global Sustainable Electricity Partnership 2016).

There are also various ecological upsides included within this project. One of the biggest concerns with wind energy is how it effects bird population and habits, in this case the Petrel was the bird in concern. To ensure that the Petrel was not affected by the turbines the location for construction was set on a hill by the name of El Tropezon. The hill is far away from any Petrel nesting site and is away from where the Petrel engage in daily activities, the ocean, as El Tropezon is in an agricultural region. Additionally, the first three km of the twelve km transmission line was built underground to stay out of the way of the Petrel’s daily activities. Elecgalapagos S.A also cleared the area of invasive plant species such as the blackberry pant and guava tree which prohibit other life from thriving. Furthermore, they also planted poison to limit rat and cat populations as they are known to eat the petrel chicks and eggs. Through these efforts not one petrel has been injured as a result of the project from 2007-2016 and

from 2012-2014 hatching success increased from 85% to 96% and reproductive success grew from 81% to 100% (Global Sustainable Electricity Partnership 2016).

With every project and effort comes some sort of struggles and setbacks, first of all in terms of functionality of the turbines. Winds in the Galapagos are widely variable daily and as well by season, which creates wide variations in the amount of energy produced by the turbines. Currently none of the turbines have a battery system in which they can store excess energy generated for use in times of minimal wind. Another issue that they are facing is that Elecgalapagos is forecasting that from now to 2024 the demand for energy will increase by 60%. This is due to the increasing population on the islands as well as increasing development including a new hospital and hotel. It is expected that 1.3 megawatts of energy will be added to the annual demand on San Cristobal (Global Sustainable Electricity Partnership 2016).

In terms of the expansion that would dramatically increase the amount of energy available from renewable resources a four step plan has been drafted to ensure this, “Overhaul and fully automate the controls that mesh diesel and wind generation, Install more solar photovoltaic capacity, Add a fourth wind turbine unit at the existing wind park at El Tropezón hill, Install batteries to store electricity generated when winds are strong for dispatch when they are low.” (Global Sustainable Electricity Partnership 2016). An expansion like this can gain much attention through out not only the island but the world and has the potential to inspire change which emulates this project and collectively we can start to take steps towards a better world.

Agriculture in the Galapagos

The Agricultural sector in the Galapagos Islands has a everchanging and growing history that has had large influences on the people, the island, and the economy and how each function. When first introduced to the island through Inter- Ministerial Agreement number 0297 in 1979 in which the

Ecuadorian government designated 60,314.14 acres of land, of the 18,940,874.6 acres of land in the national park, for agricultural purposes. This is about 3.17 percent of the land in the national park that was designated for agriculture which at first glance seems very insignificant and manageable, however, the locations of the 3.17% was concentrated in the humid highland areas of the islands which posed a significant threat to the ecosystem and biodiversity in this area. On the Island of Santa Cruz 74 % of the humid region was cleared (28.288.75 acres), on Floreana 15% of the humid region was cleared (19,502.61 acres), on Isabela (Siera Negra) 14% of the humid region was cleared (11,819 acres), and on Isabela otherwise 8% of the humid region was cleared. Farmers then introduced new species such as blackberries, Guava, and in terms of livestock, goats, cattle, horses, and mice and have now become an issue throughout the islands (MIT). This is because pesticide and herbicide use are prohibited by the national park, farmers are required to practice organic farming. This makes it very difficult for farmers to properly manage and control their farms. Many farmers end up abandoning their land to peruse something that would be more profitable for them, such as fishing. This opens the door to the invasive species on the land spreading even more and also creates an undesirable situation in terms of food sovereignty. As farmers start to abandon their land invasives become more invasive, and less food is available for the growing population in terms of residents and tourists as well. When there is less food available domestically on the island they must rely on imports which primarily come in by boat and can be very costly, i.e on a two-day shipment it cost $1.17 per 100 lbs. of vegetables imported and $0.14 per pound for item stored in cold storage (Inter-American Foundation). These charges can add up when they are importing large amounts of items due to the lack of production domestically.

It is a vicious cycle that must be addressed before it gets so far out of control to the point where there are no native or endemic species in areas once used for agricultural lands or where the food has become so expensive that social classes shift more toward poverty because residents can’t afford to buy the food that they need. This is currently being addressed and studied more to propose possible

solutions moving forward. Juan Carlos Guzman and Jose Enrique Poma of the ministry of agriculture believe that bioagriculture could produce an environment in which invasive species can be controlled on farms and domestic production can be increase to better the situation in terms of food sovereignty.

Bioagriculture:

Through the events previously explained agriculture throughout the islands has been on the decline and implementation of the Bioagriculture plan is essential in restoring the value of agriculture in the Galapagos while doing in a fashion that is sustainable and educates people about the farms and where the food comes from and who it comes from. Total restoration of the valuable industry will not be possible without a community wide effort which will give control to the farmers rather than third party distributors.

In terms of the farming that is going on the bioagricultre plan proses to us an “Agriculture for life” strategy. This strategy emphasizes “the diversification of agroecosystems, through polyculture, crop rotation and association, and the design and implementation of agroforestry systems.” (Guzman 2013-2014). Through these practices the plan hopes to maximize to productivity of the area which in turn would assist in contributing to the amount and quality of biomass produced and maximizing nutrient cycling to make everything possible. The environment that would be created by this approach towards the agricultural sector has the potential to reduce the amount of fertilizers and herbicides that are used as well as generate a stronger resilience to climate changes. With this there is more product available for consumption as well as for sale. The problem in the Galapagos is that there is not a strong connection between the producer and consumer because of the limited number of producers available. One of the main goals in the Bioagricultre plan is to bridge the gap between producer and consumer and make local markets a common outlet in which farmers have control of what Is being sold and prices and the profits go immediately to them and are not cut off through third party involvement. An increase in

the profits of the farmers can be reinvested back into the farm to improve existing practices so that the agricultural industry can be transcended in the Galapagos. Not only does it need to come from the farmers, but consumers must also be properly educated on the situation and should be encouraged to promote responsible local consumption. All in all, this plan looks to transcend farming further than just the cultivation of crops; through that cultivation they look to enhance the ecosystem value of these areas by controlling invasive species as well as providing socioeconomic benefits in terms of food that is available and the prices of goods available. Through this they plan to further conduct research through dialogue and sharing knowledge to ultimately inspire innovation and desire to learn more for the greater good of agriculture and social welfare in the Galapagos community (Guzman 2013-2014).

Waste Management in the Galapagos

As developed as the islands of the Galapagos are in the present day their efforts in terms of waste management are far behind. Waste management techniques and resources are lacking in some areas of the islands which causes a disorganized effort overall. Waste collection does not reach all inhabited areas. In areas with no waste collection methods such as dumpsites are used for waste disposal. A dumpsite is an area in which waste is dumped and then burned. This poses many ecological and environmental risks as many of the chemicals within our waste are then burned out into the atmosphere and also leech into the soils which eventually contaminates healthy, clean water sources. In addition, these areas attract high amounts of introduced species such as rats and other organisms that continue to degrade the surrounding ecosystem as well.

Liter continues to be a problem throughout the island as well especially with growing populations and increased overall development. Another contributing factor to the amount of waste littered throughout the islands is the rapidly growing tourism industry. One of the primary sources of liter in the marine environment is from tourist ships. These ships are legally allowed to dump their

organic waste into the water, however a majority of the time not only the organic materials make it into the water and other materials such as plastic bags, bottle caps and other like items will go as well. Additionally, these ships also dump all their waste water and bilge waters directly into the ocean. Santa Cruz has the highest average of waste produced per day from these tourist ships (2.1 tons/day) (Hardter 2010).

Of the three main inhabited islands Santa Cruz by far generates the most waste on average per day (16,000 people, 10 tons/day), San Cristobal (including Floreana) generates the second most (8,000 people, 4-6 tons/day) and Isabela generates the least waste (3,000 people, 2-4 tons/day). However, an interesting fact is that while Isabela may generate the least amount of waste per day when you look at in terms of waste in Kg/person/day they generate the second most waste and are not far behind Santa Cruz, the most developed island (Santa Cru: 0.617 Kg/person/day, Islabela: 0.598 Kg/person/day) (Hardter 2010). This may be explained by their lack of development in the sector overall. According to a table included in the WWF Waste Management Blueprint for the Galapagos Islands Isabella is severely lacking, their waste is not separated, there is nor recycling system, they do not collect hospital and biohazardous waste, there is no environmental education, no monitoring or control system, overall the effort is essentially nonexistent (Hardter 2010).

Outside Initiatives and Waste Management Blueprint

As time progressed people of the Galapagos realized the need for change in the waste management sector of society. The first major recycling effort happened from 2003-2006 when the Galapagos Foundation provided funding for the construction and staffing of a recycling plant and compost station, also within this time they purchased a waste compactor truck and hired a consultant that helped the city implement and launch the plant. WWF and Toyota came together to work on efforts towards a sustainable future in the waste management sector. One of the first initiatives that they

enacted was the separation of waste into three different categories, recyclables, organics, and non-recyclables. Other works that the did that had to do with recycling; they expanded the recycling center, donated 7,500 colored containers for waste separation which comes out to 3 per household, funded and assigned an environmental expert to the area to give advice, funded community outreach program in which they taught the people about recycling practices, and various other things. In term of waste collection, they extended services to the rural areas that once did not get waste collection services due to their location and the surrounding environment payed for that. They also expanded service to the tourism boats that were dumping organic and waste water right off the side of the ships. GPS monitoring systems were installed in the collection trucks along with a continuous monitoring system that established a monitoring and control aspect that was never present in the past. As a result of the new practices implemented by the WWF and Toyota there was a 260% increase in the amount of waste recycled between January 2007 and August 2009, there was a 35% reduction in the waste per person per day number between the same timeframe and also a 400% increase in composting organics and recycling efficiency (Hardter 2010).

Overall the WWF and Toyota have a plan that by the year 2020 "…an integrated waste management and recycling system will be implemented on all inhabited islands in the Galapagos. The system will ensure an efficient and complete collection of all waste types, with significant reductions in the quantities of waste generated through effective waste minimization programs, including elimination of waste at the source, improvement of current recycling activities, and the development of recycling, disposal and treatment options for other types of waste." (Hardter 2010). They plan to achieve this goal by raising awareness throughout the communities, by upgrading waste collection and disposal systems, by addressing the financial, regulatory, institutional and social barriers the most effective waste management system possible. But overall the most important goal that is set is to raise general

awareness to the community through outreach, education, and involvement. Like mentioned earlier, it must be a collective community wide effort that happens to get the province to where they need to be.

In order for the island to reach sustainability in terms of waste management they need to follow 5 general strategies in which will assist them in achieving their long term goals. Again, this must be a collective effort by all that are involved and living in the Galapagos. The first strategy is Waste Minimization, most literally it is the process of reducing waste produced by a single person or community. However more completely waste minimization is achieved through education and improved consumption patterns. Waste minimization can be achieved through long term policy shifts and educational efforts to shift the overall mentality and current waste habits of citizens. The next strategy is reuse, which is known as recovering value from a discarded item before completely processing it. For example, crushed glass can be substituted for sand in construction sites. Or even as simple as a family reusing plastic utensils or cups a few times before disposing of them. The next strategy that must be common is when reuse and waste prevention is not available waste should be recycled or used for compost. Especially in terms of the organic waste it is perfect for the use of compost. Another strategy that can prove to be effective as the island progresses in terms of waste management is the recovering of energy from waste. In other words, the Galapagos can recover oil from the tourism boats and can use the energy from it to produce cement in areas of need for construction. And the last possible option/strategy used in the attempt to be sustainable should be the use of landfills. This is the least desirable strategy available and should only be used when needed. While the Islands are not where they would like to be in terms of waste management currently, they certainly have much more room to improve and they are certainly heading in the right direction and making progress towards a sustainable future (Hardter 2010).

Conclusion

As previously stated, in the world and society that we live in today the idea and practice of sustainability is one that is imperative to be a main staple in our day to day lives. It is something that we should constantly be thinking about and looking for opportunities to implement different methods that may be more beneficial or even less detrimental to society and the world as a whole. The Galapagos Islands have begun to identify issues in the way that they conduct their day to day operations and are conscious of the state of the world and the state that the islands could be put in if action was not taken. In terms of energy, agriculture, and waste management the Galapagos Islands have sound plans and aspirations for the future. Some efforts are further along in the process than others but at least the consciousness and conversation has been started. In all three sectors a plan has been put into place to maximize the efficiency and production of each sector and each effort, once completed, can be used as a point of reference or inspiration for many different countries and communities in the coming future. If we would like to save this world and maximize the time the human race is able to live on this Earth without maximum destruction, efforts towards sustainability are a must, and the Galapagos Islands have identified and are doing just that. Progress is being made towards sustainability now it is time to get the rest of the world to stop straying away.

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