2017

Mike is Intentionally Improving Infrastructure Immensely Internationally in Ileret (MI6)

EAS 310: FINAL PROJECT REPORT

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TABLE OF CONTENTS

CONTENTS

ABSTRACT

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FOREWARD

This report intends to describe the Dassanech through observations of students studying in the Global Innovation program. Problems which the Dassanech face daily have been identified after thorough communication with the locals. Solutions have been proposed, however, these problems take creativity, innovation, ingenuity, and persistence to tackle. The authors of this report promote criticism and encourage readers to reach out with any concerns or ideas:

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CHAPTER I: INTRODUCTION

1.0 PROGRAM DESCRIPTION

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2.0 LOCATION

Areas in question are the public facilities and services in Ileret, Kenya including the health clinic, churches, primary school, roads, and utilities. The majority of this land is at a high point near the center of the surrounding population as well as the police station and water producing windmill. The water pumped from the ground in this area is salty and rich in iron, magnesium, and fluoride, and chloride. Much of the lands soil is sand that has been there for generations and gets denser below the loose surface. In periods of intense rain much of the surface and layers below are washed away as gullies are formed through the land. A recent natural disaster displaced approximately 1,000 people, claimed the lives of 30, and swept away a significant amount of livestock. However, Ileret experiences long periods of drought that can last up to nine months thus keeping the sand dry and hot with the intense sun due to the towns relative distance to the equator. All this is important to keep in mind when considering making any changes.

3.0 PROJECT DESCRIPTION

Global Innovation is a community outreach program first conceived by Richard Leakey, world-renowned paleoanthropologist and founder of the Tukana Basin Institute, to improve the lives of the inhabitants of the local town of Ileret. In collaboration with the College of Engineering and Applied Sciences at Stony Brook University, the program was launched in the summer of 2017, in which faculty and students were sent abroad to Kenya. The goal of the program is to identify problems and provide solutions, either theoretical or practical, to be implemented in order to benefit and improve the lives of the local people. The future vision for the program is to expand to other impoverished areas around the world in hopes of bettering the lives of the people there as well.

CHAPTER II: EXISTING CONDITIONS

1.0 DESCRIPTION OF FACILITIES

II.1.1 TRANSPORTATION

North and south of Ileret sections of roads go through river beds as there are no bridges this far north which causes the people to be disconnected from the rest of the country when it rains locally or even far away where the river is fed. Even without rain there is an extreme disconnect with the rest of Kenya since Nairobi is a three-day drive via unpaved, inconsistent, bumpy, sandy, dirt roads. The conditions are the same through the town, but more consistently sandy. Besides transporting supplies on the ground via big wheeled trucks there are also air strips outside of the Turkana Basin Institute, closer to Ileret that is no longer in use, and further south of TBI. Air transport is not ideal as it is expensive and cause the prices of goods or traveling to dramatically increase.

2.0 ASSESSMENT OF EXISTING FACILITIES

II.2.1 TRANSPORTATION

While the Global Innovation Field School was staying at the Turkana Basin Institute near Ileret an extreme for the state of the roads was seen. Following a record rainfall there were many large gullies through the road and some sections that looked fine had highly unstable soil underneath that caused vehicles to run into the ground and get stuck in mud. After the major storm event roads were not safe for a few days and even then, were not optimal conditions with rocks used to fill crevices carved by the powerful storm runoff. As the roads are paths seemingly blazed through the wilderness there are no utilities under or alongside the roads. These roads are very much at the mercy of the environment and get reshaped by destructive water flows heavily and by winds minorly and would therefore not support the implementation of utilities unless exorbitant amounts of materials are dedicated to making long lasting roads. The air strip(s) are also at the mercy of the elements.

3.0 OTHER CONSIDERATIONS

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CHAPTER III: PROJECTS

PROJECT ?: STORM WATER MANAGEMENT

1.1 ASSESSMENT OF ALTERNATIVES

1.1.1 DESCRIPTION OF ALTERNATIVES

A. **Roads with Storm Water Systems**: Creating roads with storm drains and piping to run under the center of the road and direct all of the water towards wherever the outlet is. In order to implement this system solid roads will have to be laid with sturdy foundations, an extreme number of pipes, drains, and boxes will be needed, and topographic maps of the area will be needed to know where to direct the flow.
B. **Open Storm Water Basins**: At the Turkana Basin Institute there is a large area where all the runoff from the buildings is collected. This idea would be applied all over and aim to thwart the effects of major storm events that damage the roads as well as homes of the locals. In addition to lessening the damaging erosion, implementation would encourage the life of vegetation around these areas and be a new water source for livestock. Sizes can vary and effectiveness will differ depending on placement. Being a stopping place for water, sediments will also be stopped and deposited.
C. **Drywell**: Drywells are perforated cavities underground where water is sent and then percolates into the ground. This idea is very similar to the previous idea and merely takes the water underground instead of holding it aboveground. Since it is now held

underground, there is no possibility to benefit with vegetation. These systems are very simple in resources following excavation.

D. **Terraces**: The idea behind terraces is water is slowed and collected at multiple points on a decline. This is done by excavating with the elevation perpendicular to the flow of water then filling with rocks to maintain the shape and cavity for water. Again, this area can be used for vegetation as water will be kept longer and nutrients from runoff may also be present. In addition to nutrients and water, sediments will be deposited as the flow of water is slowed or stopped.
E. **Drainage Ditches**: Implementation would be next to the roads as a final effort to halt the water from doing damage to the road. Roads to Ileret from the south for the most part run perpendicular to the direction water would flow so these drainage ditches would be quite effective in reducing flooding. The ditches would run to coverts, or large collection areas and pipes that run under the road to safely allow the water to pass.
F. **Weir**: A Weir, or dam, would be placed in an optimized position, such as a natural valley from erosion. If placed in the right position a weir could be effective in controlling large quantities of storm water and would retain water for livestock and vegetation. In an unnatural location, the valley would have to be excavated and expect to have some cave-ins.
G. **Vegetation Buffers**: Planting vegetation in optimized locations will direct the flow of water since the plants are secure in the ground and water will have t find another route. Not only are they rooted, but because of this, dirt will be mounded higher around them as wind and water runs into a dead end when meeting vegetation.

1.1.2 MAINTANCE / OPERATION OF ALTERNATIVES

A. **Roads with Storm Water Systems**: Rain is not frequent in the area and desertification is a factor. The soil is very loose and easily eroded so the roads will face damage during the yearly rainy periods. With road damage, there will be damage to any pipes, basins, or drains incorporated.
B. **Open Storm Water Basins**: On their own storm water basins require work in the form of clearing out debris and sediments that reduce their capacity and thereby their effectiveness. When water overflows there will be erosion that decreases the volume much more significantly unless the shape is outlined with some sort of material.
C. **Drywell**: Again, sediment deposition is a concern as storm water is being dealt with in a landscape that supports significant erosion. Maintenance is more difficult for a dry well since it is submerged underground.
D. **Terraces**: With rocks to fill and maintain the shape, the terrace may suffer less from sediment deposition. Similar to the basin alternative, erosion of the edges is also a major concern that may be reduced by vegetation.
E. **Drainage Ditches**: Since the drainage ditch takes the full force of the storm water sediments may not be deposited as heavily due to the water moving faster and moving towards the coverts instead of settling like the other alternatives. There is concern based on how close the ditch is to the roads since erosion is expected on the sides.

1.1.3 SOCIAL IMPLICATION FOR EACH ALTERNATIVE

A. **Storm Water Management**: For all the alternatives there will be long periods of construction that will disrupt the people. Manual labor will be needed in large amounts but not all people are free to work despite their eagerness to earn money. Many of the men tend their livestock while women take care of everything else.
    a. **Social Implications of Directing Storm Water**: Introduction of a new road would be exciting, new and allow for commerce to flow more easily until the first major rainfall where the roads are damaged and not fixed for a long time since the governments influence from Marsabit and Nairobi is low. In the long run, there would not be much change and the system introduced would be a waste as it becomes derelict. Drainage ditches with their easy maintenance and controlling the runoff is a better option although damage upstream of the ditch will not be addressed.
    b. **Social Impact of Collection Areas**: Having standing water in the exposed collection areas will provide more vegetation and water for the livestock the people rely on. Maintenance is less complicated and money intensive and the longevity is greater so they will be better received. The submerged collection area will be more complicated to maintain and not be to visible to the locals so there is not much of a social implication.

1.2 INTENDED OUTCOMES

1.2.1 EXPECTED PERFORMANCE

The desired outcome is a noticeable change in the scenery of Ileret in the short and long term. In the short-term, the measures implemented to handle the storm water will present a visible change near the main roads to reduce damage from weathering and erosion. Changes will also be clear for the long-term as the system should last and cause the landscape to alter in safer and more controlled capacities. Provided the system lasts, it will greatly reduce the damage and casualties that accompany major storm events. Predictable storm water management will also allow for vegetation to thrive nearby and encourage certain pathways for livestock and people.

1.2.2 FUTURE OF PROPOSED WORK

Being a standard idea incorporated in more developed parts of Kenya these simple alternatives with the right resources can find great success in many other undeveloped parts of Kenya and elsewhere. While the Turkana Basin Institute that hosts the Global Innovation Field School is currently focusing on the town of Ileret in Marsabit County there is also a facility in Turkwell. Rocks are readily available as a resource and easily dug soil are common at Ileret and will be found in many other areas in this climate.

1.2.3 EVALUATION CRITERIA

A properly functioning system will more safely handle major storm events during the rainy months in northern Kenya. This can be in the form of holding large quantities of water or channeling it safely. There will also be an additional benefit whether it be water for livestock, vegetation surrounding the system, or crops around the system with manure from a proposed waste management system as outlined in Project #. The improvement must be simple and easy to perform maintenance on. Lastly, the design must be easy to implement in other regions.

1.3 RECOMMENDED PLAN

1.3.1 DESCRIPTION OF RECOMMENDATION

In order to best protect the people and infrastructure of the community it is recommended that drainage ditches be implemented before the road after a decline that has graded terraces at intervals. This setup will hold water for secondary purposes that have been stressed and make sure there is not too much stress on the last stand of defense to preserve the road. The graded terraces will more slowly divert the water towards the coverts that safely allow the water to pass under the road. The final drainage ditch is the most important as it preserves the roads and controls the flow while the drainage like ditches are provided in hopes of increasing the longevity of the roadside drainage ditch.

The other collection based ideas were not chosen since the soil quality is so poor and they would more easily fill with blown sand or deposited sediments from flooding. The road and drainage system is far from sustainable and not feasible based off the inadequacies of the local and national governments influence in the area.

1.4 PROJECT DEVELOPMENT

1.4.1 DESCRIPTION OF POST-PROGRAM COURSE OF ACTION

With the general idea decided for the recommended plan it is necessary to further research sustainable designs and practices for implementation. A bill of materials and implementation plan are needed to either send to local governments or to local influences that can see the job through, provided proper funding is acquired. Materials already assumed to be needed are large aggregates that can be gathered locally but equipment for collection and transportation is required, material may be needed to line any terraces implemented as well as the drainage ditch, and coverts to pass the water under sensitive areas. In addition to those materials and equipment surveying equipment and other related devices will be needed; luckily, surveying equipment is already present at the Turkana Basin Institute.

PROJECT ?: WASTEWATER MANAGEMENT

1.1 ASSESSMENT OF ALTERNATIVES

1.1.1 DESCRIPTION OF ALTERNATIVES

F. **Septic Tanks**: A bathroom brings waste to a tank underground. There is a twostep process of settlement which leads into percolation. Settlement separates the solids from the liquids, creating sludge, and then the liquid is returned to the earth.
    a. **Iteration without Settlement Tank**: In cases without solid waste the settlement process is not necessary.

   b. **Methane Harvesting Waste Management**: Waste can be processed to produce methane. Typically sludge will yield methane so a septic tank may be a good system. Regardless, a waste management system can harvest methane to create energy.

G. **Sewer System**: Community centers will have drainage and waste management systems which lead into a central sewer system. This wastewater can be delivered to several places.
   a. **To Lake or River**: Lakes and rivers have the natural ability to treat certain amounts of wastewater without harming the ecosystem or chemical balance. It is possible to pass a safe threshold of waste.
   b. **To Ground**: The wastewater can be drained to a location which isn't populated by people. This will centralize contamination.
   c. **To Treatment Plant**: A wastewater treatment plant completely sanitizes wastewater and produces drinking water. There's potential to harness energy through methane, create fertilizer, or perform additional processes as well.

H. **Waste Combined With Carbon Source To Produce Manure**: A toilet is constructed out of a bucket and a seat. After use, a ground up carbon source (such as sawdust) is spread onto the waste. Once the bucket is filled up it will be emptied into a larger chamber which holds worms. The final result will be manure which can be used for plants.
   a. **Latrine Iteration**: This system still uses waste combined with worms and a carbon source to create manure, however, the waste is collected in a latrine like system underground. This can be accessed on the bottom to collect manure.
   b. **Above Ground Latrine Iteration**: This system still uses waste combined with worms and a carbon source to create manure. However, the toilet in this system will be elevated above an above ground chamber. The bottom of this chamber will have access to the manure.

I. **Make More Latrines**: Latrines have a toilet above a hole in the ground. It is a very simple system which can be filled and moved overtime.

1.1.2 MAINTANCE / OPERATION OF ALTERNATIVES

For systems 1, 2, and 4 the user will use the bathroom like any other toilet. For systems 1-4 it is important to train professionals who can perform maintenance.

A. **Septic Tanks**: The user will simply use the bathroom. The septic tank must have its sludge emptied and the waste must be processed on a regular basis
   a. **Iteration without Settlement Tank**: This iteration will require no emptying because of the lack of solids.
   b. **Methane Harvesting Waste Management**: This system will take more maintenance and expertise to care for, however, this may give potential to have the septic tank clean itself.

B. **Central Sewer System**: This system takes professional skills to maintain, however, maintenance should not be an often necessity. This is very user friendly.
   a. **To Lake or River**: Sending the waste to a river or lake will safely care for the contaminants for a little but ultimately the environmental impacts are not great.

b. **To Ground**: This is the most harmful iteration. Contaminants are still exposed to the environment and it is possible for humans to come in contact with it.
c. **To Treatment Plant**: Though a treatment plant requires the most maintaince, this is the most sustainable location to deliver wastewater to.

C. **Waste Combined With Carbon Source To Produce Manure**: This system will take effort to combine with the Dassanech culture.
   a. **Latrine Iteration**: Having latrines takes maintance away from the user. However, it is likely that staff will need to take care of the manure.
   b. **Above Ground Latrine Iteration**: Maintance becomes easier in this situation as there will not need to be underground access. However, it still is necessary to have staff take care of the manure.

D. **Make More Latrines**: This is an easy solution, however, it is not great for the environment and user satisfaction is not high because of the odor.

1.1.3 SOCIAL IMPLICATION FOR EACH ALTERNATIVE

For alternatives 1-3, the social impacts will be generally positive. Health will be improved while the community will become cleaner. Poor odors will be diminished because of less common open defecation. However, these more complicated systems will require professionals to maintain the systems.

1. **Septic Tanks**: A system must be created for pumping out the sludge, creating jobs. It is possible that contaminants from percolating will leak into underground watersources so the community must place these carefully and be aware of potentially damaging water sources. This system will be underground so implementing it may disrupt the community.
   a. Iteration Without Settlement Tank: ????????????
   b. **Methane Harvesting Waste Management**: Energy can be used for a multitude of purposes. Have a constant source of energy can benefit the community immensely.
2. **Central Sewer System**: This system requires a lot of construction. The community will be disrupted for a long amount of time. Roads may need to closed and planning around existing structures and homes may serve to be an issue. Closing roads may cause routes to become blocked which is dangerous to the community and TBI.
   a. **To Lake or River**: The community must be aware of contaminants entering a common watersource. It should be known to stay away from the effluent source. Polluting in the river may be dangerous to those who rely on it as a water source.
   b. **To Ground**: The community must be made aware of the location where the effluent will be dumped. It is likely that exposure to this area will cause sicknesses. The odor will not be pleasant either.
   c. To **Treatment Plant**: Outside of having professionals to maintain this system, there will be little impact on the community. Odors are possible but there are ways to mitigate that.
3. **Waste Combined With Carbon Source To Produce Manure**: This system requires a cultural shift. People must be ok with defecating into a bucket and manually spreading the carbon source on it. However, producing manure creates opportunity for selling or yielding more crops. No construction is required.

    a. **Latrine Iteration**: This requires more construction and staff will need to be hired to maintain the system.
    b. **Above Ground Latrine Iteration**: Again, construction is necessary but less maintance is necessary.
4. **Make More Latrines**: This system may harm water sources and will not be optimal for the health of the community.

1.2 INTENDED OUTCOMES

1.2.1 EXPECTED PERFORMANCE

After careful consideration it has been concluded that option 3, the waste combined with the carbon source to produce manure, is the optimal solution for wastewater management in Ileret. The lack of construction and materials yields this as a low cost system while it is also adaptable. In a community center such as a health clinic or school, staff can operate a larger system. In a household a simpler design can be used.

There are several options for a carbon source. The most well-known resource is sawdust. However, that is not a plentiful material around Ileret. Ash may be a good contender, however, tests need to be run. This carbon source will be distributed and the user will coat their waste with a thin layer of it.

The community will decide what they would like to do with the manure. Guidance will be given as needed.

1.2.2 FUTURE OF PROPOSED WORK

In the spirt of permaculture, it is important to see how this system can be integrated into the community's daily life. It would be interesting researching was where a storm water collection system can complement the manure processed by this system to create a sustainable farming system.

To further improve the lives of the Dassanech, it would be interesting researching ways this system can be more user friendly. If there was a way to have buckets automatically empty into a bigger container and for manure to be packaged automatically it would be a great convenience to the Dassanech.

If manure is to be sold, it is important to consider the material used for packaging. If possible, environmentally friendly materials should be used.

1.2.3 EVALUATION CRITERIA

There are certain criteria to ensure this project is a success. Firstly, the system must safely process all human waste in a manner which creates a healthy environment. Secondly, manure must be produced.

Criteria which are not essential but should be considered are odor, ease of operation, and quality of manure.

1.3 RECOMMENDED PLAN

1.3.1 DESCRIPTION OF RECOMMENDATION

The hardest obstacle in implementing this project will be the change of culture. This is why it is believed the school will be a good zone to test this system. The kids will learn to cover their waste with the carbon source and why the system is beneficial. There will be several bathrooms with a bucket and a seat. The buckets must be stabilized to avoid spillage while still allowing them to be removed.

Students will notify the school staff when the buckets are reaching capacity and the waste will be emptied into the main digestion pit where the waste is processed into manure.

Once this has been tested at schools, the system will be spread to community centers such as the health clinic while household systems are developed as well.

1.4 PROJECT DEVELOPMENT

1.4.1 DESCRIPTION OF POST-PROGRAM COURSE OF ACTION

Before taking any actions, students will reach out to communities to communicate this idea, particularly the school. If it is agreed that this system can be tested, students will beginning planning. After the global innovation program it will be important to find acceptable carbon sources. On top of that, the materials should be completely planned out and considered to ensure implementation will run smoothly. If the correct materials cannot be found in Ileret in terms of buckets and the main manure processing chamber, care packages should be put together.