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Sustainably Flourishing: A Case Study of the Aeolian Water Crisis

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Abstract
This presentation illustrates the role of the concept of flourishing as it moves toward sustainability by examining a theoretical case study of Lipari, one of the Aeolian Islands. Challenged by a lack of potable water, Lipari provides a tangible model for the interconnectivity of community agency and sustainable issues. This presentation examines the leading qualities associated with a flourishing society to suggest actions that could be most effective in shifting the islands from an unsustainable water system to a sustainably flourishing one. Using the framework of complexity, this presentation integrates a variety of fields such as ecology, economics, public policy, and sociology in developing a more comprehensive definition of the concept of sustainable flourishing.

Keywords: Flourishing, Sustainability, Aeolian Islands, Water, Complexity, Sociology, Transdiscipliary

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Introduction

The Aeolian Islands of Italy (located in the Tyrrhenian sea) provide us with an excellent opportunity to examine and explore environmental issues that threaten this small corner of the world. Not only will this study help develop an understanding of complex shifts that will lead to a more sustainably flourishing society, but it will also allow for the examination of the interconnections among the most challenging issues on the islands. My intention is to provide us with deeper appreciation of the requirements for constructing a sustainably flourishing society.

For Lipari and her sister islands, water supply is one of the most significant needs of natural resources. As Longo and Baker (2014) correctly argue, "in the modern era, ecological degradation has become a genuine threat to humans, other species and the ecosystems they rely upon" (p. 341). In the case of the Aeolian Islands, the contractual privatization of water has placed the Aeolians as victims with little agency. Lipari's economy reliant upon tourism creates an additional set of pressures, not only on the infrastructures of the water system; but also by pitting the community against its only source of income.

This study offers the following definition for "sustainably flourishing": to be better off than now, in a way that promotes positive collaboration among self, community, and nature. In so doing, the term *sustainably flourishing* is intentional as it captures a state in which humans are better off, but not at the expense of the environment, as has often been the case in the industrial past.

A set of general qualities emerge from the research on sustainably flourishing communities, namely that these communities:

- Establish a shared vision that promotes community agency
- Promote a systemic shift in thinking by both members of the community and community as a whole
- Build community support over individual gain
- Ensure that the environment and community improve
- Develop policymaking from within the community, not outside (see Roe, 2017).

Taken together, these qualities help to frame complex problems and provide a structure for their analysis. In the case of the Aeolian Islands, and namely Lipari, the abovementioned definition and its associated qualities, show that the islands' water crisis is a clear indication that they are not flourishing. Living on an island, while a unique opportunity, is constantly challenged by the needs of those living there. This is further complicated by the intense demands of tourists, who are there only a few months during the year, but still aggravate the problem in many ways.

In order to develop connections between the qualities of flourishing as determined through the literature and the current water issues facing the island, I will begin by exploring the water issues unique to the Aeolian Islands, and even more specifically to Lipari.

- **A Brief Overview of the Complex Water Crisis: Four Basic Problems**

Having been to the islands, it is clear that tourists expect to have access to clean water. However, in countless conversations with my island community of friends, nothing could be farther from the truth. There are four categories of issues with the water supply that are specific to the islands: insufficient quantity, potability, adversarial relationships between locals and tourists, and water as transportation. The challenge of sustainable water systems is a true Gordian knot. If we are to understand the complexity of the water issues that the Aeolian Islands face, we must first examine them both individually and relationally, so that we can better understand them holistically. This will allow us to understand the complex interplay between the various factors so that we can move more realistically toward a sustainably flourishing future (Gembillo & Anselmo, 2013).

Insufficient Quantity

The first issue is the significant gap that exists between what is used and what the island actually can provide. In 700 CE, the bishops of the region built the very first cisterns for holding water as a result of an already growing need for more water. Through private contracts negotiated by the city council of Lipari, water was shipped to the island in large barrels that were then moved about the island by donkey. Large cisterns were constructed to hold the water procured through private contracts along with rainwater in Canetto and Acquacalda during this period. In the 15th century, the castle on the island of Lipari was constructed with an even larger cistern. As Lipari grew, the water supply continued to be insufficient to meet the needs of the city; and over time it dried up (Archivio Storico Eoliano, n.d.). Atop Monte Sant'Angelo, the highest peak of the island of Lipari, is an antiquated water collection system. Using natural physics, water was collected in large cisterns at the top of the mountain during the winter and distributed to the towns (Ristuccia, 2015). However, this system was abandoned in the 1980s, according to a conversation with the vice mayor (G. Orto Vice Mayor, personal communication, January, 2017). In its current state, one sees that the site remains intact, but neglected for quite some time. However, solar panels have been added to the mountaintop to provide energy for the desalination plant. Although immeasurable, household rainwater collection still exists but is not locally regulated. Still, it is not enough to meet the needs of the islanders. Thus, the island continues to look to outside sources to satisfy its growing water needs. During the high point of the tourist season, huge tankers filled with fresh water travel weekly from Napoli to various points throughout the islands Almost 300,000 cubic meters are provided to the Island of Lipari (B. Bonino, personal communication, July 4, 2016). Upon their arrival at the island of Lipari, they are hooked up to large storage tanks in both Acquacalda and the outskirts of the city of Lipari. Once they are depleted of their fresh water, they are filled with salt water to weigh them down and return back to Napoli.

In addition to water that is shipped to the islands, there is also an active *desalinatore* (desalinization plant) that has been in existence since 1989 (Leone, 2009). However, this plant has not been in continual operation since its inception. In 2013, the modernization of the desalinization plant began. As could be imagined, the community had little faith that it was the solution. In response, Aqua Blue CEO, Klaus Dieter Simon, (as cited in Igor, 2009) urged the community to see the advancement of the desalinization plant as the solution to a long and hard fought battle to provide the island with cost effective water. In an open letter to the Liparoti,

Simon noted misuse of public finding which included a $38 million government bond given to the islands to improve the water system. He went further to call it "an unconscionable waste of public money" (para. 6). Further, Simon notes that with the desalinization upgrades, the use of solar power and a reverse osmosis system, he can cut the costs of water from 14 euro per cubic meter of water to as low as 3 euro (para. 4). However, as of the summer of 2016, fees for water remained the same, even with the desalinization plant up and running according to locals. Two factors explain this. The first is the fact that tankers continue to bring water having recently renegotiated another large contract. The second is the desalinization plant has not yet been brought up to full capacity, nor has the project to bring water to the entire island been completed yet. Thus, due to a variety of infrastructure issues and conflicts with local policy, the desalinization plant has been limited in meeting its potential. While, as of 2016, it has the capacity to produce up to 45,000 cubic meters a day, its ability to do this consistently is still limited (B. Bonino, personal communication, July 4, 2016; Leone, 2016c).

Potability

This brings us to our next category: water potability. When the topic of conversation turns toward water and its potability, the researchers' experiences point toward the following generalizations: the water, straight from the tap, should never be consumed. One can use it to cook, bathe, and brush teeth; however, there are varying opinions on whether it should be used for coffee. Upon closer examination, the issue is that of high levels of iron in the water. In February 2015, the water was declared potable, revoking a one-month ordinance that had been in effect (Leone, 2015). A year later, locals still purchase bottled water and prefer it over tap. In my conversation with Vice Mayor Orto (personal communication, January 11, 2017), he explicitly noted that the water that arrives by ship is clean as it must pass a sanitation check before being shipped. Further, the cisterns and the water coming from the desalinization plant is tested every three months to ensure that it is clean. However, despite the assurances of community leadership, water from the tap is still considered to be undrinkable on a daily basis. The results of this are the reliance on a third source of water: bottled water. On any given morning the average pedestrian can observe city trash bins lining the streets over flowing with empty water bottles, stores sell bottled water by the case, and it is relatively cheap. Thus, most Liparoti agree that bottled water is best used for making coffee and drinking directly. While not measured for this study, the Islands reliance on bottled water results in mass amounts of plastic that must return to Milazzo to be recycled. This means that it takes two trips across the same waterway once as a finished product for purchase, and then as recyclable trash. Taken together, the continued mistrust of water obtained by tankers or through the desalinization process has resulted in a significant reliance on bottled water and the byproducts resulting from its use. This problem is compounded by increased numbers of tourists in the summer who also rely on bottled water and by extension, contribute to an increased amount of plastic waste.

- **Tourists Versus Locals**

Because tourism is the mainstay of Lipari, the water systems of the island are set up to ensure that the average tourist does not experience even a temporary outage of water. This includes shipments of water completely dedicated to the hotel industry. During the months of June, July, August, September, and October, an average of 700 metric liters of water are shipped for hotel use alone (B. Bonino, personal communication, , July 4, 2016). However, even with the water specifically allocated to the hotel industry, shortages can still occur. For example, in July 2015 despite more than 35,000 metric liters (B. Bonino, personal communication, July 4, 2016) of water being shipped to Lipari, those that operate businesses in Marina Corta experienced a lack of water for over two weeks at the height of the tourist season. The community perception affirms that when there is a shortage of water, hotels are the last to lose water. In my own experience, each of the houses that I lived in relied on an underground well and a pump system to provide water. In order for the pumping system to function properly, the water was maintained at a certain level. Thus, around every two weeks, the water pressure became observably weaker for some private homes, until a new shipment of water was delivered. This raises a question: to what extent do the tourists' ignorance water issues fuel a level of waste that could be reduced with better dissemination of information?

Water as Transportation

In addition to the use of water for human consumption on the island, there is also the issue of the use of the surrounding seawater. Locals and tourists alike are completely reliant on boats to get to and from the islands. Further, one of the more lucrative sectors of the tourist industry is the daily boat excursions to various places of interest throughout all seven islands. This lucrative industry moves tourists throughout the islands, and it is often one of the most popular activities for tourists. As a result, policy to regulate the islands and the waterways can impact locals and tourists alike. As early as 1991, there have been proposals for a marine park or sanctuary to further protect the islands surrounding coastline and waterways (Leone, 2009). However, this is a source of great controversy for locals due to the perceived fear of restrictions that will limit the usage of such waterways. Currently, articles in the local blog suggest public opinions are torn. (Leone, 2016h)

In January 2017, a large storm front moved in, blanketing the regions of Catania and Messina in snow. Due to the high winds and the storm, ships were unable to pass between the main island of Sicily and the smaller islands that surround it. In terms of the Aeolian community, while they are accustomed to planning travel around sea conditions, an adversarial relationship often exists between people and the sea. For example, many teachers do not live on the islands; instead, they commute by sea each day. If the sea is too rough, classes are cancelled. This can happen multiple times a year. In fact, in the 2015–2016 school year, 11 school days were lost due to bad sea conditions according to locals (S. Mandina, mother, personal communication, July 7, 2016).

While the seas are mostly calm during the summer months, the occasional *sirocco* (a warm wind storm that comes up from Africa) can cause significant havoc on travel. In the summer of 2016, a hydrofoil crashed into the pier of Stromboli, ending up partially submerged under the pier and causing emergency evacuation procedures that closed off the port for a few days (Leone, 2016i).

Taken together, each of these issues challenges the Liparoti capacity to flourish. While it creates a perplexing complexity as to how to resolve issues such as effectively providing water without damaging the island's natural ecosystems, it also demonstrates the ingenuity of the Liparoti. Despite their long history of insufficient water, the people have used the natural geography of the island to move water throughout by way of cisterns and rain collection on its mountaintops. Further, when this did not suffice, resourceful leaders contracted with others to insure this resource was imported. Thus, the issue now becomes, to what extent will the current system allow the people of the island of Lipari to continue to flourish? As a reliance on tourism continues to grow, and the demands for water are further compromised by an antiquated system that forces islanders to rely on other, also limited resources for water, the capacity for them to flourish also becomes limited. The mentality of the Liparoto (a person who was born and lives in Lipari) is one that includes a strong respect for the water as it plays a significant role in their lives. From existing as a core ingredient for survival as humans to its role in the economy as a model of transportation and tourist attraction, the Liparoti are intrinsically tied to the water that surrounds them. Their capacity to resourcefully address these issues as they move forward is one of the essential keys to their future flourishing.

The Complexity of Addressing Water Issues

In terms of a complex systems approach, the challenges of the Liparoti regarding water illustrate the best examples of the complex interactions between factors and potential solutions. As seen in Figure 1, there are four main sources of water: desalinization, importation, rainwater, and bottled water. While each provides water for islanders, the consumption of bottled water creates its own loop: water obtained through bottles creates waste from the bottles that can either be recycled or remain waste. The waste creates pollution, as do the shipping of recycled bottles shipped from the islands to the mainland: the shipping pollutes the air through CO2 emissions as well as the water through the release of oil into the seawater. This pollution eventually affects the water used for desalinization and rainwater collection.

Figure 1 illustrates how some factors of water consumption on the island affect other factors. Seemingly unrelated, the transportation of water on large tankers in conjunction with desalinization and rainwater collection demonstrate the interconnectivity of these issues.

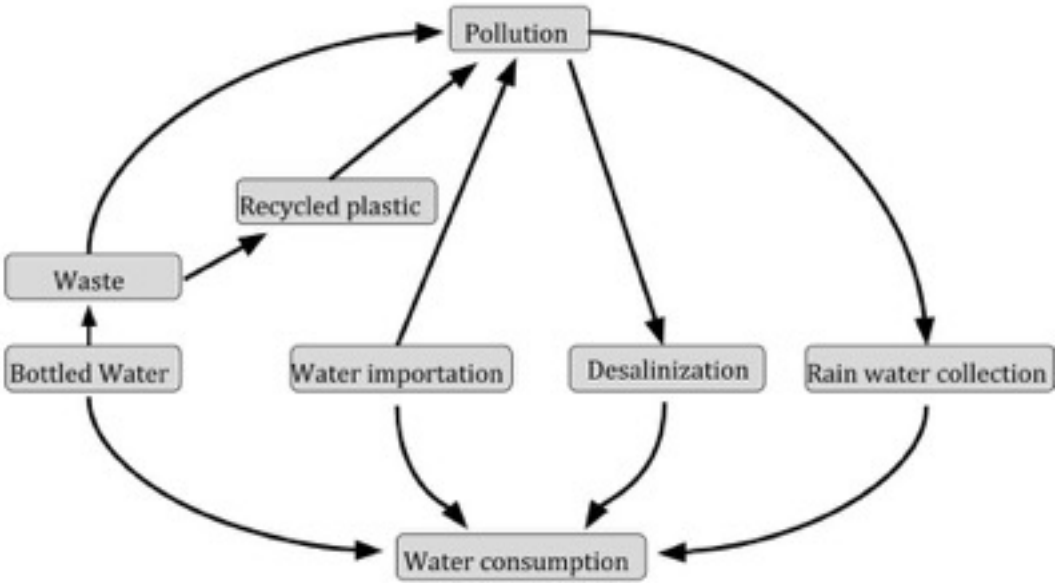

Figure 1. The water loop. This figure illustrates the feedback loops associated with water systems in Lipari. Author's figure.

Again, tankers moving water across the sea pollute the air and water—the same water used in the desalinization process for the islands. Many islanders (e.g., S. Mandina, personal communication, July 2016; E. Spina, personal communication, July 2015, July 2016, January 2017) are against importing water from Napoli, and they favor developing water structures that allow the islands to sustain themselves however, how they envision the solution is limited by several factors.

- **Promoting a systemic shift in thinking by community members**

Missing from the simplistic rendition of water in figure 1 is the role of people themselves. Community members often perceive water on tankers as unhealthy, and desalinization as an unreliable process (Leone, 2016c). These perceptions can further add to the complexity of this problem by increasing the reliance on bottled water. Thus, considering social factors affecting the holistic awareness of water can be another vital ingredient in developing a solution. Among other factors, education could help reduce use of bottled water if it informs people beyond the simplistic perception that recycling water bottles cancels out environmental damage caused by shipping them. The current disassociation between the environmental effects of pollution created in recycling water bottles and the mass consumption of bottled support the idea that there is a need for education of community members in reconnecting the consequences of their choices to the impacts on nature (Worthy, 2013). However, this is only one aspect of the complex puzzle that must be addressed.

As always, education is an effective lever in the move toward a sustainably flourishing future. In addition to helping community members become far more informed about the impacts of particular choices, thus promoting systemic shifts in individual and community thinking, education can bolster community engagement. In so doing, community and individual agency provides new opportunities for innovation and creative solutions from a broader scope of participants. Communities that enact a decentralized process where all citizens have the opportunity to do more

than just have their say and actively participate in the decision-making process, are politically empowered with great potential to flourish through creative solutions from a broader spectrum of community members. Capitalizing on pre-existing structures that support this engagement can be the most effective way to shift thinking and increase community engagement.

Within the community of the islands, there are multiple community-based organizations that demonstrate the Liparoti loyalty to their home. Even more so, they are evidence, that community members are hungry to become reconnected with nature, and have a strong desire to improve where they live with not compromising the environment. Nesos (Nesos, 2017), and "Greenriders" are two such programs designed to educate the Liparoti, to connect community members with nature, and to embody the social changes required to create lasting behavioral shifts. Nesos is a local environmental organization that promotes hiking excursions and tours specifically for locals. The "Greenriders" (S. Giardina, restaurant worker, personal communication, June 2016), is a group of Liparoti that hike together on a weekly basis. Each season, its founding member, Stefano limits the initial group to roughly 15 people, however, by the end of each season, the number of weekly participants exceeds 35 people. Hiking roughly two to four hours a week, participants explore the lesser known paths of the main island of Lipari. Further it demonstrates that locals value their connections to nature. Programs such as these have the capacity to provide community education about the ecological impacts of over consumption and waste. They offer community members opportunities while they hike to see firsthand the impacts of ecological waste (Worthy, 2013).

Another program hosted by Nesos entitled, *Conosci le tue isole!* is an Italian play on words denoting either "Do you know your islands?" or "Get to know your islands!" According to its founder, Pietro Lo Cascio, its sole purpose is to encourage locals to tour their islands because despite the closeness of these islands, some from Lipari have never visited Vulcano. Community organizations can become localized points for communication about the health standards for various forms of water production and the recycling processes. This type of activism can place the power to make environmental changes squarely in the hands of those who consume the water (Lich et al., 2012). Thus, as argued throughout this paper, one of the most vital ingredients in a systemic shift toward sustainably flourishing is the agency of community members themselves. An emphasis on connecting people and enabling their participation in developing long-term solutions directly related to their personal experiences and needs can insure the quality and support of future water policies (Zautra et al., 2008). In this case, providing opportunities for community members to examine the water issue as a multilayered system could address the negative feedback loop cause by the use of bottled water, or the over simplification of solutions such as desalinization and imported water. This can create opportunities for innovative solutions that are win–win for the environment and the Liparoti as well as address their unique needs (Wells, 2013).

One area that still remains to be explored with more detail, is the former use of Monte Sant' Angelo as a rainwater capture system. It remains unclear to me why rainwater collection was stopped. Vice Mayor Orto (personal communication, January 11, 2017) suggested that this may be due to the lack of infrastructure to create potable water. Enabling the community to come together and evaluate the capacity of rainwater may allow for alternative solutions that could be enacted with confidence.

As argued before, community created policy often results in higher rates of adherence, thus ensuring effective outcomes (Wright, 2010).

Conclusion

Water usage is an important component for ensuring a flourishing future for the Liparoti. Moving forward, it is important to recognize the multiple uses of water for the islands. Because water is also commodity that promotes economic gains (Mikhailovich, 2009), all stakeholders must be brought into the conversations to insure an open and clear process (Forno & Graziano, 2014). The continual use of short-term solutions that include shipping water to the islands, may become less sustainable as water become scarcer in the future (Sachs, 2015). An integrative approach to addressing the lack of water, that combines multiple sources, thus eliminating a reliance on any one single source, is essential in creating lasting and sustainably flourishing solutions. In addition to a deep need to improve the actual water infrastructures of the island, the islands will need to consider investing in the restoration of rainwater collection as well as examining desalinization as core pieces of their future work. As sea levels rise, warm, and acidify due to climate change, relying on the sea for water could place desalinization as a part of another negative feedback loop in the Aeolian issue of water.

Each of these issues reflects the powerful relationship between people and nature. As previously mentioned, the modern era reflects an adversarial relationship between people and nature (Crowley, 2010). However, the 21st century is marked by a great shift in this perception and a desire for harmony and connection with nature (Edwards, 2005). While we are racing to compete to for the scarce allocation of water in the Aeolian Islands, we are missing the sheer interconnections that such an issue calls for (Macy, 2007). The privatization of water has caused an unnecessary competition that hinders the islands' flourishing (Wright, 2010). By monetizing water, the economic and political structures of Italy have created a power system that leaves the Aeolians without autonomy and thus creates a competitive structure (Hardt & Negri, 2009). In monetizing such resources and creating a gap between those that "have" water and those that do not, communities such as the Liparoti are pitted against those in Napoli who own their water (Hannis, 2016). Thus, instead of working together for the benefit of all, a sense of threat and malintention is cultivated further harming the ability for all to flourish. "The value shift of the cultural turning calls us to turn from measuring well-being by the size of our yachts and bank accounts to measuring well-being by the health of our families, communities and natural environment" (Korten, 2006, Synopsis of the Argument, "The Economic Turning," para. 1). In shifting our perspective of well-being from controlling resources such as water, to promoting an equitable sense of well-being for all, water becomes a common good, not to be owned, but wisely and equitably allocated to all. In so doing our relationship to nature is restored, ensuring that no one group flourishes as the expense of others (Macy, 2007).

In terms of the qualities of a flourishing community, not only is a significant shift in the perception of water needed, but also a common and shared vision and localized policy and decision making are required. Similar to other issues presented in this paper, the complexity of water supply makes it a challenge to provide a simple solution. As has been pointed out and will continue to be pointed out, agency and lack of community involvement in decision making leaves the Liparoti victims. Lack of clarity and accessible information forces the community into an adversarial

relationship not only with water, but also with the policymaking structures of Sicily and greater Italy.

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Densification of Tropical Wood Residues for the Development of Solid Fuels

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Abstract
Densification of materials through pelletisation, briquetting and cubing to form strong and durable bonding products with greater structural homogeneity, better handling and durability properties has attracted the attention of researchers in recent past. The present work focused on conversion of residues of some tropical wood species to energy fuel through pelletisation. The woody-biomass species studied were *Apa (Afzelia Africana, AA), Iya (Daniella oliveri, DO)* and *Arira (Detarium microcarpum, DM)* which were sourced in Nigeria. The samples were prepared in different sizes of less than 0.50 mm, 0.50 - 1.00 mm and 1.00 - 1.70 mm after drying in a laboratory environment. The different particle sizes were forced into a prepared die using gelatinised starch as binder. Higher heating value (HHV), impact resistance index (*IRI*) and water resistance test were obtained for all samples with and without binder. The average HHV of pellets produced from *DM* was found to be 26.53 MJ/kg without binder, which is the highest among the three samples, showing that DM may have higher lignin content. However, pellet samples AA produced with binder has average HHV of 25.41 MJ/kg which is highest among the three samples. Result showed that *IRI* increases as particle size decreases for pellets produced without binder, while for pellet with binder, *IRI* increases as the particle size increases. Result of water resistance test showed that the disintegration time increases as particle size decreases. The basic physical properties that enhance handling and transportation operations of wood pellets have been achieved when compared with standard.

Keywords: Densification, Biomass, Residues, Higher heating value, Impact resistance index

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1. INTRODUCTION

The desire to increasingly provide sustainable and renewable energy fuels has continued to gain global concerns and renewed interests due to the yearning for reduced fossil fuel utilisation. Among the renewable energy sources, biomass is a promising alternative, which has been playing a major role in affordable and sustainable energy supply since the beginning of civilization (Medic, Darr, Shah, Potter, & Zimmerman, 2012; Wei-Hsin & Kuo, 2010). In recent times, biomass is becoming one of the widely utilised renewable energy sources, second only to hydropower in electricity generation (Ajimotokan, 2014; Jiang et al., 2016). It is such a broadly exploited energy source, perhaps as a result of its cost effectiveness and indigenous nature, which makes it account for nearly 15% of the total energy supply in the world and as much as 35% in developing countries, used customarily for cooking and heating (Tokan, Sambo, Jatau, & Kyauta, 2014).

Woody biomass residue as a source of energy fuel has continued to gain significant interest and attention, because of its renewability, greenish and global availability (Soponpongpipat & Sae-Ueng, 2015). However, some inherent properties of woody biomass residues make them not readily available as an excellent source of energy fuel. These characteristics need to be improved upon to enhance the combustion, transportation and handling properties of the woody biomass, especially as an alternative source of fuel through densification (Balogun, Lasode, & McDonald, 2018). Densification through pelletisation process is one of few methods used to enhance the aforementioned properties of biomass, which also reduces the microbial activities causing its incessant decay (Chew & Doshi, 2011). The end product of the pelletisation process of woody biomass residue is known as bio-pellets. The wood pellets have been considered as a high quality biomass feedstock, which is suitable for many industrial and residential applications, through processes like combustion, pyrolysis and gasification (Lasode, Balogun, & Aremu, 2011; Li et al., 2012).

Pelletisation is a process of increasing the bulk density of materials by application of mechanical force through a prepared die and roller like piston (Stelte et al., 2011a). It is a mass and energy densification of materials that possess low bulk densities such as sawdust, straw and other herbaceous energy crops (Mania, Tabilb, & Sokhansanj, 2006; Yang, Sarkar, Kumar, Tumuluru, & Raymond L. Huhnke, 2014). This densification process has proven to significantly reduce the cost of handling, transportation and storage facilities (Stelte et al., 2011a). Wood products, by-products, plant and crop residues generally possess low densities due to their porous inter-particles structure. Their densities range from 40 - 150 kg/m^3 for grass type biomass, and 320 - 720 kg/m^3 for most types of dried hard and softwoods (Stelte et al., 2011b). The typical bulk density of biomass chips is less than 150 kg/m^3 while those of wood pellets is typically over 600 kg/m^3 (Gilbert, Ryu, Sharifi, & Swithenbank, 2009). Generally, pellets have bulk densities that are significantly greater than the parental wood species, which typical unit densities can be as much as 1,000 - 1,400 kg/m^3 (Stelte et al., 2011b) , and bulk densities of about 700 kg/m^3 (Mania et al., 2006).

The application of densified biomass wastes in place of fossil fuels would result in low emissions of greenhouse and acid gases. In order to make the biomass wastes available for a variety of applications in residential and industrial applications, the challenges with the use of the residues in their original form must be resolved (Chew

& Doshi, 2011). For instance, high moisture content, irregular shape and sizes, and low bulk density have tremendously limited the use of raw woody biomass residues in co-combustion in industrial boiler with coal for production of steam, direct combustion for the provision of heat energy, and in thermal gasification plant (Mania et al., 2006; Yang et al., 2014).

In this study, the utilisation of woody biomass residues in form of tropical wood wastes in different particles sizes, moisture content and bonding mechanisms are examined. The overall goal is to provide an insight into the conversion of tropical wood residues to energy fuel through densification technology, and to optimise the process condition under varying pelletising process conditions.

2. MATERIALS AND METHODS

2.1 Material preparation and characterisation

The tropical wood species used in this study and their respective growth location are *Apa (Afzelia africana) (AA):* 8.19153 ^{o}N 5.21541 ^{o}E *, Iya (Daniella oliveri) (DO):* 8.19102 ^{o}N 5.21515 ^{o}E and *Arira (Detarium microcarpum) (DM):* 8.19089 ^{o}N 5.21507 ^{o}E sourced at altitude 466 m, 460 m and 448 m respectively. The residues of the woody biomass were collected during milling operations and characterised under different particle sizes of less than 0.50 mm, 0.50 - 1.00 mm and 1.00 - 1.70 mm. These materials were stored under atmospheric conditions for about three months in the Faculty of Engineering and Technology wood work Laboratory, University of Ilorin, Ilorin, Nigeria before the experiment.

2.2 Procedure for development of pellet rigs

A closed-end die was designed in cylindrical shape of internal diameter of 10 mm and 40 mm height, a piston of 75 mm in length for ramming the pellets. It is fabricated with mild steel and side hole to accommodate thermocouple probe for measuring the pellet temperature generated as a result of frictional force between die wall and pellet material. Universal testing machine was used to develop the required force to generate the pellet. The pellet was built in sequential layers and a limit speed rate was set on the universal testing machine and the pressure for compressing each sample, which is recorded when the piston reaches this limit. A thermocouple was connected to the die to determine the temperature at which pellets were produced.

2.3 Pellet produced without binder

Pellets were produced without binder to serve as control pellet model. The lignin content present in the samples was heated up due to friction generated during pelletisation between the die wall and the biomass material which acts as binder for the pellets. Approximately, 0.8 g of biomass was weighed on an AQM series OIML-R76 digital weighing balance and fed into the die for each run to produce a single pellet of 10 mm average height, closed with backstop plate at the other end. These samples were prepared in triplicate for each pellet sample at a particular particle size.

2.4 Pellet produced with binder

The gelatinised starch obtained from cassava tuber was used as the binder. Approximately, 0.5 g (62.5%) of biomass and 0.3 g (37.5%) of gelatinised starch was weighed on a digital weighing balance and fed into the die for each run to produce a

single pellet of 10 mm average height, closed with backstop plate at the other end. Each particle size was prepared in triplicate for adequate analysis.

2.5 Determination of moisture contents

Moisture content was determined using Radwag USA L.L.C. PMX 50/1 moisture analyser with 5 g of each sample placed on a tarred sample dish and the lid is closed to start the drying process. The moisture analyser determines the accurate and precise moisture contents of samples, which operates on loss of weight on drying according to ASTM D4442-16 (2003). Afterwards, the sample is weighted, heated to evaporate all moisture and when the process is completed, the moisture content of the original sample is calculated based on the weight lost, using halogen, infrared or glass, free metal heaters positioned above a precision balance.

2.6 Determination of calorific value of samples

The P.A. Hilton C200 bomb calorimeter (S/N. C200/00534, Hampshire, SO20 6PX, England) was used to determine the gross calorific value tests using method recommended by ASTM E870-82 (Akhator, Obanor, & Ugege, 2017). 0.8 g of pellet sample was place in a nickel crucible attached to a thread and burned in the bomb calorimeter, which was filled with 2 litres of water. The attached thread was ignited to combust the sample in the presence of oxygen gas, which gives a rise in temperature to the surrounding water and the rise in temperature is measured by the temperature sensor. The difference between the maximum and minimum temperatures obtained was used to compute the gross calorific values of the biomass materials as follows;

$$Q = \frac{(\varepsilon \times \theta) - Q_{fuse} - Q_{ign}}{M_f} \qquad (1)$$

where Q is the calorific value of sample (MJ/kg), M_f is the mass of fuel sample (kg), Q_{fuse} is the heat contribution from the cotton threads (MJ), Q_{ign} is the heat contribution from the nichrome ignition wire (MJ), θ is the corrected temperature rise of the calorimeter vessel (K) and ε is the effective heat equivalent of the calorimeter (MJ/K).

2.7 Determination of impact resistance index

The impact resistance test was carried out using ASTM D 440-86 to investigate the strength and hardness of the briquettes by shattering the prepared pellet (Ø10 mm by 10 mm height) at a distance of 1 m above the ground level against a concrete surface. The was done repeatedly, and the impact resistance index was then calculated in accordance to Richards (Richards, 1990):

$$IRI = \frac{(100 \times N)}{n} \qquad (2)$$

where N is the number of drops, and n is the total number of pieces after N drops as illustrated in the work of Kaliyan and Morey (2009).

2.8 Water resistance test

Water resistance test was conducted to determine the rate of water absorptivity resistance of the pellet samples, before the disintegration. Thirty-five centilitres (35 *cl*) of water at 15 ^{o}C was poured into a jar, while each pellet was placed in the water and a stopwatch was used to count the time of complete disintegration of pellet sample in the water. The longer the disintegration time of pellet, the better the quality of the pellet (Jandacka, Nosek, & Holubcik, 2011).

3. RESULTS AND DISCUSSION

3.1 Moisture content and heating value

The moisture content of sample DM is the highest as 10.6%, follow by sample AA as 10.55% while sample DO as 10.37% which are in accordance with the work of Li and Liu for quality pellets production. They showed in their work that the production of high quality pellet was a function of moisture content of the wood sawdust which were found to be in the range of 6 - 12% (Y. Li & Liu, 2000). Figure 1 shows the variation of calorific values of different woody biomass residues of African origin. It shows that *Arira (Detarium microcarpum) (DM)* without binder has highest calorific value of 26.53 MJ/kg among all the three samples. Sample *Apa (Afzelia africana) (AA)* without binder has lowest energy value of 17.14 MJ/kg, which shows that the composition of lignin content in its lignocellulosic morphology is very low since lignin has a low degree of oxidation and a considerably high combustion heat as illustrated in the work of Garcia-Maraver, Rodriguez, Serrano-Bernardo, Diaz, & Zamorano (2015). However, sample *AA* with binder has 25.41 MJ/kg and sample *Iya (Daniella oliveri) (DO*) with binder has 20.36 MJ/kg, depicting a common trend that these samples *AA* and *DO* have higher calorific values than those samples without binder. Sample *DM* with binder has the lowest calorific value of 17.56 MJ/kg among all sampled pellets, depicting that addition of external binder weakens the lignin content, thus slackening its composition.

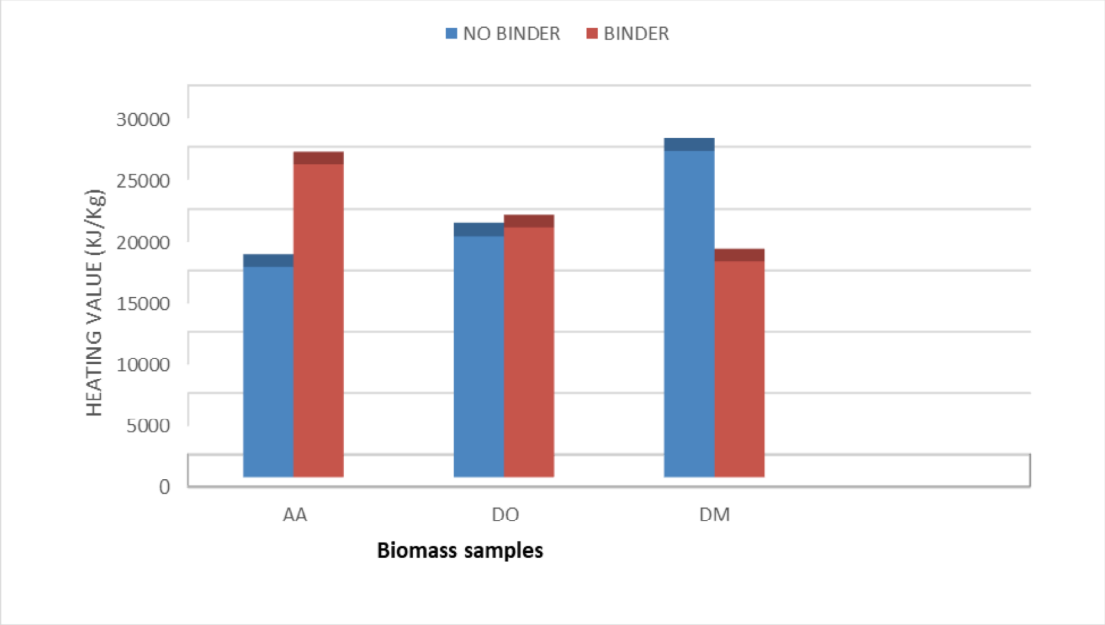

Figure 1: Calorific values of different pellets samples produced with binder and without binder

3.2 Impact resistance index

Figure 2 shows impact resistance index (IRI) for pellet produced without a binder. It indicates that the IRI increases as the particle size decrease, showing that the pellets produced from residues of less than 0.50 mm have better impact resistance property regardless of the species of the wood samples prepared without binder. Figure 3 shows impact resistance index for pellet produced with binder. Figure 3 reveals that the IRI increases as the particle size increases. It is observed that the binder has better

adhesive property on the larger particle size than the smaller particle size. Generally, sample *DO* has the highest IRI without binder at less than 0.50 mm particle size as 200 IRI and with binder at 1.00 - 1.70 mm particle size of also at 200 IRI. The higher the value of IRI the better the hardness and shear resistance of the pellets (Li & Liu, 2000; Rajaseenivasan, Srinivasan, Qadir, & Srithar, 2016).

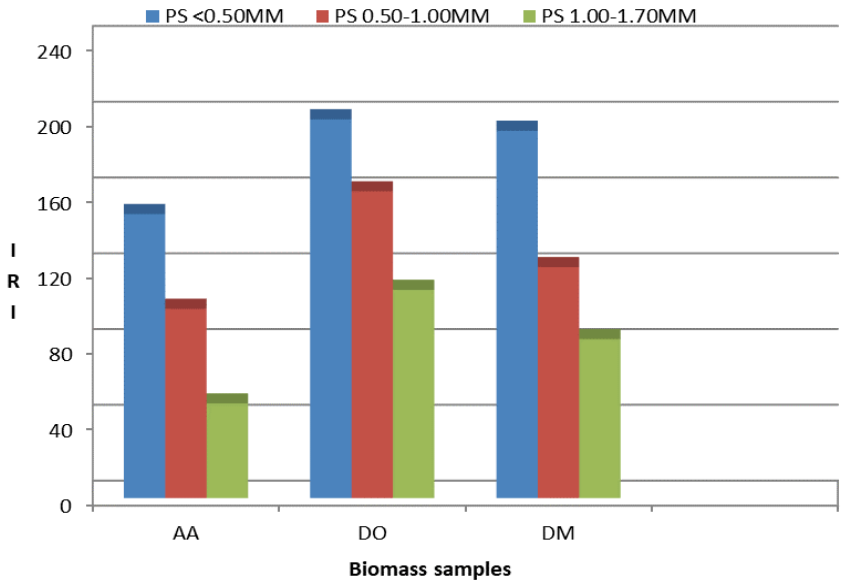

Figure 2: Impact resistance index (IRI) for pellet samples produced without a binder

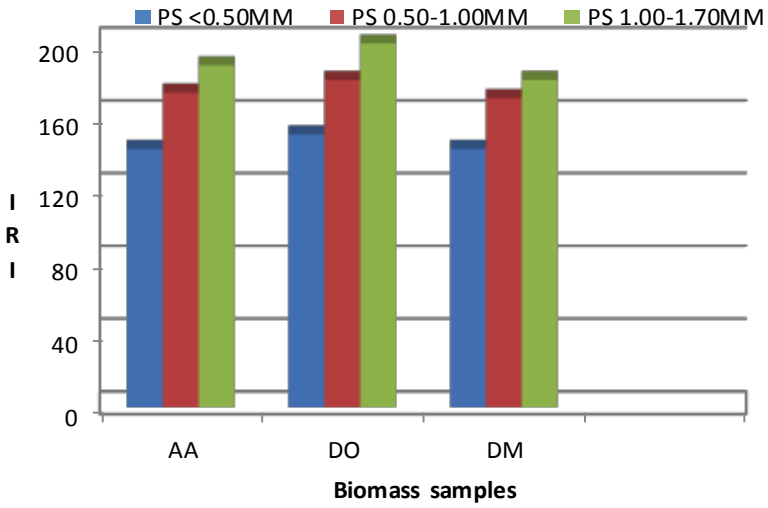

Figure 3: Impact resistance index (IRI) for pellet samples produced with a binder

3.3 Water resistance test

Figures 4 and 5 show the hydrophobicity test of different pellet samples for various particle sizes produced without binder and with binder respectively. Figures 4 and 5 show that the pellet samples with the smallest particle size have the highest disintegration time when dropped into the water. Sample *AA* tends to remain under water longer than samples *DO* and *DM*. However, samples produced with binder seemed to be more hydrophobic than the samples without binder. This can be attributed to the adhesive property induced by the presence of the binder in the crystal of the samples particles which makes it less porosity for penetration of the water

molecules into the pellet particles, thus enhancing the durability and strength of the pellets (Birwatkar, Khandetod, Mohod, & Dhande, 2014).

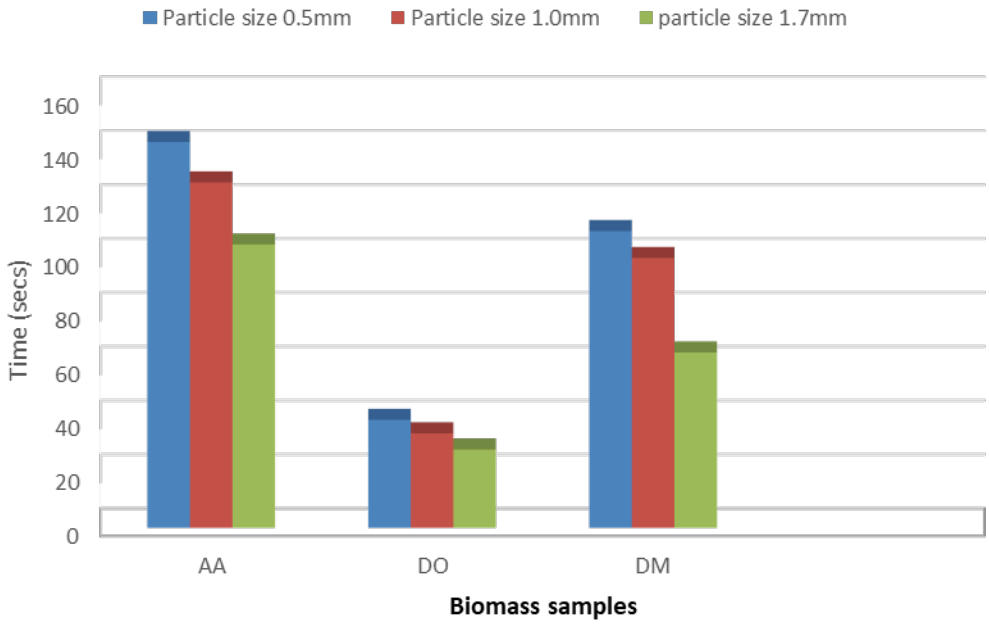

Figure 4: Water resistance test on pellet samples of different particle sizes produced without binder

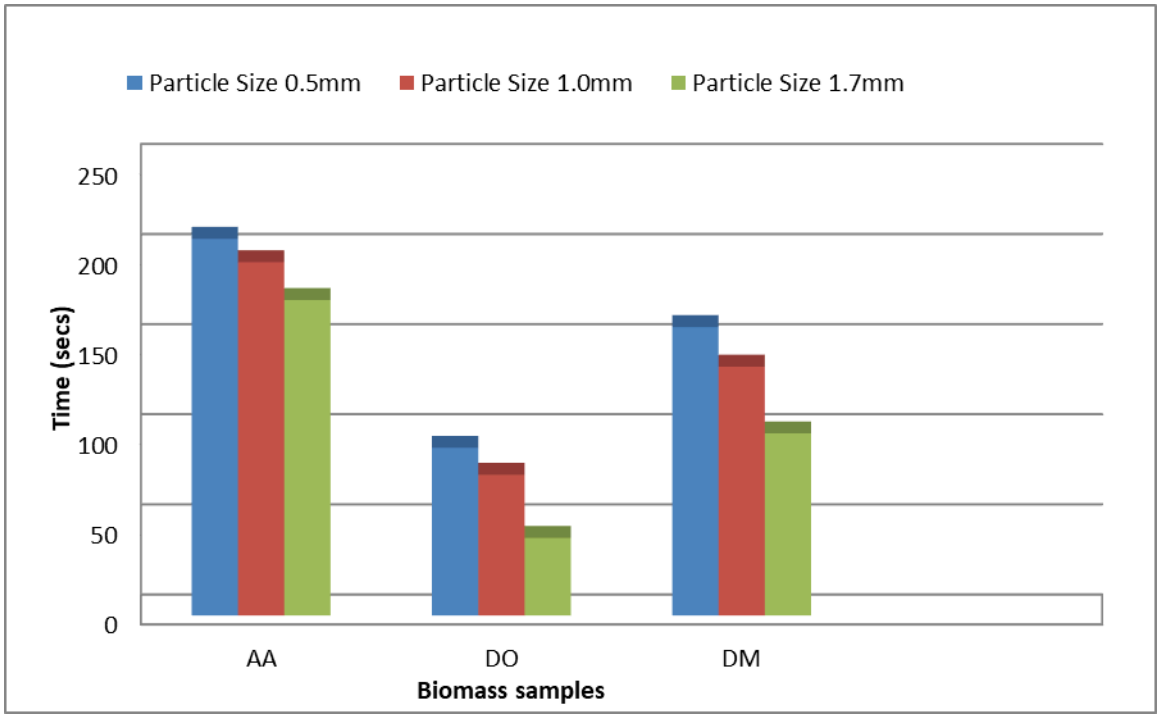

Figure 5: Water resistance test on the pellet samples of different particle sizes produced
with binder

4. CONCLUSION

The study concluded that the addition of binder during pelletisation has influence on the formation of the pellets and its properties. For instance, the calorific values of some specific pellet such as samples *Arira (Detarium microcarpum) (DM)* were higher without binder because of some inherent composition of the lignocellulosic morphology, while pellets samples *Apa (Afzelia africana) (AA)* and *Iya (Daniella oliveri) (DO*) exhibited better heating values with binder. The impact resistance index (IRI) decreases as particle size increases for samples without binder, and increases as the particle size increases for samples with binder. Water resistance test on the pellet samples produced with binder and without binder tend to behave with the same trend as the disintegration time increases as particle size decreases. The basic physical properties that enhance handling and transportation operations of wood pellets have been examined, thus some fundamental facts have been established concerning conversion of wood residues to wood fuel.

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Importance of Geographical and Sociological Factors in Household Livelihood Vulnerability to Climate-related Crisis in Rural Burundi

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Abstract
This paper analyses the vulnerability of 2 communes in the provinces of Kirundo and Bubanza in Burundi to climate change using social and geographic variables. Primary socio-economic data was collected through surveys where 450 households were involved in responding to a questionnaire. Data collected included demography, livelihood sources, asset ownership, land management practices, social organization and information sources. Initial data consisted of more than 1000 quantitative and categorical variables but these were reduced to the most representative 14. Selected variables were then used in Multiple Factor Analysis (MFA). Results showed that the first 6 dimensions of MFA contributed most variability to the data and represented financial and human capitals. Variables strongly correlated with dimensions were: education; rainwater harvesting; use of inputs; land access and food access. Clustering was then done based on the 6 dimensions and yielded 3 clusters with a mix of households from the two provinces. Elevation and land cover were analyzed to explain the clusters' geographic features. Cluster 2 had more households at higher elevation and more shrub and grasslands and consequently more cattle and sheep. Cluster 3 had the highest proportion of animals, wheat, use of inputs and highest education levels. The study concludes that cluster 3 is least vulnerable presently. Cluster 2 is vulnerable to shrinking grasslands, loss of livestock, poor wheat yields and inadequate access to food in the dry periods. Cluster 2 and 3 households will have to make changes to reduce vulnerability to future climate-related hazards.

Keywords: Vulnerability, Clustering, Burundi, Climate change, Household livelihoods

Introduction

Burundi is a country exposed to multiple stresses including impacts of natural hazards. Multi-year droughts have been registered in the periods of 1999-2005, 2007-08, 2010-11 and 2016-17 ((Vinck, Bizuneh, Rubavu, & Tahirou, 2008) with dire consequences. With almost 90% of its labour force engaged in agriculture, and the agricultural sector making up to 30% of the country's GDP, dependence on rain fed crop production significantly increases the vulnerability of Burundian communities to the negative impacts caused by vagaries of variable weather and climate.

Vulnerability is a combination of the risks people are exposed to and their social, economic and cultural abilities to cope with the damages incurred (Coulibaly et al., 2015; Yusuf & Francisco, 2009). Yet studies have been narrow, mainly analyzing the biophysical factors that contribute to vulnerability, without accounting for the role played by socio-economic dynamics. Socio-economic conditions have been found to profoundly affect food system and in turn vulnerability, through drivers such as soil fertility, irrigation, fertilizer use, demography and socio-politics. On matters scale, while there may be cross-scale interactions due to interconnectedness of economic and climate systems, local social, cultural and geographic features may differ and significantly affect vulnerability levels (Malone, 2009). In fact social vulnerability has been shown to be a partial product of social inequalities and place inequalities (Boko et al., 2007). Ludeña & Yoon (2015) noted that attempts to adapt to climate change impacts differed among communities based on geographical location, community attributes and industrial sectors. Local level assessment of vulnerability also provides a better understanding of where and when to invest and who should make the investment (Malone, 2009; Downing et al., 2005).

Bubanza and Bugabira are two rural communes in the provinces of Bubanza and Kirundo in Burundi, located approximately 97 km apart. Nyairo et al. (2014) in their paper described these two locations as being climate analogues, meaning they currently have different climates, with Bubanza being the hotter region. Using mean annual precipitation, minimum and maximum daily temperatures, Global Climate Models (GCMs) have predicted that due to climate change, the climate of Kirundo Province in the 2050s will be almost similar to the current climate of Bubanza. IPCC 2014 predicts that semi-arid regions will experience more frequent and intense droughts due to climate change. This means that negative effects of extreme events that are now being experienced in these locations may worsen and render the communities more vulnerable. While their research helped to shed some light on the expected future of these communes, Nyairo et al. (2014) failed to account for socio-economic variability as well as geographic differences between the two locations which may serve to exacerbate or ameliorate the predicted negative impacts.

The aim of this study was to assess levels of vulnerability generated by social-economic processes interacting across geographic scales in the two communes. The objectives were to identify the drivers of vulnerability and determine the vulnerability levels in the communes. Through use of surveys, this research adopted a participatory approach to evaluate the vulnerability of households in Bugabira the target location and Bubanza the analogue location. Households were clustered into 3 categories of vulnerability.

Data collection and analysis

This study utilized both quantitative and qualitative primary data that had been collected using a semi-structured questionnaire as described by (Nyairo et al., 2014). The questionnaire contained questions on household size, age, education levels, asset ownership, use of farm inputs, sources of food, land size, whether households identified with community groups and water access and any other changes in resource management and livelihood strategies. More than 1000 variables were obtained. Digital Elevation (DEM) and Land Cover maps were downloaded from open access sites on United States Geological Survey (USGS, 2014) and European Space Agency (ESA, 2017) portals.

For analysis, Multiple Factorial Analysis (MFA), Hierarchical Clustering on Principal Components (HCPC) and geographical analysis were combined so as to assess household vulnerability. 38 adaptation-specific variables were selected by expert judgement based on the aspects of demography, infrastructure, household assets, production inputs, food security and social groups. These variables were then reduced further to 14 based on the ability of policy changes to effect changes on the variables. To conduct MFA, variables were broadly grouped into the following 6 categories: education, rainwater harvesting, land access, usage of farm inputs, food access in the first dry season and food access in the second dry season. The advantage of MFA is its ability to handle both qualitative and quantitative analysis, by applying Principal Component Analysis to the quantitative data and Multiple Correspondence Analysis to the qualitative data (Fekete, 2009). The first 6 dimensions of the MFA result were retained and used for clustering household samples. All statistical analysis was done in R Statistics software version 3.4.1. The R packages FactoMineR and Factoextra were used for conducting MFA while the ggplot2 package was used for visualizing cluster results. For geographical analysis, elevation and land cover types were the main variables and analysis was conducted in ArcMap 10.4.1.

Household clusters

MFA of surveyed variables found that the cumulative contribution of top 6 dimensions explained more than 50% of total variation. Summary of variable groups as represented by dimensions is shown in table 1.

Clustering analysis yielded 3 clusters each having households from both locations with Cluster 1 dominated by households from Bubanza and cluster 2 and 3 dominated by households from Bugabira (Table 2). The total number of households in cluster 1 was 67 and that in cluster 2 was 377 while cluster 3 had 6. Cluster 3 had the highest levels of education with all household heads having attained tertiary education. The cluster also had the highest number of animals and cropland area, growing mainly wheat. Cluster 3 households are better placed education-wise to learn new technologies and adapt to their predicted future climate. Moreover, educated populations have the capacity to take advantage of various employment opportunities outside of agriculture thus reducing their vulnerability (Mertz et al., 2011).

More households in cluster 3 utilized inputs than those in the other 2 clusters. Generally, farmers whose access is enhanced either by government subsidies or better road network experience higher crop yields. In a study by Fraser et al. (2013), it was

found that fertilizer use in wheat production was positively associated with adaptive capacity in tropical and arid countries.

There was a proportionate number of livestock in all clusters. In a majority of African rural households, livestock is an important capital serving as both a source of food and income (Dougill et al., 2010). Livestock is an especially important source of food during dry seasons because rain-fed crop cultivation is more sensitive to climatic shocks than livestock production (Mertz et al., 2011).

Table 1: Significant variable groups per dimension

Dimension	Group represented
1	Inputs, rainwater
2	Education, season B*
3	Education, Land, Rainwater
4	Education
5	Education
6	Education, season A*

*Seasons A and B denote the different periods suffering by food shortage.

Table 2: Households by clusters in locations

Cluster	Bugabira	Bubanza	Total
1	17	50	67
2	225	152	377
3	5	1	6
Total	247	203	450

Geographic features

Two-thirds of households in cluster 1 were below the overall average mean elevation while more than two-thirds of the households in clusters 2 and 3 were above the average. Elevation affects climatic condition and crop yields and types, with lowlands generally experiencing low, erratic rainfall. Wheat generally does very well at 1200m above sea level and results showed that across clusters households generally grew wheat. Temperature is an important limiting factor for livestock, given that heat stress is known to cause high mortality rates in dairy cows, affects broilers and reduces reproductive efficiency in pigs. Higher, cooler areas are therefore suitable for dairy and sheep as evidenced by the percentage of households keeping cattle in cluster 2 which was almost twice that in cluster 1. More households in cluster 1 than cluster 2 reported hens as being important. This was linked to the adaptation strategy of shifting from large to small animals that do not require extensive grazing areas as was proposed by the government of Burundi in its second national communication.

Croplands were dominant across all the clusters with cluster 3 having the highest proportion followed by cluster 1. Cluster 2 had a significantly higher number of households occupying shrub and grassland areas thus promoting grazing which could explain the higher number of cattle in that cluster. However, cluster 3 had the highest proportion of shrublands. The proportion of tree cover was proportionate in both clusters 1 and 2.

Conclusion

The evaluation of household livelihood vulnerability based on socio-geographic condition was achieved using factorial and cluster analysis. This paper has demonstrated that the options for improving crop production systems are virtually inexistent in the study areas. Cluster 2 will suffer diminished grasslands, a shift from large to small animals, probable poor harvest of wheat and food shortage in the dry seasons in the future climate. Cluster 2 households are thus more vulnerable to increased temperatures and reduced water quantities than cluster 1 households. Cluster 3 is the least vulnerable in the current climate but will need to change in order to remain so in future climates. In this study a direct link between education and household food security could not be established as there was no correlation between education and the other variables. However, capacity building through technical and vocational training can raise the skills of stakeholders and help to increase farm production for example through value addition.

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Waste Management Education and its Impact on the Environment of the Kyrgyz Republic

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Abstract
In the Kyrgyz Republic, waste management has posed a great concern partly because of rapid urban population increase and poor waste management education. Past studies have shown that education for waste management can considerably contribute to reducing waste. However, few studies have examined the link between environmental education at schools and waste management in the Kyrgyz Republic. This study argues that there is an urgent need to improve waste management education at school. Therefore, the objective of this study is to examine the level of awareness, knowledge and practices of students with regard to waste management at primary and secondary schools in Bishkek city, the Kyrgyz Republic. For this purpose, a specially designed anonymous questionnaire was administered to 80 teachers from four private and four municipal schools in four districts of Bishkek city. From the survey, we found that about 35% of the respondents were doubtful about the adequacy of the current curriculum in conveying knowledge and skills to students about waste management. About 29% of the respondents thought their students knew enough about waste management. In addition, about 93% of the respondents agreed that teaching about waste management should be improved. On the other hand, about 67% of the respondents indicated that their schools hired workers for collecting and sorting school garbage. In conclusion, we discuss the level of awareness and knowledge on waste management among Bishkek schools.

Keywords: waste management education, waste education awareness, Kyrgyz educational institutions and Environmental education

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1. Introduction

The important components of effective waste management programs include modern technical support, sufficient funding, legislation, awareness, and active public participation in waste management (Hasan, 2004). However, the Kyrgyz Republic has experienced challenges to meet these factors as it has largely prioritized short-term economic development (Abdykaarov, 2001). In particular, public awareness and participation appear to be seriously lagging behind other countries.

In raising awareness and enhancing participation in waste management among the public, schools play a key role (Manuilenko, 2002). In the Kyrgyz Republic, however, schools face a number of challenges in doing so. For example, the curriculum content about waste management is very limited (Ifegbesan, 2010). Here the question is: how do students have sufficient knowledge of waste management? What do the teachers think about the current curriculum and what needs to be done to improve the level of awareness among the students? This paper seeks to answer these questions by attempting to clarify the actual level of awareness and practices for waste management among students and pupils in Bishkek city, the Kyrgyz Republic.

1.1 Study Areas

Bishkek is the capital and largest city of the Kyrgyz Republic with a population of 1 million in 2018 (NSK, 2018). The city covers 169.6 km^2 (65.5 square miles). It is divided into four administrative districts (Figure 1): Leninskiy, Pervomayskiy, Sverdlovskiy, and Oktyabrskiy (Wikipedia, 2018). The total number of educational institutions in Bishkek is 146, of which 36 schools are in Oktyabrsky district, 39 in Sverdlovsk district, 36 in Leninsky district, and 35 in Pervomaysky with a student population of 26,634, 45,218, 44,283 and 35,303 respectively (MOE, 2018).

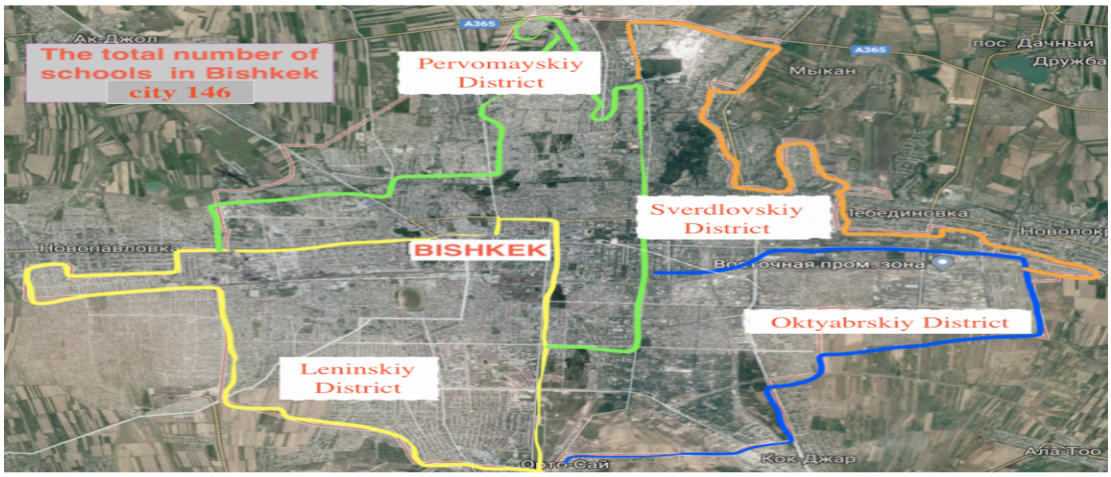

Figure 1 Map of the study area

2. Methodology

2.1 Sample

In order to better understand the level of awareness and practices on waste management among students a questionnaire survey was administered to 80 teachers

in the above four districts of Bishkek city. In total four public and four private schools with 10 teachers from each school participated in this survey. The questionnaire was administered in October 2018. When preparing a questionnaire for students in Bishkek schools, difficulties arose, such as obtaining permission to conduct a survey from parents. This survey required more time than we planned. Therefore, it was decided to interview only teachers about the current state of students in schools, as teachers have sufficient and necessary information.

2.2 Survey design

The questionnaire consisted of 25 questions and was divided into four sections. Questions in the first section focused on the demographic characteristics of the respondents. In the remaining sections, questions were related to the school curriculum, the current state of awareness among the students, and actual waste management activities like collection and sorting of garbage at school and home.
Those teachers who taught courses on ecology at private and municipal schools responded to the questionnaire through an online link (google survey). Given the teachers' busy schedule, this method was convenient for everyone, given that the questionnaire was anonymous. All questions adopted 5-point Likert scale. This decision was based on extensive work done with entry-level populations. The questionnaire was conducted in Russian, because in Bishkek city, Russian is the official language of instruction in both private and municipal schools. A summary paper of the scale used, and examples of elements presented in the text are an English translation of the original Russian version of the articles.

3. Results And Discussion

3.1 Demographic characteristics of the respondents

Table 3.1 shows the demographic characteristics of the respondents. The percentage of teachers' respondents were 51.2% and 48.8% for private and municipal schools respectively. About 37.5% of them were between 40 and 49 years old. Two age groups, 25-29 and 50-59, consisted of 18.8%, while those between 31 and 40 years old constituted 21.3%.

In terms of gender distribution, 75% of the respondents were females. This high percentage of the female respondents generally corresponds with the overall gender balance at Kyrgyz school. The number of female teachers at secondary vocational education schools for 2016-2017 was 5,094 (68%), while that of men was 2,333 (32%). The percentage of female teachers at daytime general education organizations (without part-time workers) for 2016-2017 was 84% (NSK, 2017).

In terms of teaching experience among the respondents, 38% had more than 10 years. Young teachers with less than three to four years of experience consisted of 11.3%. The rest of the respondents belonged to one of the following groups: 5-6 years (20%), 7-8 years (13.8%), 9-10 years (7%), and 3-4 years (8.8%). A relatively small percentage of the respondents with more than 10 years of experience suggests that teaching jobs are not high paying jobs, and many tend to change jobs (AKIpress news, 2019).

Table 1 Socio-demographic characteristics of the respondents

Socio-demographic characteristics	Percentage	Frequency
Gender		
Male	25%	20
Female	75%	60
Age		
< 30	18.8%	15
31 – 40	21.3%	17
41 – 50	37.5%	30
51 – 60	18.8%	15
Above 60	3.7%	3
Level of Education		
Special Secondary	5%	4
University	95%	76
Work Experience/ years		
< 3	11.3%	9
3 – 4	8.8%	7
5 – 6	20%	16
7– 8	13.8%	11
9 – 10	7.5%	6
>10	38.8%	31
Category of Teachers		
Private School	51.2%	41
Municipal School	48.8%	39

3.2 Frequency of teaching students on waste management issues

To better understand the student's level of awareness about waste management issues, we asked how often the respondents teach their students about waste management. The result shows that about 80% of the respondents taught once in a month while 5% did so twice a week and 15% once in a week (Figure 2). The low frequency on teaching waste management in schools is because of the curriculum design. The school curriculum includes "Geoecology" for the 11th grade, which has been developed since 2004. It requires teachers to teach only 5 hours of environmental issues. From the 6th grade to the 11th grade, biology is taught, but no topic is related to waste management.

We also wanted to know if there were practical activities related to waste management. We found that 43.8% of the respondents answered yes, 31.2% answered no. The rest did not respond to this question.

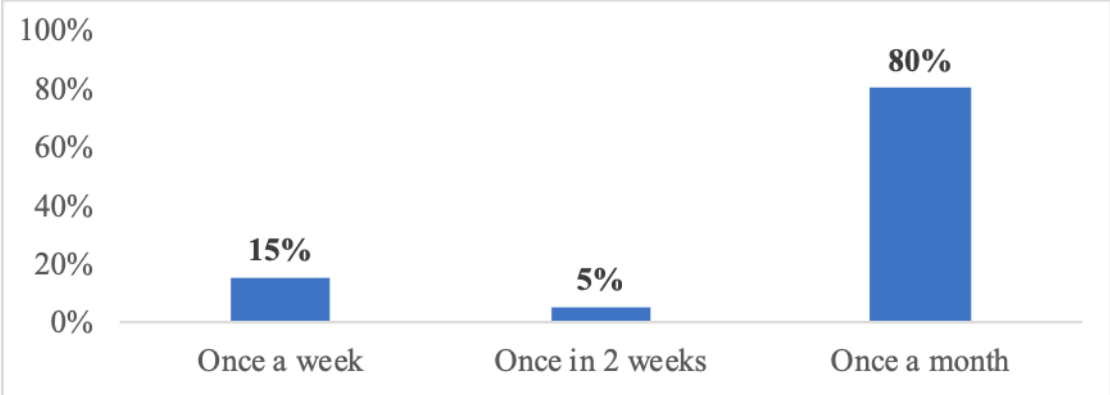

Figure 2 Frequency of teaching waste management in schools

3.3 Adequacy of the current curriculum in providing knowledge on waste management to students

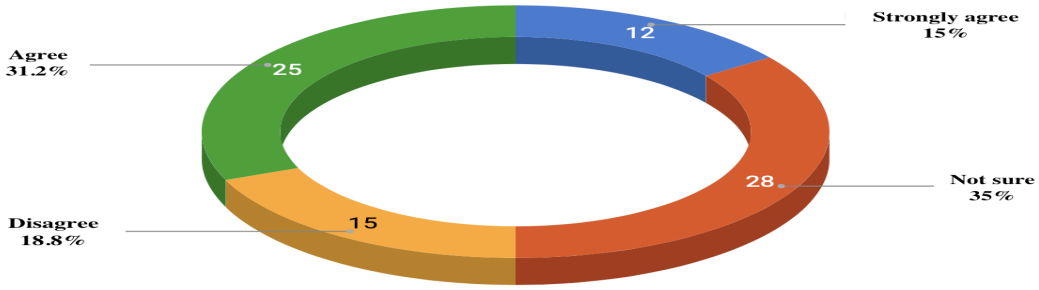

Figure 3 Adequacy of the currently curriculum in providing waste management knowledge to students

In Bishkek schools, curricula are based on the state standard that are regularly revised or updated at least once in five years to better reflect nation's strategic priorities (Ministry of Justice of The Kyrgyz Republic, 2014). On this point, we wanted to know if the current curriculum at respondents' schools is adequate to provide knowledge and skills for waste management to students. The result shows that 15% of the respondents strongly agreed and 31.2% agreed, whereas 18.8% disagreed and 35% was not sure (Figure 3). This shows divided opinion about school curricula in connection to waste management. This result also demonstrates an existing gap in the education system regarding a uniform way of teaching about waste management at schools. The Ministry of Education, Science and Culture has emphasized science-based environmental education since 2000 (Soros–Kyrgyzstan Foundation, 2001), but the national efforts have not yet been translated into local school activities yet.

In the next question, we tried to find out the extent to which teachers thought that their students had sufficient knowledge about waste management. Figure 4 illustrates that only 29% of the respondents perceived students to have adequate knowledge. For example, at Bishkek's secondary schools, environmental education is carried out in teaching biology, chemistry, geography, natural science and geoecology. These courses cover broad topics that are somewhat related to the natural environment. Although interdisciplinary communication contributes to the development of environmental knowledge, it may not be enough to engender ideas of waste

management and recycling. Additional work is required on this aspect (Lukashina, 2001; Manuilenko, 2001).

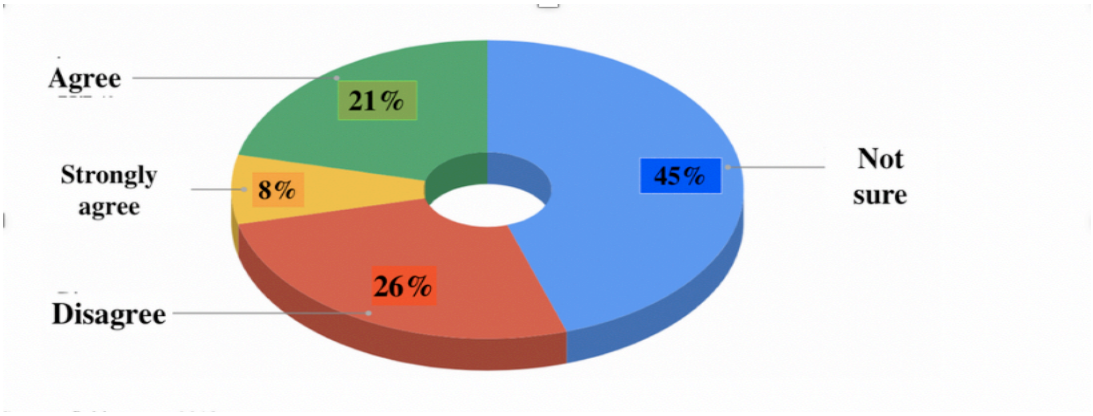

Figure 4 Students' level of knowledge of waste management

Conclusion

This study attempted to understand the knowledge and practice of waste management at municipal and private schools in Bishkek city. The results show that for the majority of the respondent's waste management was one of important topics to be taught at schools. However, both students and teachers did not appear to be actively involved in waste management activities. Therefore, there is need for the government and the school authorities to make efforts to improve the knowledge and awareness about waste management among students and teachers by funding more workshops, field excursions to landfills, or waste management activities among students.

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Evaluation of Slope Greening Performance in Promoting the Urban Ecology of Hong Kong

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Abstract
Groundcovers of Hong Kong soil slopes were assessed. Plant coverage of groundcover species was unsatisfactory and mainly occupied by native graminoids and ferns. Plant species composition varied significantly among areas under different intensities of development. Soil slopes have been established on a large scale in Hong Kong owing to its hilly topography and high degree of development. The sophisticated slope upgrading techniques currently available make revegetation of these urban landscapes possible, thus enhancing ecological restoration. Among the plants selected for revegetation, native plants are recently preferred owing to their adaptability to local climates and beneficial ecological roles. Native trees and shrubs are widely studied for their significance to the urban environment whereas groundcovers are usually ignored. The abilities of groundcovers to provide sustainable plant covers and positively influence ecology are occasionally recognized and need to be assessed. Areas with differing degrees of development that have dramatically different environmental conditions may result in alteration of this plant community. Analysis of groundcover vegetation on thirty-five soil slopes was carried out in suburban and urban areas of Hong Kong to assess plant abundance and analyze the substrates for their nutrient status. We also evaluated slope performance to determine any correlation with the groundcover community. Results showed that the plant coverage of groundcovers was generally low, with the initially planted groundcovers replaced by native ferns and graminoids. Significant differences in plant species composition were shown among areas under different intensities of development. Active management of native vegetation on soil slopes is recommended to facilitate the ecological rehabilitation of urban landscapes.

Keywords: groundcover, plant species composition, soil slopes

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Introduction

Hong Kong, like other highly developed cities, suffers dramatically from habitat loss and fragmentation. Due to presence of hilly landscapes, the formation of soil slopes is extremely common to allow housing and road development (Dai and Lee, 2002). Works such as topsoil removal and soil compaction further deteriorate our soil environment (Burghardt, 2006). Due to the implementation of advanced slope upgrading works in which soil surface is exposed. The planting opportunities are increased and therefore, revegetation of soil slopes is encouraged to rehabilitate these degraded landscapes. This can promote a sustainable greening effect associated with environmental services to our society (Rosenzweig et al., 2006).

The establishment of vegetation on slopes is constrained by several environmental conditions. Soil temperature and moisture are critical for the survival and growth of vegetation, and slope aspect is significantly correlated with plant diversity as it influences the radiation experienced by plants (Zou et al., 2012). Other environmental factors such as slope elevation or orientation, which show close association to wind speed, also draw much concern of practitioners in greening. As a result, a large variety of plants adaptable to dried locations or alkaline soil in the urban areas have been selected for revegetation (Williams et al., 2015). Among these, the use of native plants for rehabilitation of degraded sites has become more popular owing to the higher adaptability of these plants to local climatic and soil conditions (Hau and Corlett, 2003). They also show higher potential to survive in disturbed areas (Prach and Pyšek, 2001). In addition, urbanization always leads to the substantial decline of native plant species but favors the invasion of exotic ones. Planting natives can restore indigenous plant richness and suppress the abundance of exotic plants growing in degraded landscapes (Forman and Alexander, 1998; Mullaney et al., 2015).

Locally, the effectiveness of focusing on native trees has proved to be successful (Jim and Liu, 2001). Nevertheless, assessments of groundcover species are generally lacking. In fact, the establishment of groundcovers plays a vital role in greening the landscape, especially on steeper slopes on which woody plants are not recommended (GEO, 2011). Up to now, native graminoids such as Bahia grass (*Paspalum notatum*) or Bermuda grass (*Cynodon dactylon*) have been commonly selected and sown on slopes by hydroseeding. However, the fate of these groundcovers after the establishment phase has yet to be assessed. Indeed, some specific site characteristics may not be favorable to the application of hydroseeding and can influence the vegetation growth of groundcovers. Factors such as seasonality or microsite properties also govern the effectiveness of establishing sustainable groundcovers on degraded sites. With time, the groundcovers originally grown in the target sites are outcompeted by other adaptable plants, resulting in the alteration of plant species composition. As a result, the positive influences induced by native groundcovers on urban landscapes may not be guaranteed. We also need to understand the adaptability of such groundcovers in the urban environment and determine any effect on their distributions caused by the degree of development. Any possible correlations between the abiotic factors of slopes and the groundcover community should also be identified to reflect the condition of revegetating the urban landscapes.

This study aimed to (1) take an account of the plant coverage and the diversity of groundcovers on revegetated soil slopes; and (2) examine the effects of development on the plant abundance of groundcovers.

Body

Methodology

We divided Hong Kong into 7 areas based on the intensity of development (Fig. 1). These included urbanized areas (Hong Kong Island & Kowloon Peninsula) and suburban areas (Lantau Island, New Territories East, New Territories North & New Territories West). Among the suburban areas, the areas in New Territories had higher intensities of development pressure than the one on an isolated island, Lantau Island, due to the prolonged establishment of new towns. We also included a suburban area at higher elevation (New Territories Central, NTC) to determine any changes of plant species composition by altitudes. We used an online database, the Slope Information Systems, HKSAR for searching studied slopes in each area. Greening work such as pit-planting or hydroseeding was conducted on these landscapes. No maintenance work was carried out afterwards to allow natural growth of vegetation. We obtained the relevant information such as slope angle, area and elevation of each study site from the system.

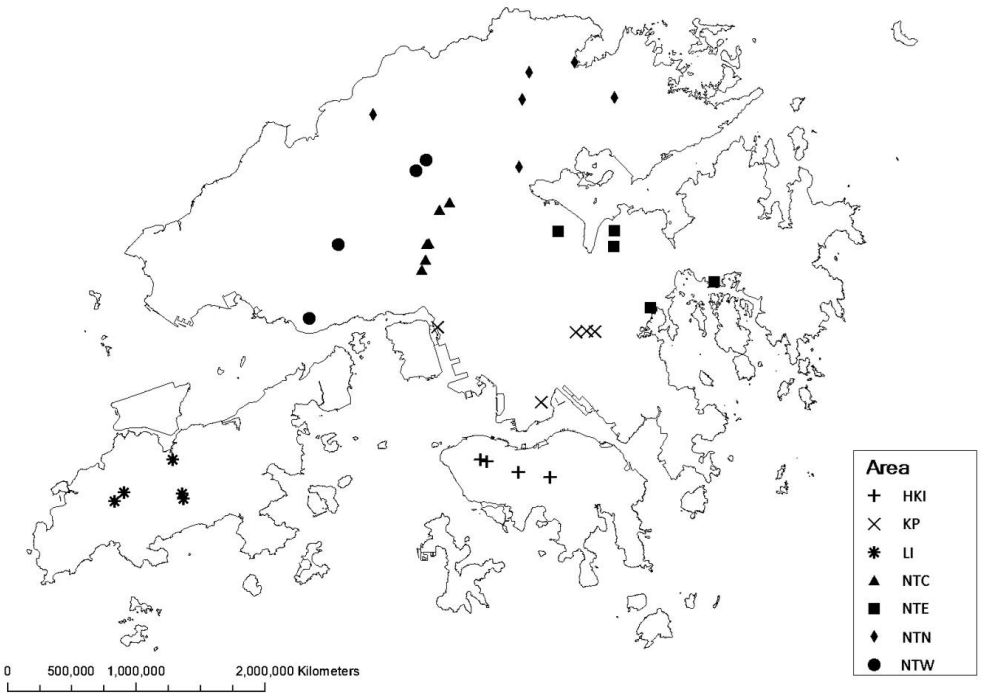

Fig 1. Thirty-five study sites in Hong Kong, southern China.

We totally studied 35 soil slopes in seven areas and each area will consist of 4 to 6 slopes. We randomly set up quadrats to examine the plant abundance of groundcovers. We decided to make 10 quadrats (0.25 m^2) at each site. We identified the herbaceous and woody seedlings of groundcovers and determined plant coverage by visual inspection. We also used a camera equipped by 180° fisheye lens to take images of tree canopy layers on slopes. They were then analyzed by the Image-J program to determine the slope openness.

We used one-way analysis of variance (ANOVA) to compare the plant coverage between different plant types and areas under different intensities of development. We examined the diversity of groundcovers and the relevant formulae are listed below:
H' = -Σ*Pi* ln P*i*, where *Pi* = the relative abundance of each plant species; and
J' = H'/ln *S*, where H' = Shannon-Wiener index and *S* = number of plant species.
The Duncan multiple range test was used for classifying groups (p<0.05). We also examined the effects of erosion control mats on the groundcovers of soil slopes by a *t*-test. The Kolmogorov-Smirnov test and Levene's test were used for the checking of normality and homogeneity of the variance respectively. All the tests were conducted by the use of SPSS (ver. 25). We also examined the plant species composition by PRIMER (ver. 6.0). The mean plant coverage of each species on each slope was transformed and used in this analysis. We performed one-way analysis of similarity by Bray Curtis similarity coefficient (ANOSIM; Clarke and Warwick, 2001) to determine the differences in plant species composition among areas under different levels of development pressure. We showed the results using non-metric multi-dimensional scaling (NMDs) plots. Besides, we determined the contribution of species to the overall dissimilarity of plant species composition among areas by similarity percentage analysis (SIMPLER; Clarke and Warwick, 2001). Those plant species making up to a level of 20% of significant differences are shown.

Results

The average plant coverage of groundcovers was approximately 30% and dramatically varied among plant types. Among them, plant cover made by ferns consisted of around 20% and significantly outweighed other plant types (Fig. 2). *Dicranopteris pedata, Lophatherum gracile, Lygodium japonicum* and *Pteris semipinnata* became the dominant groundcovers (Table 1). Besides, 153 species were encountered and woody species in seedling stage occupied for the majority (91 species). The most commonly found groundcovers were *Blechnum orientale, Cyclosorus parasiticus, Dicranopteris pedata, Logodium japonicum* and *Miscanthus floridulus*. The abundance of exotic plant species was not great that accounted for only about 11% of all groundcover species. Among them, *Parthenocissus dalzielii*, *Acacia confusa*, *Oxalis debilis* subsp. *corymbosa* and *Bidens alba* were commonly found. The application of ECMs caused a significant change in the plant coverage of soil slopes (Table 2). Soil slopes with ECMs had lower plant coverage than those without. Although the application of ECMs on soil slopes did not alter species richness as well as the Shannon-Wiener index of groundcovers, those slopes covered by ECMs consisted of higher evenness index (Table 2). The plant coverage in suburban areas was generally higher than that in urban areas, although no dramatic differences among plant types were found. Regarding to species richness, it differed dramatically among the areas under different intensities of development, with the highest in both urban and suburban areas (Fig. 3). However, no significant differences in biological diversity among these areas were found.

Table 1

Top four groundcover species on soil slopes.

Name	Plant Family	Plant type	Origin
Dicranopteris pedata	Gleicheniaceae	Ferns	Native
Lophatherum gracile	Poaceae	Graminoids	Native
Lygodium japonicum	Lygodiaceae	Ferns	Native
Pteris semipinnata	Pteridaceae	Ferns	Native

Table 2

Plant coverage and diversity of soil slopes with and without erosion control mats (ECM) (*p<0.05).

	Slope with ECM (n=17)	Slopes with no ECM (n=18)	df	t
Plant coverage (%)	26.2±3.45	36.8±3.75	33	-2.08*
Species richness	17.6±7.58	19.7±7.72	33	-0.80
Shannon-Wiener index	2.08±0.51	1.83±0.65	33	1.24
Evenness index	0.75±0.09	0.64±0.15	33	2.62*

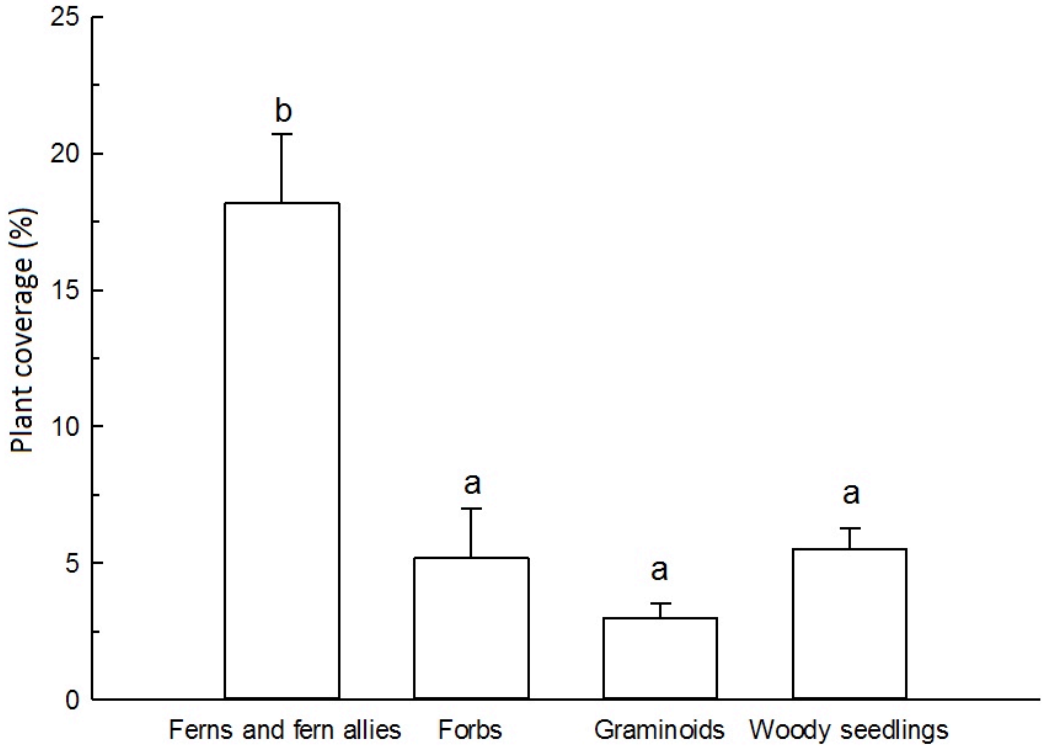

Fig 2. Plant coverage on soil slopes among plant types (mean ± standard error). Bars having different letters denote significant differences.

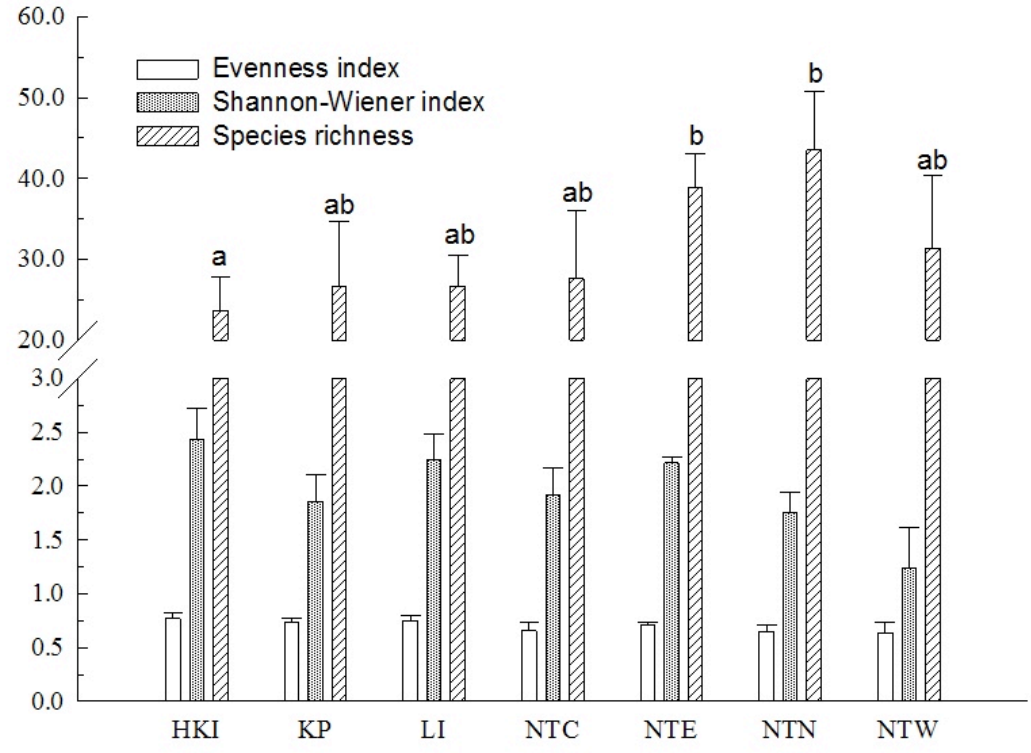

Fig 3. Plant diversity of groundcovers on soil slopes among different areas (mean ±

standard error). Bars having different letters denote significant differences ($p < 0.05$) between areas.

The two-dimensional multidimensional scaling plot demonstrated significant differences in plant species composition between suburban and urban areas (Fig. 4). LI, a suburban area with a lower degree of development, differed remarkably from the urbanized areas (Table 3). Another suburban area, NTE, also showed a significant difference when compared with the urban area nearby (KP). No significant change in plant community was found in the area at the higher elevation (NTC). There were also no dramatic changes in plant community between the urban areas, but significant differences were found between the suburban areas (Table 3). LI showed a significant difference compared to the two distant suburban areas (NTE and NTN) but showed a similar species abundance to other closer suburban areas (NTC and NTW). The plant species making significant contribution to the overall dissimilarity among areas are shown in Table 4. The dissimilarities were mainly caused by the significant higher abundance of plant species in an area in contrast to their low abundance or absence in other areas. These plant species were native fern species including *Cyclosours parasiticus*, *Dicranopteris pedata* and *Lygodium japonicum, Nephrolepis auriculata*, and an exotic species, *Bidens alba*. Moreover, the average abundance of native species in the suburban areas was significantly higher. In contrast, the urban areas consisted of higher abundance of exotic plants than those found in the suburban areas.

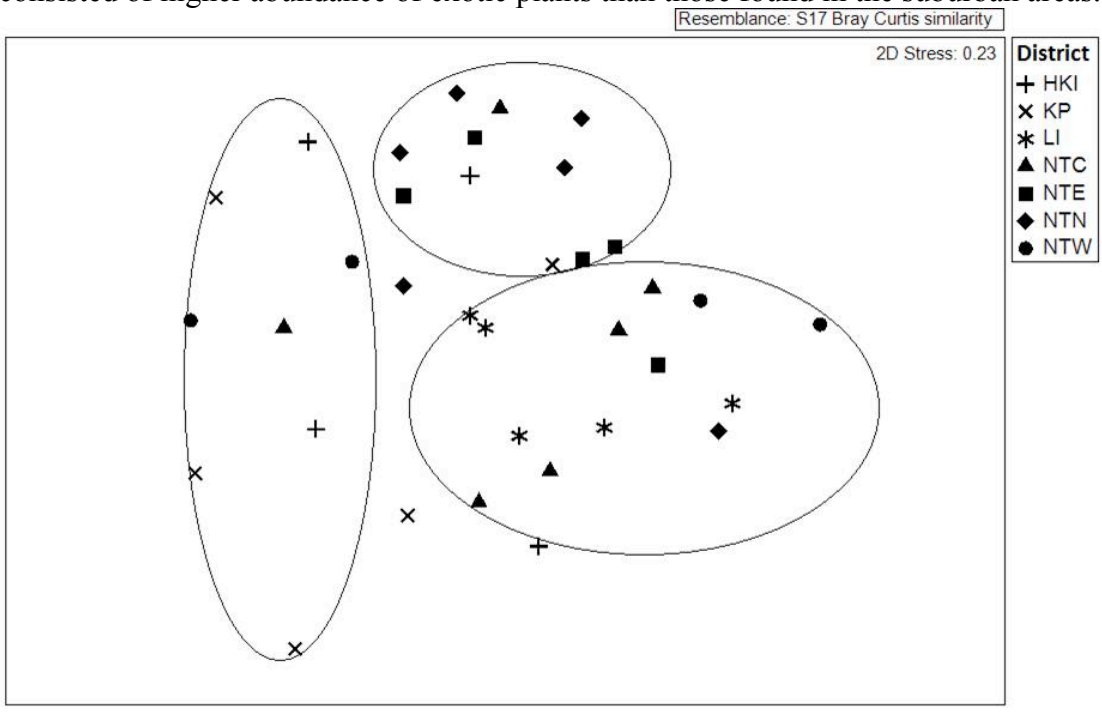

Fig 4. 2D-MDS plots illustrating plant species composition of study sites.

Table 3

Analysis of similarity (ANOSIM) on groundcover of soil slopes among different areas (global $R = 0.154$, $p < 0.05$).

	HKI	KP	LI	NTC	NTE	NTN	NTW
HKI							
KP	0.088						

LI	0.488*	0.330*				
NTC	0.143	0.220	0.168			
NTE	0.200	0.268*	0.396*	0.037		
NTN	0.187	0.160	0.301*	0.102	-0.099	
NTW	0.208	-0.006	0.281	0.091	0.069	0.095

Table 4
Plant species that contribute to the overall dissimilarity among areas.

Species	**Average abundance**		**Cumulative (%)**
Average dissimilarity = 91.83	KP	NTE	
Lygodium japonicum	<0.01	0.06	8.80
Cyclosorus parasiticus	0.01	0.06	17.17
Dicranopteris pedata	<0.01	0.05	25.06
Average dissimilarity = 90.62	LI	HKI	
Dicranopteris pedata	0.07	<0.01	13.80
Nephrolepis auriculata	0.01	0.05	24.69
Average dissimilarity = 91.65	LI	KP	
Dicranopteris pedata	0.07	<0.01	12.13
Bidens alba	<0.01	0.05	20.08
Average dissimilarity = 83.03	LI	NTE	
Dicranopteris pedata	0.07	0.05	13.26
Lygodium japonicum	0.01	0.06	23.33
Average dissimilarity = 86.72	LI	NTN	
Dicranopteris pedata	0.07	0.08	17.20
Cyclosorus parasiticus	0.02	0.10	33.63

Discussion

The revegetation of soil slopes is primarily aimed at providing a full or satisfactory green cover of an artificial environment. In this study, we found that the originally planted groundcover species were dramatically replaced after a certain period of time. The plant coverage of groundcovers was generally low, which might be contributed by the main substrate of soil slopes, completely decomposed granites. This coarse substrate is poor in nutrient and prone to erosion, enhancing the difficulties in plant establishment. The establishment of tree canopies on soil slopes, which provides a shaded environment, further disfavors the growth of groundcovers (De Keersmaeker et al., 2004). For plant richness, the number of species found in this study was consistent to that of other cities. Native plants contributed to the majority of the groundcovers except for some soil slopes that were dominated by the aggressive and invasive groundcover, *Wedelia trilobata*. Among them, ferns consisted of the highest coverage owing to their relatively large frond size. When compared to exotic plants, native plants often show higher adaptability when facing to the limited resources. *W. trilobata*, which originates in tropical Central and South America, either invades the slopes from adjacent areas or is being grown for revegetation. Its aggressive behavior

outcompetes other plants, leading to a long-lasting groundcover and lowers the ecological values of urban landscapes. As a result, *W. trilobata* should be minimized by replacing it with other native plants.

Planting native species on soil slopes can improve the plant species composition on soil slopes. However, most of the originally planted native groundcovers no longer existed. Instead, the soil slopes have been dominated by ruderal generalists commonly found in disturbed habitats. This was in line with a previous study showing that some perennial herbs could colonize and gradually replace the original groundcovers in degraded landscapes (Zhang and Chu, 2013). Plant traits such as high specific leaf area and plant height may contribute to their strong adaptations to urban environment (Calfapietra et al., 2015; Williams et al., 2015).

Both the suburban and urban areas showed insignificant differences in vegetation cover, which was caused by slopes with similar substrates and under consistent planting strategies. However, dramatic difference in plant species composition between urban and specific suburban areas was found. The plant community composition of LI, resembled to that of neighboring suburban areas, NTW and NTC. Nevertheless, the plant community of those suburban areas differed significantly to the two neighbouring urban areas, HKI and KP. This indicated the effect of urban development on the plant community. The plant species contributing to the overall dissimilarity of plant community included *Nephrolepis auriculata* and exotic *Bidens alba* (Table 4). Urban areas also promote the growth of exotic plants (DeCandido, 2004; Walker et al., 2009). Factors such as climate and environmental stress differ from those in suburban areas and are closely associated with the invasion of such plants (Cilliers et al., 2008). Locational barriers can also hinder the interactions of plant communities between different areas and therefore may have caused the formation of contrasting plant communities for groundcovers between LI and the two distant suburban areas, NTE and NTN (Bastin and Thomas, 1999; Muñiz-Castro et al., 2006).

Conclusions

In this study, the plant species composition of groundcovers on soil slopes has been changed in the urbanized landscapes of Hong Kong. The plant cover on soil slopes was unsatisfactory and colonized by native plants. Moreover, significant different plant species composition among the studied areas indicated the implications of urban development on groundcovers. Native planting strategies have a role in contributing to the rehabilitation of degraded landscapes and should be actively promoted. Improvement of plant selection, substrate amendment and engineering design should also be considered to facilitate the revegetation of soil slopes.

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Climate Change Law: Limitations of the Legal System to Respond to the Threats

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Abstract
From clean air regulations that affect cars and the transportation industry to government subsidies/incentives for renewable energy (solar & wind) to protecting the first amendment rights of scientists and journalists who maintain that climate change really exists and is caused by human activity, the American legal system is an integral part of the response to climate change and the public policy of sustainability and resilience. The importance of legal rules to deal with the threats posed by Climate Change cannot be overstated. At the federal, state and local levels of government regulations reducing air pollution and controlling energy that increases greenhouse gases, taxes on emissions, required insurance on flooding hazards and the like have been enacted to deal with Climate Change by reducing the causes and by adapting to reduce the physical risks to promote resilience. Yet, the U.S. legal systems has limitations that affect the impact. Legislation requires a political situation supporting regulation of the causes of climate change, financial support for alternative fuels and the will to develop and get laws passed that will be effective and acceptable to political bodies. Then there are the courts. Litigation is a slow process and the law created by appellate cases or federal district court decisions may be narrow and not comprehensive. Additionally, there are arguments that the public policy reflected in statutes, regulations and court decisions may not be based upon valid economic analysis. In a capitalist environment the response of business may be critical not only because of the severe limits of the legal system but also because government alone cannot work to meet the basic goals of dealing with the threats of climate change.

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Introduction

The perspective of this article is that of the attorney[1] for a business client that should know about risks of climate change and ways to adapt and be resilient.[2] This article begins with the notion that climate change is real. Bill McKibben's article identifies serious threats to humanity[3] and Vollman, W.T. (2018). *Carbon Ideologies,* reviewed by Rich, N. offers no comfort. [4] Climate change skepticism which has an impact on public policy that is the basis for development of law[5] is a worry.

The law developed to respond to climate change includes law seeking to mitigate climate change by controlling emissions of CO2- greenhouse gas and by government incentives for renewable energy. The Clean Air Act is an example of mitigation. Other laws deal with the threat of climate change by requiring or supporting adaptation to climate change to achieve resilience. An example of adaptation to threats of sea level rising and flooding by encouraging retreat of people and communities from threatened areas is the Biggerts-Waters Flood Insurance Reform act of 2012 that amended the federal flood insurance by eliminating the taxpayer subsidies to premiums paid by landowners [6] but the enforcement of that law has been deferred since it was to take effect in April 2014!

Most legal experts agree that laws meeting both public policy goals of mitigation and adaptation to climate change are needed.[7] Some advise manufacturing a cooler climate through geoengineering described by the Royal Society in 2009. Indeed, even environmental law scholars like Ruhl, J.B. expect that it will be adaptation law, recognizing that there is no way to avoid climate change, which will "push back on environmental law as we know it." [8]

Economics and role of business in dealing with threats of climate change deserves our attention

Learning that there are businesses that recognize the threats of climate change and that plan to support both mitigation & adaptation with or without legal requirements is

[1] Dernbach, J.C. (2013). Lawyering as if tomorrow matters. Retrieved from http://ssrn.com/abstract=3068735.
[2] Hammond, C. (2013). The evolving role for the transactional attorneys responding to client needs in adapting to climate change. *John Marshall Law Review, 47,* 543-607.
[3] McKibben, B. (2018 November 26). How Extreme Weather is Shrinking the Planet. *New Yorker*. Retrieved from https://www.newyorker.com/magazine/2018/11/26/how-extreme-weather-is-shrinking-the-planet
[4] Rich, N. (2018 October 16). The most honest book about climate change yet. *The Atlantic*. Retrieved from https://www.theatlantic.com/magazine/archive/2018/10/william-vollmann-carbon-ideologies/568309/
[5] Wang, J., & Kim, S. (2018). Analysis of the impact of values and perception on climate change skepticism and its implication for public policy. *Climate, 6*(4), 99. https://doi.org/10.3390/cli6040099
[6] Hammond, C. (2013). The evolving role for the transactional attorneys responding to client needs in adapting to climate change. *John Marshall Law Review, 47,* 543-607.
[7] Sokol, K. (2013). Possibility of climate manufacturing and the need for global governance. Retrieved from https://papers.ssrn.com/sol3/papers.cfm?abstract_id=2320513
[8] Ruhl, J.B. (2018 November 15). Preparing environmental law for the climate dystopia. *Environmental Law Prof Blog.* Retrieved from https://lawprofessors.typepad.com/environmental_law/2018/11/preparing-environmental-law-for-the-climate-dystopia.html

a very positive experience. The legal system alone will not be able to deal with climate change either in slowing its development by mitigation or in dealing with the disasters it causes (wildfires, sea level rising, etc.) [9] by adaptation.

Businesses of all kinds are growing aware of risks posed by climate change. [10] Owners, users and developers with interests in real estate are obviously affected by disasters caused by climate change. So are their investors and their lenders and all sorts of insurers. So are other types of businesses in all fields of endeavor. Additionally, the role of specific industries contributing to climate change is becoming clearer. News of industries as diverse as global textile production (that generates more greenhouse gas emissions than do international maritime shipping and aviation combined) [11] and the travel industry (not only transportation but hotels and tour operators allegedly are responsible for between 5 and 10% of the world's carbon emissions) [12] and utilities providing energy (in California liability for damages from wildfires is being challenged by utilities who blame climate change) [13] all recognize their special impact.

Some businesses are even taking advantage of opportunities to respond to climate change, through the redevelopment of infrastructure and investment in new energy and insurance products. A recent article in Bloomberg's Businessweek reported how a top investment strategist for JP Morgan Asset Management advised clients of the dire reality of sea level rising that would threaten 40% of Americans BUT still foresaw some business opportunities! [14] For example, it listed sea "walls costing $2.7 million per meter" as one opportunity. According to this view businesses need to be aware of costs of adaptation both as a risk if affected directly by one of the threats like water rising and as an opportunity to protect others from the threat.

At a minimum businesses need to develop information about the type of risks, the extent of risks, the likelihood of risks, the ability to avoid the risks and the costs associated with risks caused by climate change. This is a tall order. Yet, businesses no longer hide their corporate heads in the sand about the reality of climate change. The shareholders who "own" the businesses are becoming activist at least in their demand for information and disclosure about the risks of climate change to their investments.

Indeed, it is becoming clear that business and the economic interests of their owners will have a broad role and/or function in demanding reduction of GMH emissions to avoid catastrophes to the entire world economy. These may become the moving force, the leaders in demanding integration of individual efforts and those of

[9] Corelogic. (2018 August 22) 48,000 homes in Hawaii threatened by hurricanes. Corelogic (2018 November 12). 48,390 Homes at high risk from destructive California wildfires.
[10] Dernbach, fn. 43: Stern, N. (2007) *The Economics of Climate Change: The Stern Review*. Cambridge: Cambridge University press. doi:10.1017/CBO9780511817434
[11] Tramuta, L. (2019 January 1). Beautiful and sustainable big players in one of the planet's most polluting industries are finally getting serious about their environmental responsibilities. *Fortune,* p. 49.
[12] Vora S. (2019 January 6). Travel Industry uniting to fight climate change. *Honolulu Star-Advertiser,* p. travel.
[13] Chediak M. (2018 August 20). Don't blame us, blame climate change. *Bloomberg Businessweek,* p. 16.
[14] Flavelle, C. (2018). Climate change will get worse- bet on it, *Bloomberg Businessweek,* pp. 24-26.

government. In the United States the RISKY Business Project provides a good look at economic risks of climate change in its detailed report in 2014. [15] It alerted many to a "range of potential consequences for each region of the US…." It focuses on three of the clearest and most economically significant risks: 1) damage to coastal property and infrastructure from rising sea levels and storm surges; 2) climate driven changes in agricultural production and energy demand and 3) the impact of higher temperatures on labor productivity and public health.

According to its Executive Summary, a goal of the report is to promote a "standard practice for American business and investment community to factor climate change into its decision-making process." It judges that "business still tends to respond only to the extent that these risks intersect with core short term financial and planning decisions." It hopes for a more active role for American businesses including helping government determine how best to react to risks and costs of climate change and how to set the rules that move the country to more sustainability.

The awarding of the 2018 Nobel Memorial Prize in Economic Sciences to William Nordhaus shows a recognition of the economic perspective on climate change. Nordhaus has spent four decades trying to convince government to address climate change especially by imposing a carbon tax. Nordhaus decried the reaction of the current president: "It's hard to be optimistic. And, we're actually going backward in the US with the disastrous policies of the Trump administration." [16]

Development of law in the U.S.

Before explaining the limitations of the legal system to respond to the threat of climate change, a simple, basic look at how law develops generally in US will be useful. Thereafter this article will review how the law has responded to the fact of climate change by mitigation, adaptation, and even manufactured climate change.

In the United States there is an underpinning of the Common Law that followed the early English emigrants to America. The American legal system relies on development of legal precedent by appellate courts that review decisions of trial courts about disputes. Courts follow the existing common law rules until such courts determine that new legal principles are needed to deal with particular facts of the case in light of current societal public policy goals.

While the Common Law as enunciated by appellate courts provides a default rule of law, legislative bodies locally in cities and towns, state wide and nationally in the House of Representatives and U.S. Senate may alter the Common Law when the latter does not deal adequately with societal needs.

[15] Bloomberg, M. (2014 June). Risky business: the economic risks of climate change in the United States: A Climate Risk Assessment for the United States. Retrieved from https://riskybusiness.org/site/assets/uploads/2015/09/RiskyBusiness_Report_WEB_09_08_14.pdf. Houser, T., Hsiang, S., Kopp, R., & Larsen, K. (Eds.) (2015). *Economic risks of climate change: an American prospectus*. New York, NY: Columbia U Press.

[16] Appelbaum, B. (2018 October 9). Economics of climate change and innovations, *The New York Times,* p. A7.

Moreover, because of the importance of the three branches of government in the American legal system, legislation requires the approval of the executive branch. The executive branch, whether the president of the United States, the governor of a state, the mayor of a municipality or even administrative agencies at all levels to which powers to enforce the legislation have been delegated, has an important function in the developing the rule of law through legislation.

Finally, legislation is subject to review by the judiciary in light of laws and underlying constitutional principles. Global rules to which the U.S. becomes bound are approved by the US Senate in the form of treaties

There are limitations of the legal system that affect the success of it responding to the threats of climate change.

Legislation requires a political situation to support the laws. Even if you have that, it requires money. And identity based conflicts of the sort that have become more acute since the 2016 elections interfere with developing a coherent public policy on climate change. Indeed, research by Wang, J. & Kim, S. reports that significant declines in climate change beliefs, risk perceptions and trust in scientists in the U.S. have occurred. From a political perspective, the great difference between Democrats, 72% of whom believe that "changing temperatures are due to human-induced climate change," as compared with Republicans, only 27% of whom hold that view, suggests why legislation is difficult to enact.

Peck, A. considers how the insights of peace and conflict studies researchers to move past such identity- based conflicts that threaten to bring lawmaking to a standstill" [17] may be useful. In this period of skepticism and denial Lucas, G. and Mormann, F. argue that we need prediction markets to sway public policy to achieve acceptable resulting law. Their research deals with the problem of policy makers in deciding which policies are best suited to "tackle the enormous challenges presented by our changing climate" in preparation for legislative proposals.

After reviewing and criticizing four decision making mechanisms that commonly are used by legislators,[18] Lucas, G. & Mormann, F. recommend using the same prediction market techniques that have forecast election results, economic trends and Oscar winners. Using group deliberations, peer review, cost benefit analysis and expert surveys, market participants would bet on important climate outcomes conditioned on the adoption of particular policies. They expect that this approach to policy making might also "overcome resistance to climate change mitigation efforts, particularly among market-oriented conservatives."

Passage of laws by legislators depends on the politics at any particular time. Legislation to deal with climate change will not be enacted when current political support is lacking. And because of the role of the executive branch in the American government system, federal legislation cannot be enacted without support of the

[17] Peck, A. (2018). Identity-based conflicts in public policy: hydraulic fracturing Pennsylvania. *University of Pittsburgh Law Review*, *79(3)*, 437-509. DOI: 10.5195/lawreview.2018.567

[18] Lucas, G. & Mormann, F. (2018). Betting on climate policy: using prediction markets to address global warming. Retrieved from https://ssrn.com/abstract=3178337.

president. (Unless a large percentage of both houses of Congress overturns the president's veto).

In the U.S. legal system, rules also are made by administrative agencies to which a statute or ordinance specifically delegates a legislative function to implement the statute or ordinance. Because leadership of administrative agencies are determined by the executive branch, a president may interrupt enforcement of climate change statutes by failing to enforce administrative rules and even by changing those administrative rules. The New York Times reported that "New E.P.A. Plan Could Free Coal Plants to Release More Mercury into the Air" in its referral to revision of the underlying reasons that the Obama administration used to justify restrictions on mercury emissions from coal in 2011. [19]And, of course, the recurring budget crises that are being used as the reason for a near total shutdown of the federal government interfere with the administrative agency work.

Litigation as the creator of law is a slow, narrow process. Often litigation is begun with a goal of avoiding clear statutory or common law. Thus, litigation may challenge the constitutionality of a statute or, more likely, seek an interpretation or application of a statute, sometimes to undercut the public policy that responds to climate change in the first place. And, because of the vagaries of our appellate court system that determines the Common Law and interprets the statutory law, litigation results in unclear and inconsistent rulings.

Craig, R.K. provides details of litigation brought in eight cities and counties in California regarding the impact of sea level rising.[20] The procedural moves include removing cases from state courts to federal courts and identifying the cause of action as in state tort law or the federal common law often with conflicting results. And, in an effort to support the defendants in all eight law suits, the Competitive Enterprise Institute (CEI) and the National Association of Manufacturers (NAM) asked the Securities and Exchange Commission (SEC) to investigate whether the local government plaintiffs violated SEC law by withholding information about their vulnerability to sea level rising when those local governments issued and sold municipal bonds.[21] Indeed in reflection on the limitations of litigation as a developer of the law, a prominent jurist, Judge Richard Posner of the federal 7th Circuit Court advised a group of Chinese judges to avoid adoption of the Common Law approach of the American and the English system. He urged China to instead adopt the bureaucratic approach to developing law of the Civil Law countries[22]

And litigation initiated by the executive branch of the government, whether by the Justice Department of the President of the U.S. or the attorney general of a state, may seek to negate the positive common law and/or legislation that has been enacted to

[19] Friedman, L. (2018 December 28). New E.P.A. plan could free coal plants to release more mercury into the air. *The New York Times.* Retrieved from https://www.nytimes.com/2018/12/28/climate/mercury-coal-pollution-regulations.html?em

[20] Craig, R.K.(2018). California climate change lawsuits: can the courts help with sea-level rise and who knew what when? Retrieved September 2018 from https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3225312.

[21] Craig, R.K. (2018). California climate change lawsuits: can the courts help with sea-level rise and who knew what when? Retrieved September 2018 from https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3225312

[22] Video of his lecture on file with author January 22, 2019.

deal with climate change. So it is a mixed bag. The bottom line is that the rule of law that is supposed to support the protection of society may fail to achieve that goal in a timely way.

In a market /capitalist economic system, the response of business to climate change is critical.

The economic risks of climate change are important motivators[23] for business in the US. Both the law and organizations, like CERES reflecting shareholder and other stakeholder interests, emphasize business disclosure of climate change risks because of a belief that investors will notice such disclosures as they make investment decisions and because investors are entitled to know as they invest. The administrative regulations of the Securities and Exchange Commission (SEC) require companies to disclose risks that may affect their business/profit. In 2010 those regulations were expanded to require disclosure of risks associated with climate change.[24] The four categories of impacts that could trigger disclosure obligations include: "1) newly enacted or pending greenhouse gas laws and regulations; 2) treaties and other international accords;3) indirect consequences and business trends brought on by climate change; and 4) the physical effect of climate change."[25]

Still criticism of the SEC requirements stems from not broad enough disclosure requirements and a lack of enforcement of the administrative agency regulations. And as Kirsch & Custer conclude, "{I}t is important to remember that determining whether making an environmental disclosure is required is only the first step." Unless investors and management of companies see sufficient value in mitigation of or adaptation to climate change, the information alone will not respond adequately to the threats. Sjafjell, B. describes a Sustainable Governance Model that can provide guidance on how to integrate sustainability into the decision making of corporate boards and which can be the basis for law reform proposals.[26] Fisch, J.E. provides the argument for a broader "Sustainability Disclosure" that would not leave the decision of what is "material" enough to warrant a disclosure to the company and would not limit enforcement to the SEC because the latter's enforcement is "vulnerable both to political pressures and shifting administrative priorities." [27]

The need to communicate about climate change and its importance to business and the markets cannot be overstated.

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[23] Houser, T., Hsiang, S., Kopp, R., & Larsen, K. (Eds.) (2015). *Economic risks of climate change: an American prospectus*. New York, NY: Columbia U Press.

[24] Kirsch, R.C. & Custer, N.B., (2013). Disclosure of environmental liabilities: sec obligations, auditing standards, and the effect of Sarbanes-Oxley. *SU035 ALI-ABA 2055 The Impact of Environmental Law on Real Estate and Business Transactions: Brownfields & Beyond. American Law Institute-American Bar Association (ALI-ABA),* Volume 2.

[25] *Kirsch, R.C. & Custer, N.B., (2013). Disclosure of environmental liabilities: sec obligations, auditing standards, and the effect of Sarbanes-Oxley. SU035 ALI-ABA 2055 The Impact of Environmental Law on Real Estate and Business Transactions: Brownfields & Beyond. American Law Institute-American Bar Association (ALI-ABA), Volume 2.*

[26] Sjafjell, B., (2018). Beyond climate risk: integrating sustainability into the corporate board. Retrieved from https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3279316

[27] Fisch, J.E., (2018). Making sustainability disclosure sustainable. Retrieved from https://scholarship.law.upenn.edu/cgi/viewcontent.cgi?article=3000&context=faculty_scholarship

Solutions must come from the markets which are the most powerful organizing institution on earth. Hoffman, A. of the Business School at University of Michigan points out that climate change brings market shifts from the systemic risks that affect the entire economy to more specific risks to certain industries and sectors.[28] His examples of the shifts include:

- Regulatory changes that can alter the price of carbon that may affect many levels of the business from production to transportation
- Financial markets shifts due to investors and shareholders considering the issue of Climate change in relation to asset decisions.
- Risk management shifts e.g. with insurance and reinsurance a company considers as it evaluates physical, financial and disclosure risks posed by climate change and
- Consumer shifts with demand moving to products that are less wasteful and more energy efficient even when the motivation may be more economic than altruistic.

Hoffman points out that he is not looking at Corporate Social Responsibility (CSR) or the morality of what a corporation should do, but rather the response to business constituents who bring concerns about climate to the corporate agenda. Hoffman stresses that the solutions to climate change must come from business. It does not matter whether business leaders and investors are "agnostics about the science of climate change." They must see it as a "business issue."

This is all consistent with the research of Petersen, H.L. & Vredenburg, H. who found that investors in and the management of businesses espousing CSR are motivated by a belief that CSR adds economic value to the firm. There is no inherent/necessary conflict between a business goal to mitigate and/or adapt to climate change and the basic goal of business to increase profits.[29] It is with this prominent role of businesses of all sorts that the most effective response to the threats and destruction caused by climate change can occur. Actually, this should be no surprise.

Conclusion

In reaction to the limitations of public law dealing with threats of climate change, the question of what rules, even if not rules of law, can be developed and how they can be developed to respond to the threats looms. The process and the results should and must be consistent with the business forces. Although a solution is beyond the scope of this article, it is worthwhile to identify and consider some of the possibilities.

In 2005 Orebech, P., Bosselman, F., Bjarup, J., Callies, D., Chanock, M. & Petersen, H. argued for a new evaluation of customary law, a "bottom-up-system" that would

[28] Hoffman, A.J. (2016). Communicating about climate change with corporate leaders and stakeholders. Retrieved from http://deepblue.lib.umich.edu/bitstream/2027.42/117584/1/1313_Hoffman.pdf

[29] Petersen, H. L., & Vredenburg, H. (2009). Morals or economics? Institutional investor preferences for corporate social responsibility. *Journal of Business Ethics, 90*(1), 1-14. doi: 10.1007/s10551-009-0030-3

play an important role in sustainable development of the land.[30] Although sustainability itself may no longer be enough of a goal for the planet, it does offer a recognition that the use of natural resources should be guided/restricted by a common sense approach. How to identify that common sense and implement it as a rule challenges us still.

Kenny, B., Vredenburg, H., and Lucas, A., offer a new role of law to reconcile economic development, environmental protection and entrepreneurship in the energy industry.[31] In describing "reflexive law," they suggest that rather than a rights based approach that only considers whether technical legal standards will be met by business, an interest based proactive approach considering the stakeholder concerns would be a more effective approach to meeting the complex goals that must be considered in the context of climate change. Indeed, as they describe reflexive law, it would take elements of responsible institutional decision making that are based upon the kind of information generation and exchange that the disclosure rules of the American SEC require. [32] Reflexive law ideas respond to the "challenges of how to ensure that the rules governing society can adapt effectively in complex and turbulent times." Kenny, Vredenburg and Lucas conclude that this reflexive law process may be effective to meet challenges companies face when "operating in this complex business environment …where significant gaps in public policy leave a wide range of unresolved issues to contend with." [33]

In 2007 Vandenbergh, M.P. shared his studies of Private Environmental Governance (PEG).[34] His work on how this approach can work in response to climate change follows work by Hardin, H. [35] who explained why private control over public resources would not be effective and Ostrom, E. who described how communities "can collectively, and with external government force, manage natural resources." [36] Galperin, J.U. defines the word, "private" as a description of the locus of decision-making: non-governmental. [37] Apparently, Galperin and Vandenbergh agree that

[30] Orebech, P., Bosselman, F., Bjarup, J., Callies, D., Chanock, M., & Petersen, H. (2006). *The Role of Customary Law in Sustainable Development*. Cambridge: Cambridge University Press. doi:10.1017/CBO9780511550621

[31] Kenny, B., Vredenburg, H., and Lucas, A. (2012). The new role of law in stimulating industrial innovation and regional development: the Canadian experience with reflexive law in reconciling economic development, environmental protection and entrepreneurship in the energy industry. International Journal of Innovation and Regional Development, 4(1), 8-27.

[32] Kenny, B., Vredenburg, H., and Lucas, A. (2012). The new role of law in stimulating industrial innovation and regional development: the Canadian experience with reflexive law in reconciling economic development, environmental protection and entrepreneurship in the energy industry. International Journal of Innovation and Regional Development, 4(1), 8-27.

[33] Kenny, B., Vredenburg, H., and Lucas, A. (2012). The new role of law in stimulating industrial innovation and regional development: the Canadian experience with reflexive law in reconciling economic development, environmental protection and entrepreneurship in the energy industry. International Journal of Innovation and Regional Development, 4(1), 8-27.

[34] Vandenbergh, M. P. (2007). The new wal-mart effect: The role of private contacting in global governance. *UCLA Law Review* 54(4), 913-970.

[35] Hardin, G. (1968) The tragedy of the commons. *Science, 162(3859),* 1243-1248. DOI: 10.1126/science.162.3859.1243

[36] Galperin, J. (2018). Private, environmental, governance. *George Washington Journal of Energy and Environmental Law* 9(1), 1-4.

[37] Galperin, J. (2018). Private, environmental, governance. *George Washington Journal of Energy and Environmental Law* 9(1), 1-4.

governance is "a restriction on behavior" where the limits can arise from a number of sources including public law, private law and community norms.

Vandenbergh's recent article uses a case study of global civil aviation sector as an industry where PEG could be used to fashion guidance, or "a private governance agenda," with examples of the initiatives that might be included. [38] That industry clearly contributes to greenhouse gas emissions as well as experiences the disasters to which it must adapt to achieve resilience. Yet based upon review of the past few decades and the current political climate, Vandenbergh does not expect government to deal with the problems. He recognizes that although private governance initiatives are an option, they "are not a first-best response." [39] They cannot get a decline in large scale emissions which a carbon tax could, but they are a second-best approach because in the short term they may bypass the barriers to government action and achieve at least some important mitigation results. [40]

Given the limitations of law in the US to respond to climate change, scholars like those mentioned will provide a basis for new approaches that incorporate discussions with businesses and other stakeholders.

[38] Vandenbergh, M.P. & Metzger, D.J., (2018). Private governance response to climate change: the case of global civil aviation. *Fordham Environmental Law Review,* 30(1), 62-110.
[39] Vandenbergh, M.P. & Metzger, D.J., (2018). Private governance response to climate change: the case of global civil aviation. *Fordham Environmental Law Review,* 30(1), 62-110.
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Education for the Emerging Future

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Abstract
Educational leaders need a framework to lead schools fearlessly into the uncertain, emerging future. In our rapidly changing world there is growing concern around the suitability of an industrial revolution based education model and debate around the keys to educating students for an unknown world. Many educators want change but feel confined by the existing system. The challenge for educational leaders is to look towards and lean into emerging future possibilities. To develop a pathway that rewrites the role of education and co-creates education systems that support and prepare students for an uncertain future. We explore ongoing research into the following structural elements that support this shift and provide a framework for every educator, student and parent to reshape education:
Rethinking schools as businesses where client (student) engagement drives decision making.
Embracing Purpose-Led leadership, developing adaptive cultures and aligning all aspects of education towards a purpose of educating students for an emerging future.
Exploring the power of design and to promote creative, individual experiences.
Increasing engagement using experiential methodology centred around solving meaningful, real world problems.
Using student led project based experiential learning to shift the focus from a knowledge based curriculum to a skills based curriculum and strengthen cross curricular relationships
And reframing existing systems element – like standardised testing, to be opportunities to manage uncertainty, problem solve and fail forward, rather than summative evaluations to be prepared for and taught to

Keywords: education, emerging future, change, leadership,

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Introduction

There is wide spread dialogue in the education world about whether the current education system is adequately preparing students for a rapidly changing world[1] and how to best equip students with the skills required by the emerging workplace. This conversation parallels one in the business world as businesses grapple with changing rules of engagement and strive to adapt to disruption and a rapidly changing world.

While we know the world is changing, to a large degree, that's all we know. As identified by (Japp & Kusche, 2008: 80), "the future is uncertain" and as such "human beings are fundamentally incapable of predicting it" (Simon, 1990: 7–8; Taleb, 2008). There are a multitude of possible scenarios.

According to Shah (2008), "Education comprises a lifelong learning system to cope with the changing needs and aspirations of society," and by default, should be responsive and adaptive to the changing needs of an evolving world.

And yet it doesn't seem to be. Having spent the past 20 years working in a variety of traditional and non-traditional contexts across four different countries, my experience mirrors research[1]: while there are pockets of exciting and hopeful innovation, for the large part we are still educating students with an industrial mindset with no clear answers about how to do it differently emerging.

The research reflects this: "Educational change is known to be challenging and therefore research exploring the conditions that seem to facilitate change is important." (Woolner, P, Thomas, U & Tiplady, L 2018).

And so this ongoing research began with my appointment as Director to a remote education campus in the remote wilderness of Australia that serves as a residential, off the grid, experiential campus.

Attached to a city based private school, approximately 80 14-15yr old girls spend a term (or 8 weeks) of their grade 9 year immersed in farm life, living independently with limited access to technology and exploring broad sustainability concepts.

The program had existed for 15 years prior to my appointment as Campus Director. By the time I arrived, big questions had been asked and answered about the College's willingness to invest significantly in the program and infrastructure or shut it down completely.

Having committed to that investment our team was tasked with transforming all aspects of the campus - physical, cultural and educational, so it became an international leader in holistic sustainability education.

And we were encouraged to experiment with different pedagogy and program elements that could contribute to a transformational framework. Our research and practice centred around the questions of "How could we do things differently and create a system that was adaptive to the changing needs of an evolving world?"

Our first step was to clarify the purpose of this standalone experiential program and the student outcomes we were hoping to achieve.

Through a consultative process, our big idea became: to have students "Explore their unique role in promoting a sustainable future".

And we became immediately aware of two different sorts of problems: Firstly related to student outcomes - how do we integrate the transformation into the rest of their schooling and their real life at the end of the program? And secondly related to organisational culture and leadership mindset, how do we overcome the fear and reluctance of leadership to embark on a new radical path without assured outcomes (which only come as a result of the experience of the new pathway). Classic chicken and egg problem!

This was the starting point for our research.

This paper outlines where and how we looked for solutions. It then explores a series of interconnected tools that together, support and prepare individuals and communities to journey on the pathway to an emerging, unknown, uncertain future. Elements which provide a pathway that facilitates ***organisations*** to be adaptive and constantly respond to a changing world. And outlines our findings related to how these tools work in different situations or might be applicable in different contexts.

Methodology

Two core beliefs shaped our methodology:

Firstly, John Elliot's belief articulated in 'Action Research for Educational Change' that "teaching and research are innately and inextricably connected, rather than two separate activities".

And secondly, the concept of Improvement Science as outlined by Langley et al (2009) and the idea that improvement emerges from developing, testing, implementing, and spreading change (Perla et al., 2013).

Our Action Research attempted to identify system elements that cataylsed transformation and promoted adaptation to the changing needs of an evolving world. The majority of the research was undertaken over 4 years and involved 1120 female students and 26 staff from two different campuses of the same K-12 school in Melbourne, Australia. Process and reflections accompanied student, staff and management interviews.

In addition, ongoing research in various education and business contexts across several industries is still being undertaken to identify the cross-industry relevance of these elements.

So far, across these different contexts, our findings are that there are at least 5 elements that support the capacity to build skills, schools and organisation primed to navigate change:

1. Real world experiential learning - Increasing engagement using experiential methodology centred around solving meaningful, real world problems;
2. Purpose-led leadership driving organisational values and decision making
3. The practice of reframing assumption and structural elements
4. Co-creative Design and genuine stakeholder engagement driving decision making
5. Promotion of Adaptive cultures that value change and are action oriented.

While we initially expecting to find a framework, what we have uncovered is more of an interconnected web of elements. This finding mirrors the idea that multiple components interact to achieve a planned result (Lee et al, 2009) and underpins the work of Project Zero at Harvard[2].

As we do more research, it would seem there are possibly more than these five elements. Similarly, as we understand how they look in different contexts and the interplay between them better, elements we initially saw as two, have become one. This journey has been about uncovering something, embedding the theory in practice, realising it's not the whole answer and looking for something else, as advocated by idea of Improvement Science (Lemire et al, 2017) and the work of the Carnegie Foundation, Stanford[1].

Body

Element 1: Real world experiential learning

There are various experiential based pedagogies – project based learning, problem based learning, design thinking, and service learning, to name a few, can all be categorised as experiential and potential embedded within a real world context.

Our research mirrors other research (Jarrotul Khoiriyah, & Husamah (2018). Anderson, (2012); Watson, 2015; Scheer and Plattner (2011)) indicating that the value of real world, experiential based approaches is that they:

- strengthen identity and connection to place,
- increase relevancy and
- provides opportunities to practice skill transference.

They also allow skilled facilitators to nurture and develop more sophisticated cognitive skills such as analysis, synthesis, critical thinking, systems thinking, creativity and design by designing them into projects or experiences.

One Action Research project centred around the journey of shifting a K-12 single gender, city based private school Community Service program to a Service Learning model. Looking to embed something more aligned with College values, we embarked on research to determine effective ways of delivering/embedding genuinely student led, contextually relevant, experiential, service projects that met a genuine need and worked within the existing school framework using year 9 as a starting point.

A year into the project, our results demonstrate greater collaborative problem solving in staff, increased creativity in the results, larger commitment to their agenda and yet interestingly a less fixed mindset about how to achieve that agenda.

Shifting to a problem-based learning model with no specific pathway or right answers challenged both staff and students in a variety of ways. And while we have by no means achieved our goal of developing a culture of service embedded throughout the College yet, our findings in terms of student outcomes mirror outcomes outlined by Vanderbilt University[3], Astin et al., (2000), Craig (2017) and Brail, S (2016)

- Engagement increased in student groups who were more genuinely involved in the ideation, design and execution of the service learning project.
- There were observed increases in student understanding of how skills could be applied in different contexts.
- The shift in the student teacher dynamic increased students reported experiences of autonomy, willingness to creatively problem solve and capacity to reframe failure as an essential tool in discovering solutions.
- Creativity, critical thinking, curiosity, and resilience markers increased

Unexpectedly, students in leadership positions reflected a shift in their leadership style from directive to more facilitative which has direct implications for students as they move beyond education and into the world of work.

Ongoing, the challenges we now need to overcome are:

- How do we create authentic experiences for our students embedded within our community within the perceived constraints of the curriculum, timetable, and standardised assessment?
- How can we effectively train teachers and leaders to seek to ask great questions and facilitate well? This is key if they are going to feel comfortable leading their student to uncover solutions to problems that are genuinely unanswered.
- And how do we bring parents and other key stakeholders on the journey of transformation.

Element 2: Purpose-led Leadership

Purpose led leadership starts with defining a purpose larger than any single individual, which inspires other to bring to fruition. Then striving to embed that purpose throughout every aspect of an organisation and holding steady to that anchor in the face of adversity, uncertainty and criticism.

Walker and Soule (2017)[4] outline, 'A good organizational purpose calls for the pursuit of greatness in service of others. It asks employees to be driven by more than personal gain. It gives meaning to work, conjures individual emotion, and incites collective action'.

Research by Hadfield and Ainscow (2018) theorises, 'The creation and maintenance of a strong political mandate' creates the conditions within the system that are supportive of change as is "requires new thinking, attitudes and relationships across education systems". This highlights the interconnection between element 3.

Implicit in the concept of Purpose-led Leaderships is a Transformational Leader, characterized as one who articulates a vision of the future that motivates people to go beyond their self interest for the sake of the shared vision. (Yammarino & Bass, 1990).

In our research we have found many organisations to lack clarity of purpose – schools and otherwise. Or perhaps it exists, but is not clear to all members of the team. And on the rare occasions it is clear, it is not embedded throughout the organisation and doesn't drive every decision.

One aspect of our work was to clarify and embed the purpose of the remote residential campus.

When this research began, the purpose of the campus's existence was murky. Obviously, it took girls out of school at a challenging time and put them in a beautiful environment where they lived and learned experientially all those important things we are often too busy to teach at a regular school. Such as, communication and conflict resolution and owning the outcome of actions and decisions. But I would argue that you don't need a world class sustainability focused campus to do that.

By co-developing a purpose larger than 'to learn lifeskills' with a variety of stakeholders (Wilson and Ortega, 2013), and deciding the campus existed to facilitate an "exploration of students unique role in promoting a sustainable future'' everything shifted.

While the scope of this paper is not to outline how this re-shaped purpose was embedded within this school context, we can outline the outcomes of the shift.

- With a clarification of the term 'sustainable' to extended beyond saving water or utilising renewable power sources, teachers stopped pushing everyone towards science based investigative projects if they weren't appropriate for the individual student.
- Students were provided the opportunity to more genuinely co-design projects (element 4).
- Staff focus shifted from "getting through curriculum" to bringing every experience back to what this would mean for them beyond their residential experience.
- Crucially, over 7 years the reported student experience shifted from something students did (often described as being 'the best thing I did while at school') to something that catalysed a shift in the way they saw themselves in relation to the world and their place in it.

These finding are mirrored in research undertaken in an architectural firm. Once leadership was able to identify organisational purpose and lead from that perspective, it resulted in a simple shift in communication process. The shift allowed team members to more clearly see how some specific aspects of their work connected to the larger purpose of the organisation which then increased compliance with that specific process by 423%.

Element 3: Re-Framing

Initially we identified **Rethinking Assumptions** and **Re-Framing of Structural Elements** as two different elements, but as we explore them more and draw on other research, we are coming to feel they are actually two flavours of the same idea.

According to Ellis (2018), reframing is about seeing things from a different perspective and involves perceptions, meaning-making, and change. Essentially, changing our thinking around something. Mezirow (2000) outlines how it requires underlying and often tacit assumptions to be uncovered, articulated, examined, and changed.

Thinking drives behavior and behavior causes results. As Einstein is often quoted, "The significant problems we face cannot be solved with the same level of thinking we used to create them". And yet we are trying to build a new system with the same thinking as we built the old system – in both the business world and the education world. When we start to rethink assumptions and system elements infinite possibility opens up. And this is reflected in research from the Cloud Institute for Sustainability Education[4] and their belief that "it all begins with a change in thinking".

We see evidence for the argument of rethinking and reframing in Cairney's (2018) work with Remote Australian Aboriginal communities exploring the need to understand the variables that affect behaviour change and not assume that culturally significant elements will shape behaviour in the same way in different cultures.

And in research from the FYA (2017)[5]outlines the value of rethinking how individuals can apply the skills they have to different situation and different contexts in order to be successful in the emerging future.

One aspect of our research was reframing the value of standardized testing in a Melbourne based kindergarten. In interviews, teachers expressed concern about the time preparation for these test was taking and leadership expressed concern about the subtle competitive culture growing among staff in terms of cohort results. Our research explored possible ways to reframe these tests and the value of various reframes.

Results indicated a shift in mindset. The standardized tests went from being a way to evaluate teacher performance (which had become a reported pervasive unintended outcome of these tests) to an opportunity for students to experience uncertainty, problem solve in new ways and get comfortable with not knowing. Staff attitude to work also changed, reporting increased satisfaction, feelings of competency and being part of the team.

Element 4: Co-creative Design where Genuine Stakeholder Engagement Drives Decision Making

There is much scope for co-design in both school and business settings and research suggests outcomes increase with practices such as building collaborative cultures, restructuring, building productive relations with stakeholders, and connecting the school to its wider environment. All of which allow individuals (staff, students, parents, stakeholders) to make a contribution more in line with their motivations and capacities. (Leithwood et all, 1996.)

Co-design requires the role of the leader to be change agent and they openly challenge the status quo and assumptions (Wilson & Ortega, 2013), which links to element 3.

Our Action Research focused on co-creating updated curriculum at the remote campus curriculum as a result of purpose clarity. And providing student more genuine co-design opportunities as part of their assessment, also as a result of purpose clarity. This highlights the essential role of element 1.

Once the curriculum vision was agreed on by key stakeholders, a framework for adaptive transformation (which links to element 5) and a forum for ongoing implementation review was provided and staff invited to be part of the process in any way that worked for them.

Results indicated:

- Increased staff buy in as their reported sense of flexibility and autonomy increased.
- Increased sense of collaboration and shared ownership of the program which led to average staff tenure increasing from 1.2 months to 4.2 years over a 7 year period.[6]
- Increased willingness to experiment and openly feedback about successes and failures due to encouragement and lack of reproach when things 'didn't work'.
- Increased student outcomes as a product of:

1. The continual iteration process encouraged if outcomes were not yet being met
2. Increased creativity of ideas due to the experimental culture which provided scope to meet the needs of varied learning types.
3. More focus on student needs and outcomes, as focus on 'delivering curriculum' decreased. Nesbit and Lam (2014) describe identify a client centric organisational culture as being a key element in developing an adaptive culture (element 5)

While we didn't set out initially to promote an adaptive culture, inadvertently the process of co-design promoted adaptive behaviours, which shows the inter-related nature of element 4 and 5. And led to further research focused on the creating of a culture that embraced experimentation without fear of reprisal.

Element 5: Promotion of Adaptive Cultures that Value Experimentation and Shared Process.

Closely linked to element 4, O'Reilly et al (2014) define "Adaptive" cultures to be those that encourage risk-taking, a willingness to experiment, innovation, personal initiative, fast decision-making and execution and the ability to spot unique opportunities. In addition, they minimise the behaviors of being careful, predictable, and avoiding conflict.

Research suggests adaptive approaches prioritise shared processes among stakeholders (Wilson and Ortega 2013) (which links to element 4), and require individuals and organizations to question values, assumptions, process and policies that dictate behaviour. A culture of avoiding risk discourages people from challenging basic assumptions embedded within existing systems and processes that are necessary for provoking effective learning and (Lee et al, 2008) which shows the interconnection to element 3.

Kenney[7] identifies the attributes of an adaptive culture to be threefold:

- The ability for all employees, departments, and groups within an organization to collaborate effectively.
- The ability for members at all levels to network with others outside the organization,
- The ability for all employees at all levels to innovate and experiment without fear of "reprisal" or marginalization.

Ironically, this research stemmed from experimentation with different pedagogy and system elements within a risk averse culture because the experiential program was fixed in time and standalone in nature. In the context of College wide culture, it was a significant experience to try and transform and yet wasn't significant enough academically that we couldn't make a mess of that exploration.

Our Action Research had three elements:

- The showcasing of innovative efforts of staff regardless of outcome
- The creation of structured opportunities for groups to collaborate more effectively
- The opportunity for staff to question assumptions about various program elements and critically evaluate their relevance to the larger purpose.

Our findings indicated that

- There was initial reluctance to share teaching pedagogy and ideas that was not completely formed outside of the formalised action research process. Early adopters felt simultaneously proud and ostracised by their peers. Creating opportunities for those most disengaged and sceptical to share ideas was the most effective method of creating a more experimental culture.
- A shift in mindset catalysed by challenging assumptions (element 3) was required in order for staff to access opportunities to collaborate outside of the campus due to the perceived limitations of the location and unique timetabling due to the residential nature of the program
- Fear of conflict and defensiveness in staff around the validity of particular program elements was high at the beginning of the research. Encouraging debate around how various elements related to the purpose was sound to be most effective in dismantling this defensiveness and attachment. This then led to increased flexibility about how outcomes could be achieved and a higher level of acceptance of others 'doing it differently'.

Conclusion

In conclusion, we have found there are at least five interconnected structural elements, which together, provide a design framework – a set of tools any intrepid leader can use to navigate and adapt to the changing needs of an evolving world.

The interconnected nature of the elements is key and we see them becoming more powerful when they work together and the interconnections are emphasized.

We believe it is unlikely these are the only five elements and we are not yet clear if starting with a specific element in different contexts is more effective. With the limited research we have undertaken, at this stage, in different context the ranking of their importance seems different:

- In our work in schools, project based, real world experiential learning seems to be a priority consistently across all the research and literature.

- In our work with communities, purpose-led leadership and opportunities to co-create within that purpose driven framework seem to be most impactful. But what is a school if not a community?

- In our work with business, purpose-led leadership and rethinking assumptions seems to foster a culture of innovation and creativity which then drives profitability and engagement in a changing world.

This research has led to more questions, such as, how do we best foster these elements as skills in our educators, our learners and our leaders? How can we develop stronger interconnections between the elements? How do we develop the courage to pioneer when we sometimes believe the outcomes are too important to experiment with, especially in schools? How do we promote practices of co-design and co-discovery and best dismantle competitive cross silo cultures so wicked type problems can be tackled with greater likelihood of success because of the diverse perspectives and more wholistic understanding of the system elements people can bring.

In reality, the conundrum facing leaders and education administrators about how to shift to a framework or system or model that better supports our young people developing the capacity to journey fearlessly into the unknown is inherently challenging.

Many leaders are never going to feel comfortable making changes without the reassurance of results they can't see until they implement those changes. And as educators, culturally we are intrinsically uncomfortable with the idea of trial and error, or getting it wrong on the way because we value our young people too much.

But we can only develop a framework that will lead us fearlessly into an uncertain future when we are willing to constantly rethink attitudes as this allows us to choose what and who we become within the system, rather than what the system makes us.

And it is our willingness to experiment, review and then iterate that will allow us to adapt to the changing needs of an emerging future.

My hope is that by understanding the value of these interconnected elements leaders are emboldened to use them as a framework and society can reap the rewards of that boldness.

Footnotes

1 - Carnegie Forum on Education and the Economy, A Nation prepared: Teachers for the 21st Century, Carnegie Foundation, Washington, DC, 1986

2 - http://www.pz.harvard.edu/sites/default/files/2017-2018%20Annual%20Report%20Final3.pdf
Lemire, S., Christie, C. A., & Inkelas, M. (2017). The methods and tools of improvement science. In C. A. Christie, M. Inkelas & S. Lemire (Eds.), Improvement Science in Evaluation: Methods and Uses. New Directions for Evaluation, 153, 23–33.

3 - https://cft.vanderbilt.edu/guides-sub-pages/teaching-through-community-engagement/

4 - Cloud, J (2012) Education for Eustainability EfS Standards & Performance Indicators 2012 edition with enduring understandings as found at: http://static1.1.sqspcdn.com/static/f/424420/16021174/1386274120107/Cloud+Institute+EfS+Standards++Performance+Indicators+2012+CE.pdf?token=MCdRXJljvgx9dwGEXt/a5AUaa6o%3D

5 – The New Work Smarts (2017) Foundation for Young Australians as found at: https://www.fya.org.au/wp-content/uploads/2017/07/FYA_TheNewWorkSmarts_July2017.pdf

6 – It is unlikely that providing staff the opportunity to co-design the curriculum was the only factor contributing to increases in staff tenure given the transformation of other aspects of the campus, however our research methods did not allow us to effectively control for other mitigating factors such as changes in staff physical work conditions etc.

7 - https://www.amanet.org/training/articles/creating-adaptive-organizations.aspx

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Evaluating Effectiveness of Length of Closure in Remediating Coliform Contamination in Boracay Island

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Abstract
The international tourist destination of Boracay Island was closed by national authorities last April 2018 due to the persistent high coliform concentrations found in its beach waters. The cause of the contamination is identified as inadequate sanitation systems whose outflow goes to the groundwater. This water in turn leaks out to the sea. The rationale of the temporary closure is to allow natural mechanisms to clean the groundwater—mainly by the shutdown of all coliform contamination sources, coliform die-off and flushing via recharge of rainfall. The period of closure is six months. With a first order die-off rate of 0.03/day for coliform bacteria in karst soils, computer simulations show that the period of closure removes 99.4 percent of the contaminant-marker—adequate to bring the contamination down to levels that are acceptable for recreational waters. A further closure extension of six months would most likely bring the contamination below detection limits.

Keywords: Sanitation, Sustainable tourism, Computer simulations

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Introduction

Tourism is one of the industries that the Philippine government has been giving priority to the past years as it has lagged behind its neighbors. The government has capitalized on its popular summer destinations to attract foreign visitors. Nevertheless, many of these locations are not equipped with adequate sanitation facilities to meet the volume of visitors and to make tourism sustainable.

Boracay, off the northern coast of Panay Island in the Visayas region of the Philippines has been ordered closed last 26 April 2018 due to the persistently high coliform concentration in its beach waters. The contamination is caused mainly by unregulated discharge by establishments into the sea and contaminated groundwater migrating seaward.

The freshwater lens of the island resort is contaminated due to the absence of wastewater collection and treatment system that the island needs to meet the volume of visitors. The complete closure to tourists will last for six months. The island resort will reopen in November.

The objective of this study is to evaluate the effect of the closure in the reduction of coliform contamination using computer simulations. The study specifically aims to predict the concentration of fecal indicator bacteria by modeling its transport to an unconfined aquifer from non-point surface sources through the vadose unto the saturated zone. It does not consider the mechanism of coliform migration from the freshwater lens to the shoreline water body. It uses a monthly average recharge and thus, neglects intra-day (tidal) and daily variability (rainfall) in the boundary conditions.

Study Area

Boracay Island belongs to the municipality of Malay in the province of Aklan. It is dumbbell in shape. It is 7 kilometers long and less than a kilometer at its narrowest. The total land area of Boracay is 10.32 square kilometers.

The predominant geology of the island is limestone (Punongbayan, 1990).

Boracay is characterized as having a Type III climate based on the Modified Coronas Classification shown in **Figure 1**. In Type III climates, seasons are not markedly pronounced, although for Boracay, it relatively dry from November to April and wet during the rest of the year.

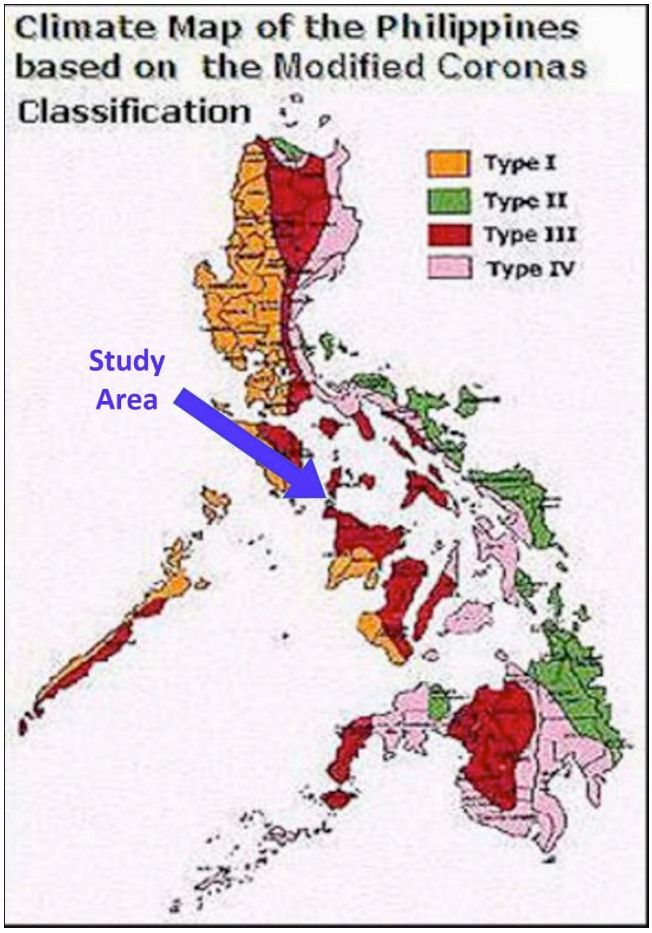

Figure 1. Study Area in the Philippine Climate Map

The annual rainfall in the island is estimated at 1,986 mm. Temperature observations show that the average in the island was 30.75°C. The coldest month is March (27°C) and the warmest, May (35°C).

Review of Related Literature

Total coliforms and fecal coliforms are commonly used as indicators for the presence of feces-derived pathogens in groundwater since their detection protocol is simple and relatively inexpensive. The main bacterial strain in both enumerators is *Escherichia coli* (Foppen, Mporokoso, & Schijven, 2005)

The interest in modeling the transport of *E. coli* arises from its being commonly accepted as a reliable pathogen indicator due to its high concentration, its exclusive presence in feces (Edberg, Rice, Karlin, & Allen, 2000), and its relationship to the presence of pathogenic viruses (Van Cuyk, Siegrist, Lowe, & Harvey, 2004) and protozoans (Personne, Poty, Vaute, & Drogue, 1998). Thus, the effects on the water table of percolating septic wastewater from septic tanks are monitored through the differentiation of enteric *E. coli*.

Escherichia coli is a gram-negative, rod-shaped bacterium and is considered one of the smaller bacteria with an average length of 1.95 micrometer or µm and an average diameter of 0.67 µm (Foppen & Schijven, 2005).

Like any bacteria foreign to the subsurface, the persistence of fecal coliforms is associated primarily with high water content (Poucher, et al., 2007). This is logical since the natural habitat of fecal coliforms is anaerobic and thus, they have to stay submerged so as not to be exposed to air (or oxygen) which is toxic to them.

Methodology

The governing equations for coliform transport through groundwater systems are derived based on the laws of continuity of mass and flux.

As they travel through the porous media in time and distance, bacteria are removed from the transiting water by several processes. Those that are of major importance are adsorption, inactivation or die-off, entrainment in pumped-out water, and biodegradation or more precisely, predation by endemic bacteria.

The transport equation is thus given by

$$\frac{\partial C}{\partial t} + \frac{\rho_b}{\theta}\frac{\partial S}{\partial t} = \nabla \cdot (D \cdot \nabla C) - V \cdot \nabla C - k_w C - k_s \frac{\rho_b}{\theta} S - qC \tag{3}$$

where
C = concentration
S = adsorbed concentration
ρ_b = bulk density of the medium
D = dispersion coefficient
k_w = first-order biodegradation rate constant in free fluid
k_s = first-order biodegradation rate constant in adsorbed fluid
V = Darcy velocity

Bacterial decay is ordinarily described as a first-order rate (Schijven & Hassanizadeh, 2000).

C and S in equation (3) are physical variables that are related through an adsorption and desorption mechanism. There are three manners, called isotherms, in which attachment could proceed. These are described by:

$$S = k_d C \quad \text{for linear isotherm} \tag{4}$$

$$S = \frac{S_{\max} k C}{1 + kC} \quad \text{for Langmuir isotherm} \tag{5}$$

$$S = kC^n \quad \text{for Freundlich isotherm} \tag{6}$$

where
k_d = distribution coefficient
S_{max} = maximum concentration of the medium in Langmuir isotherm
k = Langmuir or Freundlich isotherm
n = Freundlich power index.

The characteristic constants in Langmuir and Feundlich are specific to both bacteria and soil type together. There are still no data available for this. This could only be determined through laboratory experiments.

In an effort to render a simpler mathematical formulation for this field study, the processes of microbial growth and decay have been lumped into one term—a sink term (net death)—in support of the observation that fecal coliforms ultimately do not persist in the subsurface since it is not its natural habitat: its ideal environment is characterized by anaerobic and high nutrient conditions, i.e., in the gut of mammals. Linear isotherm was used by Wall et al. (Wall, Pang, Sinton, & Close, 2008) although they recommended Freundlich isotherm since they argue that it is more accurate for geologically heterogeneous materials such as those found in field conditions.

The use of the linear isotherm follows the reasoning that the sorption is reversible and instantaneous at equilibrium (Harvey & Garabedian, 1991) for low pore-water velocities as in the case of this study. The same assumption was made by Bekhit et al. (Bekhit, El-Kordy, & Hassan, 2009) in their colloid and bacteria combined transport finite difference model. Thus,

$$\frac{\partial S}{\partial t} = k_d \frac{\partial C}{\partial t} \qquad R = 1 + \frac{k_d \rho_b}{\theta} \tag{7}$$

where R is the retardation factor, which is the ratio of mean pore-water velocity to the mean contaminant transport velocity. Equation (3) can then be rewritten as:

$$R\frac{\partial C}{\partial t} = \nabla \cdot (D \cdot \nabla C) - V \cdot \nabla C - \left[k_w + k_s (R-1)\right]C - qC \tag{8}$$

Equation (8) can be further simplified to:

$$R\frac{\partial C}{\partial t} = \nabla \cdot (D \cdot \nabla C) - V \cdot \nabla C - \lambda C - qC \tag{9}$$

where λ is the first-order total *die-off* rate defined as:

$$\lambda = k_w + k_s (R-1) \tag{10}$$

An analytical solution is not possible for the initial-boundary value problem described by the governing equations for transport. Numerical methods are used for this task. The most common methods are the Finite Difference and Finite Elements.

As yet, there are no numerical models designed for bacteria transport in the subsurface. An accommodation is to use models designed for solutes as demonstrated by Caloza in his dissertation (Caloza, 2012).

Visual MODFLOW Flex®, the software employed in this study, uses the Finite Difference method. The theoretical background as well as the numerical procedures of this method, including the setup and techniques of the banded matrix solver, can be found in any good groundwater modeling book such as that of Wang and Anderson (Wang & Anderson, 1982) and therefore will not be described here.

For this study, the die-off rate is assumed to be 0.03/day based on a similar study on a karstic geological island formation (Caloza, 2012). The island is assumed to be monolithic and isotropic.

The boundary condition of recharge is determined via a monthly accounting procedure based on the method originally presented by Thornthwaite and Holzman

(Thornthwaite & Holzman, 1939) was used to make a water balance analysis. The required data for the model are: mean monthly temperature (degrees Celsius), monthly total precipitation in millimeters (mm) and the latitude (decimal degrees) of the study area. The latter is used for the computation of the day length, which is needed for the computation of potential evapotranspiration.

The computed monthly effective recharge is presented in Table 1.

Table 1. Computed Monthly Recharge in Boracay Island

Month	Recharge, mm
January	30.8
February	54.5
March	41.3
April	31.3
May	20.0
June	65.7
July	60.3
August	52.3
September	31.3
October	64.4
November	92.1
December	47.9
Annual	591.9

The model uses May as the start month.

A constant head boundary condition is also set for the shoreline or surrounding waters (sea) and is held at 0 meters, which is the mean sea level. The bottom of the model volume (**Figure 2**) has a no flow boundary condition. There are no rivers or lakes in the island.

For transport, the concentration of contaminant in the recharge is assumed zero since all anthropogenic activities in the surface have been minimized due to the government shutdown. Since Visual MODFLOW Flex® does not yet handle flux boundary conditions, the contaminant concentration in the seawater that surrounds the island is held zero. This is supported by the fact that the contaminant is outbound due to the higher concentration of the coliform in the groundwater.

The government mandated closure is assumed to effect zero or near-zero effluents due to absence of tourists and the consequent reduction of the workforce and resident populations.

Results and Discussion

The coliform concentration distribution (contours) in MPN/100 ml by November are shown side by side in **Figure 3**.

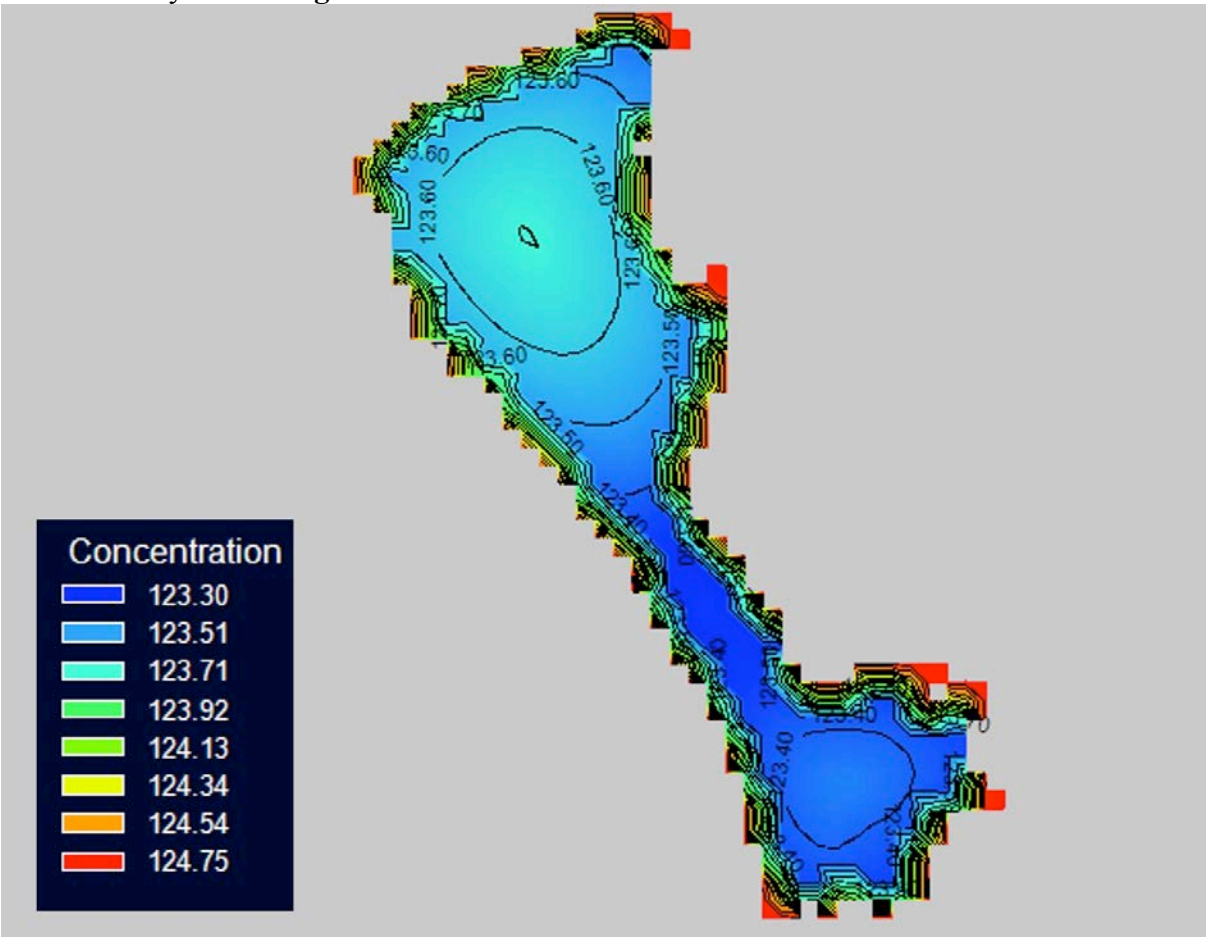

Figure 3. Groundwater Coliform Concentration After 6 Months

The concentration was reduced to a 124 MPN/100 ml from an initial 22,000 MPN/100 ml or about 99.4. This is near the level of acceptable coliforms concentration for recreational waters, which is 100 MPN/100 ml (Department of Environment and Natural Resources, 2016).

Extending the model run to one year shows further reduction of coliforms to almost zero level. **Figure 4** shows results of the ninth and 12th month along with the results of the first and third months.

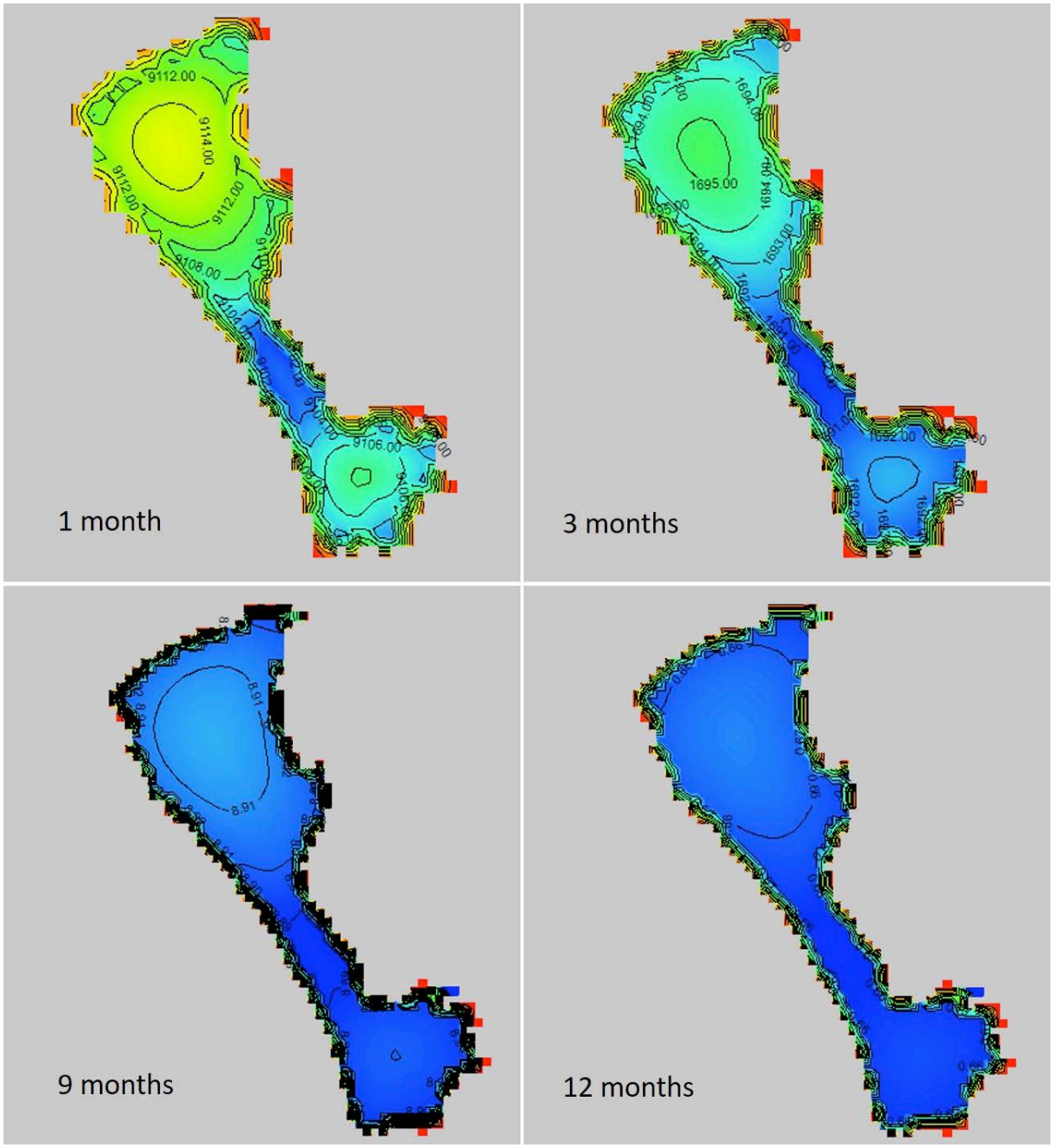

Figure 4. Groundwater Coliform Concentration After 1, 3, 9 and 12 Months

The organic load composed partially of dead bacteria, will not be reduced as rapidly. In the absence of other contaminant data, a parallel model run, this time without the use of retardation, shows that non-degradable solute species will be removed more slowly from the aquifer. **Figure 5** shows the organic load after six months in relative percentages.

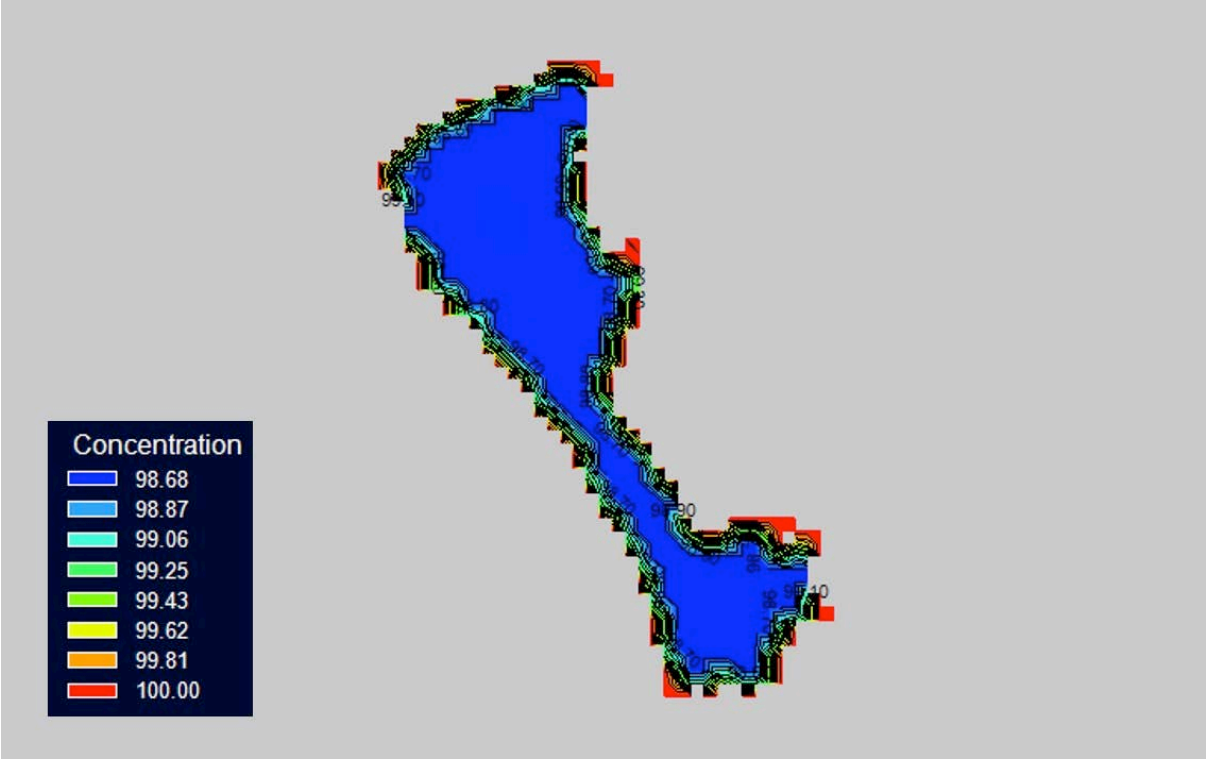

Figure 5. Relative (%) Organic Load Concentration After 6 Months

By estimate, it would probably take more than a decade to reduce the most recalcitrant pollutant—no retardation—to single digit percentages.

Conclusions

The strategy of complete closure, according to the computer model, would reduce the coliform concentration to near acceptable levels. The contamination is reduced by 99.4 percent. The main driver for the disappearance is bacteria die off. The contribution of flushing through recharge is only 1.32%.

Initial field findings as reported in national media outlets support the results of the computer model.

Other contaminants, such as Biological Oxygen Demand (BOD) and nitrates will not be as easily reduced. By estimates from the model, it will take another 10 years to reduce the most recalcitrant pollutant to reach the same magnitude of reduction as the *E. coli*. This assumes the same methodology of simple closure without any other engineering intervention relying on recharge to flush the contaminant.

Recommendations

This modelling effort has not been calibrated although the die-off rate and hydraulic conductivity were derived from an analogous calibrated model. Thus, it is necessary to calibrate the model with actual results from field samples to get an estimate of the die-off rate which should be characteristic of the local conditions of Boracay Island.

Likewise, a time-series of at least seven samplings of the static water level would be adequate to establish the hydraulic conductivity of the subsurface geologic material. Coliform tests give only a partial, if not limited, assessment of the contamination in the aquifer of the island. Tests for other contaminant markers such as BOD, nitrates, phosphates and potassium should also be undertaken to acquire a true picture of the overall contamination of the aquifer.

For a more focused and accurate description for conditions of specific locations within the island further refinements such as delineation of recharge and non-recharge areas, location of septic discharges, and the types of domestic or commercial sewage water treatment facilities in the island are needed. If the modelling effort is to continue with the restoration of anthropogenic activities, a comprehensive inventory of wells—shallow and deep—would also be necessary.

The effects of the closure will only be temporary if no infrastructure intervention—e.g., sewage collection and treatment—was implemented in the intervening months. The coliform concentrations will just return to previous levels in no time.

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Current Status of Non-Thermal Plasma (NTP) Ammonia Synthesis and Its Potential to Build a Sustainable Nitrogen Fixation Industry

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Abstract
Ammonia has far more sustainable applications than use as a fertilizer. For instance, ammonia's rich hydrogen content makes it ideal for use in chemical fuel cells, as a clean-burning transportation fuel, and many other off-grid power applications. Currently, large-scale ammonia synthesis is achieved via the Haber-Bosch process, a high temperature and high-pressure technique for nitrogen fixation. Unfortunately, the extreme conditions required for the Haber-Bosch method make the process inefficient, and demand that production be highly centralized. These intrinsic characteristics place significant limitations on the nitrogen fixation industries ability to explore alternative and sustainable uses for ammonia. Therefore, it is critical to introduce and develop a sustainable nitrogen fixation process that can be carried out at low temperature and pressure and can be decentralized. Non-thermal plasma (NTP) technology allows for the synthesis of ammonia at low temperature and pressure. Furthermore, it has been proposed that the moderate process conditions can potentially allow the wide distribution of ammonia and hydrogen production sites, which are powered by renewable energy. In this study, we present an overview of the technology, and some of the most recent development on the NTP ammonia synthesis from the interdisciplinary perspective. Analysis and recommendations will be made on the potential of changing the ammonia production industry using this technology, leading to further discussions on how a closer interdisciplinary collaboration could improve the current plasma-assisted ammonia production and contribute to a sustainable nitrogen fixation infrastructure.

Keywords: Non-thermal plasma, ammonia synthesis, nitrogen fixation, distributed production

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Introduction

The agricultural industry's use of ammonia as a fertilizer is a well-known practice. Unfortunately, ammonia's potential as a renewable and environmentally friendly means of energy storage is not common knowledge. Specifically, ammonia is a simple and stable molecule whose complete combustion releases a significant amount of energy in a carbon-free and greenhouse gas-free process. While the ammonia's potential as a fuel source is intriguing, the application of this idea is inhibited by inefficiencies in the current method of industrial ammonia synthesis, the Haber-Bosch process. The Haber-Bosch process is a Nobel Prize winning chemical synthesis process, which relies on high temperature and high-pressure conditions (up to 400 atm and 600C) to synthesize ammonia. These extreme conditions require a significant amount of energy input (1-2% of the world's annual energy production) (Tanabe & Nishibayashi, 2013), which results in large greenhouse gas emissions. Furthermore, the extreme conditions demand that the process be highly centralized, which prevents small industries and farms from producing ammonia locally in an economically viable manner. As a result, farmers have to store large amounts of ammonia on site, much of which becomes waste and pollution. Additionally, the centralized production of ammonia requires additional energy input, as the nitrogen fertilizers are shipped to the end use site.

Therefore, researchers have been developing a method of ammonia synthesis, which occurs under low temperature and low-pressure conditions. In this manner, the process would circumvent many of the issues associated with the Haber-Bosch process. It is believed that non-thermal plasma (NTP) technology may provide a method of synthesizing ammonia under low temperature and low-pressure conditions. The term plasma describes a fully or partially ionized gas, rich in reactive chemical species, and represents the fourth fundamental state of matter. In general, NTP technology has low operational/maintenance costs, can operate under a broad range of pressures (vacuum, atmospheric, high pressure), and requires limited amounts of space. A recent study showed that non-thermal plasma was found to have the lowest theoretical energy requirement among the different ammonia production methods, such as the conventional Haber-Bosch process, thermal plasma, biological production, and Haber-Bosch with renewable hydrogen inputs (Cherkasov, Ibhadon, & Fitzpatrick, 2015). In this study, the current development on the NTP ammonia synthesis approach will be presented, along with an analysis of the future perspectives of how this approach should be incorporated into the distributed and sustainable ammonia production/nitrogen fixation infrastructure.

Plasma systems and catalysts

Figure 1 shows an illustrative diagram of how NTP-based ammonia synthesis works. The systems for the NTP ammonia synthesis approach generally consist two parts, the plasma generation system and the plasma reactor. Plasma is produced by ionizing gas under high intensity electric field or electromagnetic field (microwave) conditions. For plasma generated by electric field, the primary purpose of the plasma generation system is to provide a high frequency and high-voltage electrical signal to the plasma reactor. To convert the off-grid signal into what is required to form plasma, a step-up transformer is required to increase the voltage. An inverter is usually added prior to the transformer to provide a stable high frequency pulsed/continuous alternating

(AC)/direct (DC) current signal. Note that this setup only applies to the plasma generated by strong electric fields. Other types of plasma, for example microwave, uses electromagnetic waves to excite and ionize the gas, which requires different generating mechanisms.

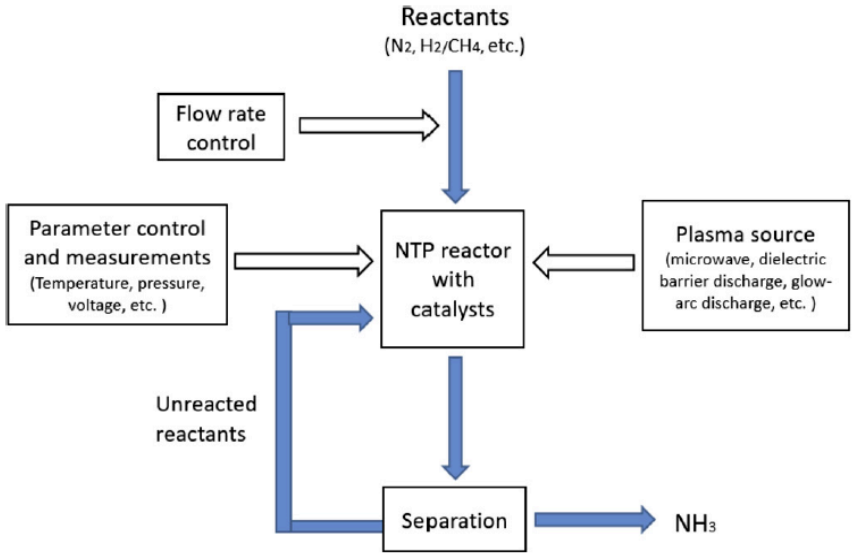

Figure 1 An illustrative flow diagram of the non-thermal plasma ammonia synthesis process. Re-printed from Peng, Chen, Schiappacasse et al. 2018 (Journal of Cleaner Production), with permission from Elsevier.

There are many types of plasma reactors that can be powered by the high intensity electric fields, including dielectric barrier discharge (DBD) plasma, gliding arc discharge plasma, corona discharge plasma, etc. The different types of plasma reactors and catalysts studied on/before 2018 for the NTP ammonia synthesis processes can be found in detail in the previous review articles (Hong, Prawer, & Murphy, 2017; Peng, Chen, Schiappacasse, et al., 2018). To summarize, the DBD plasma is the most commonly used discharge method, shown in Figure 2. Due to the fact that it has a dielectric barrier between the high voltage and ground electrodes, it can produce a uniform microfilament discharge and can be operated under atmospheric conditions with relatively small temperature rise.

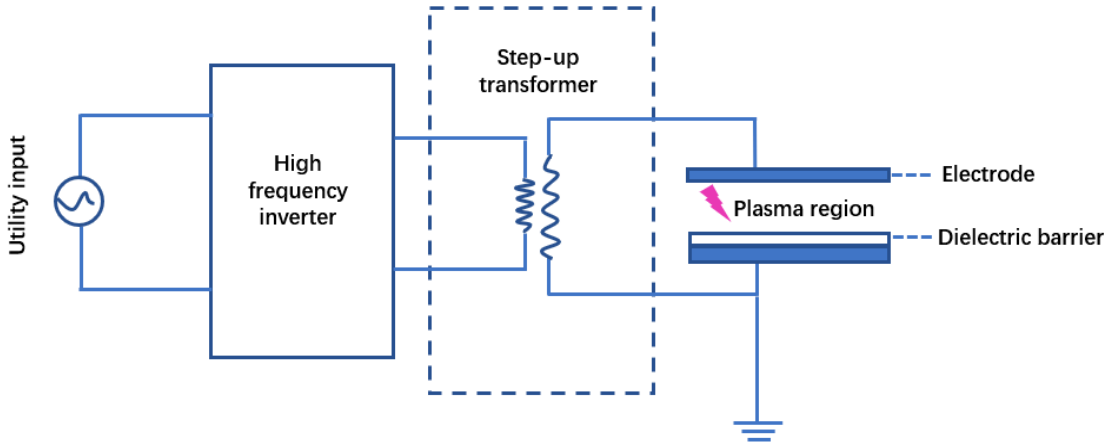

Figure 2. A simplified diagram of NTP systems, using dielectric barrier discharge as an example

The catalyst used for the NTP ammonia synthesis is critical to the system. As summarized in Hong, Prawer, & Murphy (2017) and Peng, Chen, Schiappacasse et al. (2018), many types of catalyst, for example ruthenium-based, nickel-based, iron-based, and Mg-based catalysts have been explored (Hong, Prawer, et al., 2017; Peng, Chen, Schiappacasse, et al., 2018). The catalysts are placed in the plasma discharge region and can be used directly or supported on other metal oxide frameworks such as MgO (Peng et al., 2016) and Al_2O_3 (Hong et al., 2016; Xie et al., 2016). Also, it was found that the performance of the process can be enhanced by depositing the catalyst onto mesoporous supporting materials that have larger surface area, and adding promoters to facilitate the catalytic synthesis (Peng et al., 2017). Most recently, it was found that supporting nickel onto the Metal organic frameworks (MOF) can enhance the NTP ammonia synthesis yields and energy efficiency compared with traditional nickel catalysts (Shah, Wu, Lucero, Carreon, & Carreon, 2018). For details of how the reactant interacts with the catalysts on the molecular level, Hong et al. 2017 provided an up-to-date review on the kinetic modeling of the NTP ammonia approach, and pointed out that the catalytic functions of the catalysts are mainly to absorb the dissociated nitrogen/hydrogen molecules to form reactive sites on the catalyst surface. Also, under atmospheric and non-thermal conditions, the radicals and vibrationally-excited molecules are the determining reactive species instead of the ions (Hong, Pancheshnyi, et al., 2017).

Hydrogen sources for NTP ammonia synthesis

The hydrogen sources for the NTP ammonia synthesis are critical to the overall process efficiency. Compared to nitrogen, which can be made directly from air via various separation methods, hydrogen is much harder to produce. Therefore, the hydrogen source can significantly effect the capital cost and overall energy consumption of the system. Needless to say, the most common hydrogen source used in the NTP ammonia synthesis is from hydrogen gas, which can be produced from electrolysis of water or steam methane reforming. The NTP-based ammonia synthesis approaches that use hydrogen gas are straightforward, feeding both nitrogen and hydrogen gases to the plasma reactor, which is performed by most of the aforementioned studies. Again, the main purpose of using plasma to synthesis ammonia is that under plasma environments, the hydrogen and nitrogen gases can be ionized into reactive species. Therefore, the goal of producing the hydrogen source for the NTP ammonia synthesis process is to generate hydrogen radicals rather than hydrogen gas. In other words, the hydrogen source of the NTP ammonia synthesis does not have to be hydrogen gas. Researchers have successfully generated ammonia using plasma-ionized nitrogen, from alternative hydrogen sources such as methane and water. Similar to ammonia, methane is a hydrogen-rich molecule and is a relatively reactive gas. A study that used methane and non-thermal plasma to produce ammonia achieved good results, with a peak CH_4 conversion of around 60% and the highest concentration of 7000 ppm (Bai, Zhang, Bai, Bai, & Gao, 2008).

Water is also another common hydrogen source and could be considered as a reactant for the NTP ammonia synthesis or nitrogen fixation approach. The idea of using water as the reactant for the NTP process is plausible for several reasons. First, at the current stage, the ammonia synthesis rate for the NTP process is low, and water could help capture the produced ammonia to prevent it from being decomposed in the plasma region. Second, with water being used as the hydrogen source, the

intermediate step of electrolyzing water to produce hydrogen gas could be eliminated. There have been several studies that used water to produce ammonia under NTP conditions, since this idea was first introduced by Kubota et al. 2010, who used water and a plasma jet to synthesis ammonia in its liquid cation form (Kubota, Koga, Ohno, & Hara, 2010). The follow up studies performed recently by Haruyama et al. 2016 and Sakakura et al. 2018 utilized the excitation effect of UV light on water to produce more reactive hydrogen species to enhance this process (Haruyama et al., 2016; Sakakura et al., 2018). In their processes, the plasma was generated outside of the water-UV reactor, and Peng et al. 2018 took a further step of generating the plasma directly above the water surface and also studied the temperature effect for the N_2-H_2O plasma nitrogen fixation (Peng, Chen, Addy, et al., 2018).

The two alternative hydrogen sources, methane and water, have their own advantages. As discussed in our previous review, methane can be produced via waste streams by processes such as anaerobic digestion, which increases the overall sustainability of the NTP ammonia synthesis approach (Peng, Chen, Schiappacasse, et al., 2018). As for N_2-H_2O plasma ammonia synthesis, aqueous NO_3- and NO_2- are also the main products. Therefore, the liquid products of this process may be used directly as fertilizers for hydroponic and irrigation systems. In this case, the nitrogen source for the plants/crops could come from the NTP N_2-H_2O synthesis, with the addition of other nutrients to generate liquid fertilizers directly. Since this process does not require high temperature/pressure, it could be possibly made into a mobile on-site and on-demand liquid fertilizer generation system for the farmers.

Energy efficiencies

The reported energy efficiency for the NTP ammonia synthesis ranges widely from 0.025 g/kWh (Matsumoto, 1998) to 25-36 g/kWh (H.-H. Kim, Teramoto, Ogata, Takagi, & Nanba, 2016; H. H. Kim, Teramoto, Ogata, Takagi, & Nanba, 2017), and even over two orders of magnitude difference for the studies published on/after 2010. The conversion ranges from 0.00025% (Nakajima & Sekiguchi, 2008) to 19% (Shah, Wang, Bogaerts, & Carreon, 2018). It was found in several studies (Gómez-Ramírez, Montoro-Damas, Cotrino, Lambert, & González-Elipe, 2017; Peng et al., 2017) that higher flow rates of nitrogen and hydrogen gas lead to greater energy efficiency. An explanation for this is that under the same conversion rate, increasing the reactant feed rate leads to increased product. Therefore, it is recommended that plasma-assisted ammonia synthesis processes be operated at their greatest gas flow capabilities to achieve higher energy efficiencies. Furthermore, increasing turbulence is beneficial to the system as well. If the plasma synthesis process is operated in the laminar region, the concentration profile of the reactive plasma species in the gas steam will not be as uniform as those operated under turbulent conditions.

It is notable that the energy efficiencies reported in almost all previous studies were calculated differently. Until now, there have been many different attempts at measuring and calculating the energy efficiencies of the plasma ammonia synthesis process. Such examples include the efficiencies that were calculated by the dissipated power measured at the plasma region, the input power to the plasma system, and the total input power to the entire process, etc. The large range in the energy efficiencies may also depend on how the same power value is measured and calculated. The common methods used for plasma power measurement are the Lissajous method,

current & voltage-based method, and the input power method. The first two methods aim to determine the energy efficiency at the plasma region, whereas the third tries to calculate the utility power input to the plasma generating system. To use the Lissajous method, a small capacitor is introduced into the circuit and is connected in series with the plasma reactor. The voltage difference between the capacitor is then measured to plot the Lissajous curve for calculating the dissipated power within the plasma reactor. For the current & voltage-based method, the in-line current at the plasma reactor is directly measured using a current probe. As the high voltage line will significantly interfere, or likely break the current measuring device, this approach has been performed in-line between the plasma reactor and the ground, rather than from the transformer to the reactor (Ni et al., 2013). In other scenarios, the current could also be measured on the primary side of the high voltage transformer where the inverter sends in high-frequency signals to the transformer, and then determine the current on the reactor side using the coil ratio/turns ratio of the transformer. For the same location, there are also different ways to measure the current, such as the Rogowski coil (magnetic), the shunt resistor method (direct measurement), RDS (on) sensing method (transistor), etc. In our previous publication, the magnetic sensing method was selected because compared to the other methods, it is flexible, and more importantly, non-intrusive (does not introduce additional resistor to the circuit, which will cause power/current loss). However, this method might be influenced by the phase shift between the voltage and current since DBD plasma is a combination of a resistive and inductive circuit. The different methods and/or locations used to measure the current and power could introduce a one to over two orders of magnitude difference between the measured power and the real input power to the system, which could contribute to the wide range of energy efficiencies in the published literature. To resolve this issue, unification of the methods used to measure/calculate energy efficiency is recommended. Specifically, the authors recommend that the total energy input to the entire NTP system should be used in the future studies to avoid any discrepancies caused by methods, locations, and other factors (heat generation, recycle, vacuum pump for some processes) that might contribute to the different power measurements. Furthermore, it is the overall energy efficiency of the whole system per mole of products that should be considered for any scale up analysis.

The future of NTP: Building a sustainable nitrogen fixation industry

Using NTP to synthesize ammonia is a siginificant step toward improving the broader issues of the nitrogen fixation industry. In addition to ammonia, nitrogen compounds such as nitrate/nitrite could also be produced by NTP in aqueous environments. Shown below are the different stages required for the development of the NTP nitrogen fixation process, including ammonia, nitrate, and nitrite synthesis. The primary potential advantage of this technology is the non-centralized, local production of ammonia, produced on an as-needed basis. For example, farmers could produce nitrogen-based fertilizer on-site using renewable energy sources, thus preventing waste/pollution and reducing greenhouse gas emissions. However, greater interdisciplinary efforts are required for this technology to become commercialized. Until present day (2019), development of NTP technology has been limited to small-scale research explorations. As this innovative process moves forward, more efforts to understand and plan the future of the NTP nitrogen fixation technology will likely be made from the policy makers and end-users. For the end-users, such as local nitrogen fertilizer producers and farmers, the power source and product composition of the

plasma nitrogen fixation process are important considerations. The relative concentrations of the ammonia, nitrate, and nitrite may determine how this process will utilized. For example, the composition of the different nitrogen fixation products will determine the types of plants/crops that can utilize the corresponding nitrogen source. Lastly, the feasibility of using renewable energy source to power the NTP nitrogen fixation system is crucial for the policy makers and end-users to see the potential of this technology.

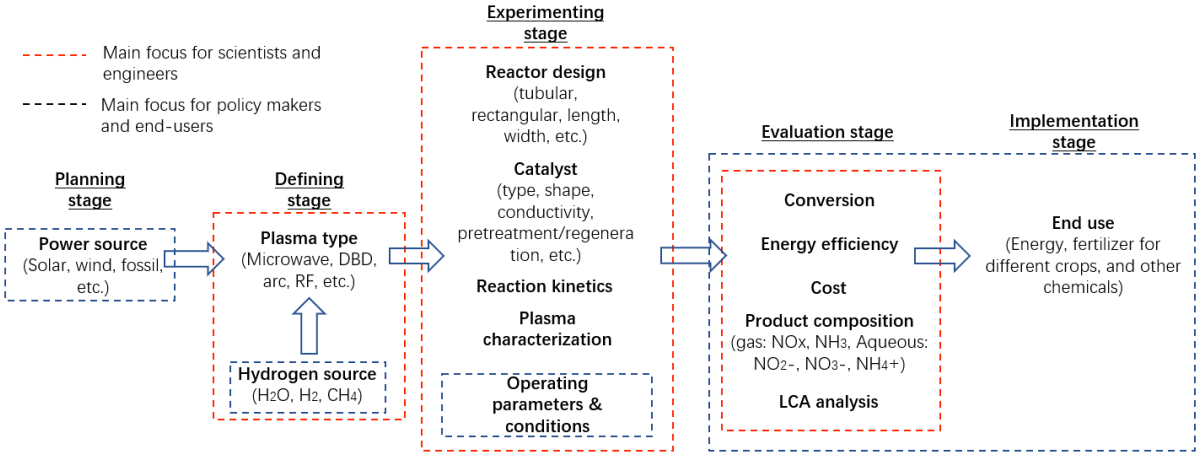

Figure 3 Process flow diagram of the interdisciplinary development for NTP nitrogen fixation

More interdisciplinary collaborations are required to improve the science and engineering aspects of the NTP nitrogen fixation technology. For example, chemical engineers are interested in the catalytic kinetics, physicists have the strength of characterizing and modeling the plasma behaviors, and electrical engineers may be able to develop more efficient high-voltage and high-frequency generators. Furthermore, agricultural/biological engineers may contribute by investigating the environmental impacts and overall efficiencies of a field-ready system. It was shown by a recent LCA analysis that under many operating scenarios, the greatest energy consuming process within the NTP system was the conversion of electrical energy to plasma (Anastasopoulou, Butala, Lang, Hessel, & Wang, 2016). It was recently reported by Wang et al. 2017 that the plasma discharge power occupies only up to 35% to 56% of the total energy input to the plasma generating system (Wang et al., 2017). Therefore, inputs from the electrical perspective are highly beneficial for the current stage of this technology to provide a new direction of increasing the energy efficiency of the NTP ammonia synthesis process by optimizing the plasma generating system. For example, minimizing power transistor switching losses, increasing control effectiveness of the NTP ammonia synthesis system could reduce the current between the inverter and the transformer and increase the dissipated plasma energy efficiency at the plasma region (Peng et al., 2019). Also, Kim et al. reported that that by switching from AC to DC power supply could increase the nitrogen fixation energy efficiency by 3 to 4 times (H. H. Kim et al., 2017). Therefore, with more electronic improvements added to the reactor/catalyst/kinetics development, it is promising that the energy efficiency of the NTP nitrogen fixation can be further enhanced.

Conclusions and future perspectives

In conclusion, NTP can potentially benefit from improvements in reactor configuration and catalyst development. Scientific investigations into each of these areas have helped the NTP technology approach commercial viability. The hydrogen source of the NTP ammonia synthesis process determines whether the end products are ammonia gas or aqueous ammonium with other nitrogen compounds, which further decides the end use of the process. Although the studies of the NTP ammonia synthesis are relatively small in scale and the energy efficiency still needs to be improved by at least one order of magnitude for this technology to be compatible with the Haber-Bosch process, it has the potential of being directly applied by farmers. To build a more sustainable nitrogen fixation infrastructure in the future, the NTP technology could be incorporated onto a mobile, on-site, on-demand system that can generate nitrogen fertilizer as needed for the end users.

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The Sharing Cycle of Science Learning: A Method to Connect College STEM Courses with Tribal Community Topics that Enhance Sovereignty

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Abstract
American Indian students are underrepresented in all science and engineering fields by almost 50%. At the same time, the fastest growing occupations for the past half century require knowledge of science and mathematics. To address the need for relevant science training, the "Framing the Chemistry Curriculum" project was created by the University of Nebraska-Lincoln (UNL), Little Priest Tribal College (LPTC), and Nebraska Indian Community College (NICC). These partners iteratively developed a model to increase the number of tribal college students taking an introductory chemistry course. Specifically, the goal was to create sustainable chemistry laboratory experiences at NICC and LPTC. Our hypothesis was that American Indian students will be more inclined to engage and persist in chemical education when lessons and laboratory activities are framed within the context of community-relevant topics because of their strong sense of kinship and place. Since these colleges have low enrollments, the project was assessed using mixed methods to learn about attitudes and engagement. The following four objectives were completed: (1) An Advisory Board of local scientifically-oriented stakeholders developed the frame's tribal community topics; (2) Created a lab manual that connects these topics to chemistry content; (3) Developed a two-semester chemistry sequence, integrating lecture and laboratory experiences; and (4) Disseminated the method locally and regionally through workshops, outreach, and recruitment. The most common statement from the several dozen students who took the course is that it helped them understand why chemistry is important. NICC also hired a full-time science instructor to teach several chemistry courses.

Keywords: Case Studies; Chemistry; Science; Sovereignty; Tribal College

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Project Summary

We chose to present at the 2019 IAFOR International Conference on Education because its theme of "Independence and Interdependence" succinctly expresses the nature of our collaboration between Nebraska Indian Community College (NICC), Little Priest Tribal College (LPTC), and the University of Nebraska-Lincoln (UNL). Specifically, we created a method to connect the science laboratory experiments at Nebraska's two tribal colleges with their local community topics. Addressing the need for relevant science training is the long-term goal of our collaborative effort. We also chose to present at the 2019 IAFOR because we wanted to reach out to others around the world who are interested in connecting science to their communities.

The specific goal of our funded project (National Science Foundation #1348382) is to create sustainable, culturally- and locally-relevant chemistry laboratory experiences. Both colleges are located in northeast Nebraska. NICC serves students living primarily on the Omaha Reservation, the Santee Sioux Reservation, and within the South Sioux City urban area. LPTC primarily serves students who belong to the Winnebago Tribe of Nebraska and within the Sioux City urban area. The American Indian Higher Education Consortium (AIHEC) and the Tribal College and University (TCU) system were created in 1973 (AIHEC, 2000). There are now 38 TCUs serving about 20,000 students and providing services to an additional 46,000 community members.

We justify our focus and approach by noting that American Indian students are underrepresented in all science and engineering fields by almost 50%. For instance, "Native Americans and Alaska Natives" are 1.2 percent of the U.S. population (U.S. Census Bureau, 2012) but earn 0.8 percent of the bachelor's degrees in chemistry and 0.6 percent of the PhDs in chemistry (National Research Council, 2012). At the same time, the fastest growing occupations for the past half century require knowledge of science and mathematics (National Research Council, 2012). There was also an immediate local need in that NICC had not offered a chemistry course in the past five years and LPTC's chemistry enrollment was consistently low at 1 to 4. To address these issues, we said we would create sustainable chemistry laboratory experiences at NICC and LPTC with a target enrollment of 6, which is considered sustainable at both. We argued that American Indian students will be more inclined to engage and persist in chemical education when lessons and laboratory activities are framed within the context of community-relevant topics because of the students' strong sense of kinship and place.

To achieve our goal of developing a two-semester chemistry sequence, the team developed a method to connect science courses with tribal community topics that we call the Sharing Cycle of Science Learning. According to the ethnoscience approach (Davison & Miller, 1998; Cajete & Little Bear, 1999), a science course can be made relevant to American Indian students by the inclusion of culturally rich examples. Every tribe has a distinct culture and it should be noted in this regard that there are 566 federally recognized sovereign Indian nations (called tribes, bands, nations, pueblos, rancherias, communities and Native villages) in the United States (National Congress of American Indians, 2019). Place-based education posits that places are rich in social, cultural, and historical significance (Gruenewald, 2003). This approach

connects with native cultures because of their holistic view concerning land, language, and history.

The Sharing Cycle of Science Learning (Figure 1) is a cycle with four objectives and outcomes:
1. A list of topics important to the community and greater dialog between the communities and their tribal colleges.
2. Connections between these community topics and any science discipline at the tribal colleges to provide context for inquiry-based science laboratory experiences and improved attitudes toward chemistry.
3. A sustainable, two-semester chemistry sequence at NICC in which the lecture and laboratory experiences are integrated and have a community focus through the use of the connections. The outcome will be an ability to use scientific tools to address community topics.
4. Dissemination of the laboratory experiences from NICC to LPTC, as well as from chemistry to other science courses at those colleges, and by raising awareness locally and regionally through workshops, outreach, and recruitment.

Figure 1: "The Sharing Cycle of Science Learning" painting (gouache on paper, 2014) by Laurie Houseman Whitehawk whose tribal affiliations are Santee and Winnebago. Our cycle is placed in a Medicine Wheel, where the circle is the cycle of life, the center is the individual, and the cross is community. All parts of the Medicine Wheel are interconnected, part of a whole, and have multiple associations. For instance, there are four directions, four stages of life, and four seasons. With regard to our cycle, the upper left sector represents the Advisory Board managing the Community Topics but it also represents the grant from the National Science Foundation in the form of Barack Obama handing an Erlenmeyer flask to an Indian woman who is giving a gift in return. The upper right sector represents the search for connections between scientifically measurable parameters within the Community Topics. The lower right sector represents the Instructor and Students in the chemistry lecture and laboratory course. The lower left sector represents dissemination of what we've learned.

The Tribal Community Topics (Table 1) were created by the Advisory Board at its first annual meeting in 2014 and then managed by them in subsequent years. The Board was asked to generate a list of things that a tribe would need to maintain their sovereignty now and into the future. They knew the tribal colleges were going to connect the topics to science experiments but were asked not to concern themselves with making the specific connections. The Advisory Board included four scientifically-oriented community members (tribal college science faculty, water board member, environmental board member, and high school science teacher) for each tribal college. Other members were selected based on their broader expertise: Judi gaiashkibos, Director of the Nebraska Commission on Indian Affairs; James Riding In, Associate Professor of Indian Studies at Arizona State University; and Shelly Valdez, President of Native Pathways.

Table 1. List of Holistic Tribal Community Topics (subtopics are in parentheses) *

Air Quality
Animal Habitat
Biopiracy
Climate Change (Trends, Historical Knowledge, Ecosystems)
Community Health (Genetics, GMOs, Food Sources)
Economic Development (Environmental Racism, Trust Lands)
Food Sovereignty
Medicinal Plants
Natural Resources (Soil, Land, Forests, Fire Management)
Oral Histories
Ownership/Stewardship
Renewable Energy (Solar, Wind, Compressed Wood Pellets)
Waste (Hazardous, Landfill)
Water Sources (Natural Disasters, Remediation Programs, Metals, Testing, Policy, Watersheds)

*All topics and subtopics are interrelated.

To make the connections between community topics and the chemistry laboratory experiences, a group of faculty and students made explicit connections during our initial iteration. By the third year of the project, however, we decided to begin each experiment with a brief discussion in which the students themselves make the connections. During interviews, many students report that they find these discussions to be the most meaningful.

The List of Community Topics and Connections to the Chemistry Laboratory Experiments were disseminated in several ways. First, they are posted on the tribal college websites as a way to generate further reflection and discussion. Next, we published a paper (Griep et al., 2016) that described the Science Cycle. The paper won the 2017 Frederick C. Luebke Award for Best 2016 Article Published in *Great Plains Quarterly*. Finally, tribal college students helped create a 3-minute video describing our Science Cycle that was entered into a showcase of NSF-funded projects (Griep et al., 2017). Our video received hundreds of views in its first week and hundreds more since then.

The Chemistry Laboratory experiences were initially the same as those offered in the UNL Chemistry and the Citizen sequence. Each year, the experiments were

indigenized and otherwise adapted to local needs until we published the result this past year (Griep et al., 2018). At NICC, over 25 students have now taken a chemistry course who would not otherwise have had the opportunity, and NICC has been able to hire an instructor to teach the chemistry course. Experiment 2 is about measuring density and provides an example how the experiments were indigenized. The goals of the experiment are to learn how to use a balance, measure the volumes of irregularly shaped objects, and to calculate means and standard deviations. In this case, we chose to measure the density of corn kernels, squash seeds, and beans. The pre-lab discussion provides an opportunity for the instructor to interact with the students about their familiarity with the Three Sisters agriculture system (Kimmerer, 2013), which is not described in the lab manual but is described in the associated Instructor's Manual. The Three Sisters System was developed by American Indians in what is now Mexico and then spread to tribes across the continent. The corn plant grows tall and requires a lot of water and nitrogen fertilizer to grow. Squash has tendrils that form a network around the base of the corn stalks to retain moisture and create a dense enclosure. Beans are short, add nitrogen compounds to the soil, and gain protection from herbivores. Since we are using food items in many of the experiments, we added a prayer that students can read before beginning each week's experiment. The prayer for the density experiment is: *We are thankful for the bounty of food that we are able to use the corn, beans, and squash seeds in this lab.* The prayers reinforce the idea that everything is interconnected part of a whole.

One of the enjoyable aspects of chemistry is performing demonstrations at local middle and high schools. For that reason, one of the Spring semester laboratory experiments teaches the tribal college chemistry students how to do chemical demonstrations while explaining to the audience what they are doing. Each tribal college students practices one demonstration and then the group performs them at one of local schools. In between the demonstrations, we raise awareness about our chemistry course.

We are now in the sixth and final year of our grant, during which we are focused on disseminating what we've learned. Throughout Fall 2018 and Spring 2019, we've been participating in several national meetings and the IAFOR international meeting to raise awareness about the lab manual that we published in August 2018. So far, seven tribal colleges and two high schools have decided to use it. In addition, a few institutions have asked for our help to indigenize their other science courses. We will end our essay by offering to do the same for anyone who attended the IAFOR meeting. Thank you for your interest in our project.

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A User Research for Developing an Augmented Reality-based Teachware

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Abstract
While Augmented Reality(AR) and AR teachwares including word cards, books and blocks become very popular. existing AR teachwares only focus on repeating the same content without changing level of difficulty and/or interest of changing planer images into 3D images. Because of this, users feel funs only in earlier phases of the life cycle, thus continuous education could not be promoted. Above all, most existing teachwares are developed for 3 to 5 year old children, for whom smart devices are not allowed by their parents. To do specific research and to identify additional user needs of corresponding problem, I have identified an overall trend of teachware through Town Watching and seller interview. In addition, I have analyzed with Affinity Diagram through an interview conducted towards the student parents that have used an Augmented Reality teachware. The problems of the existing Augmented Reality teachware and the contents that was analyzed with Affinity Diagram derived through this study will be suggested as an important indicator to solve the problem of existing teachware and in designing Augmented Reality teachware.

Keywords: Augmented Reality, Teachware, User Research, South Korea.

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Introduction

According to the 2018 research of strategy consulting and investment financial company 'digi-capital', the global market scale of Augmented Reality and Virtual Reality is expected to grow in a scale to $105 billion in 2022. In addition to these predictions, the interest of the general public for Augmented Reality are also getting bigger as Augmented Reality applies to various industries such as medicine, education training, architecture, tourism, game, art, shopping recently.

In particular, the teachware that uses the Augmented Reality is increasing and the actual sale is also made recently. The teachware that uses Augmented Reality is mostly made up of books or work cards. It is possible to do an education with reality by overlapping the three-dimensional shapes of the materials involved when showing the corresponding book or word card with a smartphone or the camera of a tablet PC. Moreover, the educational contents that are difficult to realize in the textbook and teachware can be solved easily by showing the overlapping three-dimensional graphics. Due to these reasons, the products converged with Augmented Reality that expresses hard-to-see object in existing life form teachware are being researched.

However, in case of the Augmented Reality that appears in books or work cards, there is a problem that the consistency time of education is short, and the targeted age is young as people focus on the fun of the corresponding two-dimensional content that looks realistic in three-dimensions.

Like this, the teachwares that use the Augmented Reality is being developed, but there are parts that need to be improved. We would like to research these problems more in depth and derive various problems additionally that were not discovered. In addition, to develop a teachware that could improve the problems and give much higher educational effect, we would like to conduct a user research and analyze with an Affinity Diagram.

Research Process

Since the Augmented Reality teachware is a product that is actually sold, there is a need to look at trends in stores and conduct a deep research on the subject that actually uses or purchase. For this, the lifestyle and trend of consumer group need to be identified. Therefore, I have done Town Watching research by visiting to a store where I could meet an actual product, consumers, and sellers. I have studied the product that the purchaser wants, and the teachware with high sales rate. For the UCD (User Centered Design), I have progressed in depth interview with the seller and the purchaser of the Augmented Reality teachware. The problem of existing Augmented Reality teachware was identified and organized through an interview. The organized contents were analyzed with Affinity Diagram.

Town Watching

1) Method

Prior to this experiment, I have decided to conduct the Town Watching to understand how consumers buy on the site where the teachware is sold. The detailed observation

items of the Town Watching were set with the contents obtained by the literature search and after discussion by 2 designers. To search the trend in detail, it was conducted by dividing into 2 times. In the first time of Town watching, the overall trend was searched. In the second time of the Town Watching, the error was minimized with repetitive observation and the seller interview was also conducted.

Table 1: Town Watching 1

Item	Contents
Lead time	4 hours
Place	Book store, Toysrus (Seoul, Korea)
Researchers	Two graduate students
Target	Teachware, Teachware Purchaser
Method	Observation of products, Observation of purchaser
Note	-

Table 2: Town Watching 2

Item	Contents
Lead time	5 hours
Place	Book store, Toysrus(Seoul, Korea)
Researchers	Two graduate students
Target	teachware, teachware seller
Method	Observation of products and seller, seller Interview
Note	-

2) Purpose

The purpose was to establish a rationality of the research subject. It is possible to know the trends of teachwares' sales desk. In addition, it is possible to know the actual behavior of purchasers that purchases the teachware.

3) Results

In case of large book stores, a staff that was in charge of selling the teachware was assigned. Moreover, the intellectual development teachware was arranged by making a sales desk called, 'Our child intellectural development teachware'. Through this, it was possible to confirm that the sales of intellectual development teachware were high. In case of the student parents, they were focused on an intellectual development when purchasing a teachware. The focus for children and lower grade students of an elementary school was set on a package that cause interest or a teachware that can be thouched. Mostly, the teachware that the children chose were purchased.

Table 3: Town Watching data

Item	Contents
Place	- 'Our children intellectual development teachware' sales desk was prepared separately at a bookstore - There was a separate seller that sells only the teachware in a bookstore. - In the toy store, it was subdivided as drawing teachware, science teachware, and making teachware - In the toy store, various parts were managed together by the staffs. - There was augmented reality teachware, but unusual.
Parents	- Intellectual development teachware was searched when only the students' parents have visited (for present) - Buys a product that the children like - If the children ask to buy, the form of ordering as lowed price was seen after searching the internet.
Child	- Children showed interest on a shape that cause interest and on a product package - Showed interest on a textware that is made to be touched - In case of boys, they showed interest on game, dinosaur, and animals - In case of girls, they showed interest on colorful teachware and doll

Seller Interview

1) Method

The questionnaire was written by synthesizing the information obtained at Town Watching. The seller who was working constantly until now was interviewed to see the recent trend. In addition, the teachware sales experience was selected for a seller that have more than 3 years' experience.

Table 4: Seller Interview

Item	Contents
Lead time	45 minutes
Place	Book store(Seoul, Korea)
Researchers	Two graduate students
Target	teachware seller
Method	Interview based on research
Note	Sales experience : 4 years work experience

2) Purpose

The purpose was to verify the contents researched at Town Watching. It was checked whether the purchase and sale of the intellectual development teachware such as spatial perception capability was made actively. The interview on a seller that have met various consumers in teachware store was interviewed. Through this, it was possible to know the purchase propensity of consumers and various sales experience that could not be obtained only by the observation.

3) Results

There isn't much Augmented Reality teachware yet, and it was possible to know that the market was not big yet and is in developing status as it was released as a form of book and work card from 1 year ago. In case of Augmented Reality teachware, there were students' parents who did not purchase as the smart phone and smart pad was used, but it was shown that it was purchased as the children enjoys it. There was not much difference compared to other teachware for the sales amount of Augmented Reality teachware, and it was shown that the Augmented Reality book form was sold a lot.

In case of general teachware preference, the teachware that each boy and girl preferred were different. In case of boys, not a plane but they liked 3D teachware that were 3D such as an animal and dinosaur. In case of girls, it was shown that they liked planes such as Tangram or beads puzzle or cute shapes and various colors.

Parent interview

1) Method

The questionnaire was written by synthesizing the information obtained by the Town Watching and seller interview. To find out the inconvenience experience that comes out when actually using the Augmented Reality, the interview was conducted only on the students' parents that have an experience of actually using the Augmented Reality teachware with children after purchase.

Table 5: Purchaser Interview

Item	Contents
Lead time	30 minutes per session, 720 minutes in total
Place	Book store, Toysrus(Seoul, Korea)
Researchers	Two graduate students
Target	24 parents who have bought AR teachwares
Method	Interview based on research
Note	-

2) Purpose

It is an interview to derive the Affinity Diagram and to find out that inconvenience in actually using the Augmented Reality teachware. It is possible to know the various experiences when actually using the Augmented Reality teachware, which could not be obtained with only the observations and seller interview.

3) Results

As a result of students' parents purchasing the Augmented Reality teachware and using with children, the satisfaction rate was high as it gives different fun and surprising at first. However, the focus was only on the things that the shape made of word card and book image or block was shown as 3D Augmented Reality, and there

was a boredom of simple repetition. The issues were organized by summarizing the main cases as below.

Story 1. When the Augmented Reality teachware were firstly used, the children showed a response of, "Wow! Cool". However, there was no other special things after that, and similar patterns were repeating. So, we only saw it few times, and does not see it anymore.

Story 2. Most of the parents tries to not give a mobile phone to young children (young child.) However, I am reluctant to buy to young children(child) as the Augmented Reality teachware age limit is low mostly.

Story 3. It is good to see an object up, down, and side in three-dimensional through Augmented Reality. However, in case of toys, it is possible to touch but in case of Augmented Reality, it is pity that it can't be touched or so.

Story 4. I have bought it because the children like it, but as the Augmented Reality teachware uses an application, I am worried for their health when using it for a long time.

Story 5. There are times that an error occurs as it plays on other location not an Augmented Reality teachware. Also, the coloring is not recognized when it springs out, and the Augmented Reality tend to not play. Also, when the coloring can't be done, the shape get's weird, so it is not that good.

Research Analysis

1) Method

Two researchers have participated and analyzed for three days. The environmental and behavior characteristics were extracted from 24 users interview and the problems that was derived was classified using the Affinity Diagram. The requirements and goal were derived after classifying the ideas through screening after recording the ideas that was enormously listed on a post-it memo paper.

Based on the results obtained through user research, the 30 responses content like below Table. 6 was groupage using the Affinity Diagram technique. In the classifying process, the duplicate content or similar terms such as an opinion that the learning method is simple or the opinion that the Augmented Reality teachware is easy were excluded.

2) Purpose

The purpose was to derive a common value and requirements that is on across the user by combining the user interview results. It was possible to derive the key words that could become a requirement by groupage of the things that are relevant or the similar ones, and by combining the response contents that the meaning duplicates. New facts could be inferred and found by arranging the response contents that are enormously listed by groupage of the interviews.

3) Results

For the Augmented Reality teachware, the problems such as simple repetitive education, subtraction of learning difficulty, the production of only the teachware for infant, and the matters that need to be improved such as various interaction, team play function, the correction of recognition error were derived. In addition, the necessity such as an education through wearable device, the method of using the healthy Augmented Reality teachware, Augmented Reality of friendly image, and operation and maintenance of an application was also derived. Through this, the goals that requires consideration when producing the Augmented Reality teachware ultimately were derived. The contents are as below Table 6.

Table 6 : Affinity Diagram

Purpose	Requirement	Response Contents
Providing educational method out of simple repetitive education	People should not get tired of simple learning repeats	- It only repeats to see the Augmented Reality that is seen over the teachware - There aren't any special elements other than Augmented Reality - They are having interest only in the beginning and gets bored soon - the learning process is too simple
	The next Augmented Reality contents that will be shown on the teachware is expectable	- It only repeats the process that transforms the plane image to 3D - It is possible to expect the Augmented Reality by seeing the word cards only
Producing Augmented Reality teachware for subjection various ages	It requires learning stage by level	- There is no level of difficulties in the teachware - It is impossible to learn by the level of the user - The age range is narrow
	It requires an Augmented Reality teachware for a much higher age	- The target age of Augmented Reality teachware is young, but it is hard to use as it needs to use the smart phone - Existing Augmented Reality teachware are too easy - Mostly, people don't give smart phone to infants(1~6 age)
Provides an improved function related to Augmented Reality	More free interaction is required	- It is pity because it is impossible to touch the Augmented Reality - I would like to communicate more freely with the Augmented Reality characters
	It would be nice to do it together	- It can't be used together - There is no feeling of doing together with other people

	The recognition error of Augmented Reality must be minimized	- There are times that the Augmented Reality operated in weird place - When the color of the drawing teachware goes out, it does not recognize - When using the block type teachware, the location of Augmented Reality and the block does not match
Provide Augmented Reality education through Wearable device	It is cumbersome to run the application	- It is cumbersome to run the application - Later on, I only read the books without using the Augmented Reality
	There is a need for an Augmented Reality device that is more convenient than smart phone	- It is cumbersome as there is a need for machine when seeing the Augmented Reality - It would be nice to see the Augmented Reality even without smart phone
Suggest healthy usage method of Augmented Reality	Worried about the health due to the use of smart phone	- I am worried about children's eye health - I am worried about the electromagnetic waves of smart phone - I think children are addicted to smartphones if used for a long time
Provide Augmented Reality of friendly image	It should be improved as a 3D graphic of friendly image	- They are scared as the Augmented Reality is too realistic - We don't use it as the Augmented Reality animal is scary
Produce as an application that is also possible offline	The maintenance of an application is not done well	- The application does not work as the population of the product is lost - The Augmented Reality application does not work as the production company went bankrupt

Conclusion

This research was researched through Town Watching and the teachware seller interview of the Augmented Reality teachware that are actually sold on the store, and the questionnaire was made based on this. The student's parents that have used the Augmented Reality teachware with child was interviewed based on this questionnaire. The contents of the interview was analyzed by an Affinity Diagram.

Through this, it was found that the Augmented Reality teachware was made according to the focus of simple fun that the Augmented Reality is played. Due to this, the problems such as simple repetitive education, subtraction of learning difficulty, the production of only the teachware for infant, and the matters that need to be improved such as various interaction, team play function, the correction of recognition error were derived. In addition, the necessity such as an education through wearable device, Augmented Reality of friendly image, maintenance of an application, and the method of using the healthy Augmented Reality teachware was also derived. Through this, the goals that requires consideration when producing the Augmented Reality teachware ultimately were derived.

The Affinity Diagram produced based on the user interview content helps the understanding of the user, and it possesses a useful value in the point that it could be used as an important indication when making and opinion decision and development directions on a development project of an actual Augmented Reality teachware.

However, this research cannot be seen that it substitutes the total users, but shows only the needs, behaviors, attitudes of a user. Moreover, this is a survey progressed in South Korea, which it could be researched differently in accordance with the culture, society, economical situation of other country, and there is a limitation that this research could be applied differently.
In the future follow-up study, I would like to produce a user modeling and user scenario based on the user research. I am planning to progress teachware design and make prototyping based on the arranged contents. I am planning to measure the effects whether the user satisfaction rate or the learning consistency have increased than the existing Augmented Reality teachware through experiment for the produced teachware.

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Power-Dependence in Domestic Politics and Interdependence, Balance of Power and Soft Law in Diplomacy, Comparison of Bureaucracy in the History

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Abstract
This paper investigates Power-Dependence in Domestic Politics and Interdependence, Balance of Power and Soft Law in Diplomacy, Comparison of Bureaucracy in the History between the U.S., U.K., EU and Japan. This paper consists of four parts. First, this paper investigates the similarity and common factors of Power-dependence in Domestic Politics and Interdependence in Diplomacy. I consider the power-dependence theory in intergovernmental relations by Rhodes and the interdependence theory in international relations by Nye and Keohane have similarity and common factors. Second, this paper investigates the Bureaucracy of Power-Dependence. In Japan, the Bureaucracy and Government coordinate the politicians, interest groups and local government. On the other hand, Bureaucracy and Government have conflicted to take initiative of politics. This paper investigates the cooperation and conflict between bureaucrats and government in Liberal Democratic Party and Democratic Party in Japan. Third, this paper investigates the Soft Law and Balance of Power in U.S., U.K., EU and Japan focusing on the Bureaucracy and Government of Power-Dependence, and Interdependence in Diplomacy. The diplomacy of United States, United Kingdom and European Union is influenced by the Balance of Power and Collective Security. This paper investigates how the balance of power influences the diplomacy. Finally, in Japan, Bureaucracy and Official Residence have cooperated and fought to take initiative and leadership. This paper investigates the history of Bureaucracy between the U.S., U.K., EU and Japan.

Keywords: Power-Dependence, Interdependence, Linkage, Balance of Power, Soft Law

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Introduction

I have researched Power-Dependence, Interdependence, Linkage, Linkage Diplomacy, Bureaucracy and how Diplomacy and Domestic Politics are related each other.

I consider that power-dependence theory and interdependence theory have similarity and common factors.

I have researched the similarity and common factors between power-dependence of domestic politics and interdependence of foreign policy.

I think that Diplomacy and Domestic Politics are related each other.

Table 1 Comparison between Power-Dependence Theory and Interdependence Theory

	Power-Dependence Theory	Interdependence Theory
representative Researchers	R.A.W. Rhodes	Joseph Nye Robert Keohane
Research Area	Administration	International Relations
Objective	Intergovernmental Relations between Centre and Local	International Relations among States
Common Concept 1	Linkage between Centre and Local Connection between Organizations, Policy Networks	Linkage between States
Common Concept 2	Asymmetry between Centre and Local	Asymmetry between States
Common Concept 3	Cost Unilateral decision is not cost-free.	Cost Short-term sensitivity Long-term vulnerability
Law	Law, Statute	Treaty, Soft Law
Sanction	Law with sanction	Treaty and Soft Law without sanction
Stability	Principle of *Ultra Vires*	Collective Security and Balance of Power Alliance

This Table is made by the author based on Rhodes (1986a, 2006), Nye (2007), Keohane and Nye (1977), (Yoshihiro Nagata, Policy-Making Process of Education and Politics in the EU focusing on the Norm and Legalization, the Master's Degree Paper of Osaka Kyoiku University 2013), (Yoshihiro Nagata, Power-Dependence of British Central-Local Government Relations and Interdependence of International Relations in the EU, ACPEL2016)

Table 2 Comparison between Policy Networks and Linkage

	Policy Networks	Linkage
representative Researchers	Katzenstein R.A.W. Rhodes	H.Kissinger Joseph Nye Robert Keohane
Research Area	Administration	International Relations
Objective	Intergovernmental Relations between Centre and Local	International Relations among States
Common Concept	Linkages between governmental and other actors	Linkage between States
Actor	Bureaucracy, Central Government, Parliaments, Politicians, Interest Group Local Government	States International Organizations

This Table is made by the author based on Rhodes (1986a, 2006), Nye (2007), Keohane and Nye (1977), (Yoshihiro Nagata, Policy-Making Process of Education and Politics in the EU focusing on the Norm and Legalization, the Master's Degree Paper of Osaka Kyoiku University 2013), (Yoshihiro Nagata, Power-Dependence of British Central-Local Government Relations and Interdependence of International Relations in the EU, ACPEL2016), (Yoshihiro Nagata, Policy Networks of Central-Local Government Relations in the UK and Japan and Linkage of International Relations in the EU, IICSSHawaii2017)

Table 3 Linkage in the History

Linkage			
1960s (1969)	James Rosenau	Linkage Theory	Domestic Politics and Foreign Policy
1970s	Henry Kissinger	Concept of Linkage, The Linkage Strategies	The concept to alleviate the conflict relations between the United States and the Soviet Union
1980s	Joseph Nye Robert Keohane	The concept of linkage	the relationships between the allies and the friendly nations

This Table is made by the author based on (Yoshihiro Nagata, Power-Dependence of British Central-Local Government Relations and Interdependence of International Relations in the EU, ACPEL2016), (Yoshihiro Nagata, Policy Networks of Central-Local Government Relations in the UK and Japan and Linkage of International Relations in the EU, IICSSHawaii2017), (Yoshihiro Nagata, Bureaucracy of Power-Dependence in Domestic Politics in Japan and Interdependence of International Relations in the UK, U.S. and EU, ECSS2017Brighton), (Yoshihiro Nagata, Policy-Making Process of Education and Politics in the EU focusing on the Norm and Legalization, the Master's Degree Paper of Osaka Kyoiku University 2013).

Table 4 Domestic Politics and Foreign Policy in the History

Domestic Politics and Foreign Policy			
1950s	Kenneth Waltz	The relationship between domestic politics and foreign policy is not found in Waltz's concept in 1959. Later, however, Waltz pointed out importance of domestic determinants of state action, such as leadership and bureaucracy. (Waltz 1979), (Katzenstein, Keohane and Krasner 2004, p. 653)	
1960s (1969)	James Rosenau	Linkage Theory	Domestic Politics and Foreign Policy
1970s	Henry Kissinger	Concept of Linkage, The Linkage Strategies	The concept to alleviate the conflict relations between the United States and the Soviet Union
1978	Peter Katzenstein	Peter Katzenstein presented a theory that domestic policy influences the foreign policy. In the preface of Katzenstein's literature, "it was to understand how "domestic structures" shape political strategies in the international political economy".	
1980s	Joseph Nye Robert Keohane	The concept of Linkage	the relationships between the allies and the friendly nations
1980s	Robert Putnam	Concept of two-level games	

This Table is made by the author based on (Yoshihiro Nagata, Power-Dependence of British Central-Local Government Relations and Interdependence of International Relations in the EU, ACPEL2016), (Yoshihiro Nagata, Policy Networks of Central-Local Government Relations in the UK and Japan and Linkage of International Relations in the EU, IICSSHawaii2017), (Yoshihiro Nagata, Bureaucracy of Power-Dependence in Domestic Politics in Japan and Interdependence of International Relations in the UK, U.S. and EU, ECSS2017Brighton), (Yoshihiro Nagata, Policy-Making Process of Education and Politics in the EU focusing on the Norm and Legalization, the Master's Degree Paper of Osaka Kyoiku University 2013).

Balance of Power in Japan Politics

Balance of Power is applied to Diplomacy and Domestic Politics.

I think the Balance of Power in Japan Politics was maintained in Liberal Democratic Party from the 55 system. After the Conservative Merger 1955 of Liberal Party of Prime Minister Yoshida and Japan Democratic Party of Prime Minister Hatoyama, the Balance of Power was maintained in several factions of Liberal Democratic Party.

Hashimoto Administration of the Liberal Democratic Party emerged change from bureaucratic leadership to official residence leadership. However, resistance of the bureaucracy is strong. Prime Minister Koizumi attempted to abolish special corporations but failed. However, Koizumi Administration succeeded realization of

Japan Post Privatization. Koizumi Administration also succeeded organization reform of every governmental department and agency.

Democratic Party Administration cannot make use of the bureaucracy. However, In Abe Administration of Liberal Democratic Party, the official residence leadership is remarkable. The bureaucracy become to be controlled by the government, because Abe set the bureau of personnel at Cabinet Office and this bureau decides personnel above the assigned rank at every governmental department and agency. At the same time, the domestic interest group became to influence the foreign economic policy, and the self-regulation at Japan side disappeared.

(Yoshihiro Nagata, Bureaucracy of Power-Dependence in Domestic Politics in Japan and Interdependence of International Relations in the UK, U.S. and EU, ECSS-Brighton2017)

Bureau of personnel at Cabinet Office(Naikaku-Jinjikyoku) in 2014 strengthened the power of Official Residence and changed bureaucrat-led politics to politician-led politics.

Bureau of personnel at Cabinet Office(Naikaku-Jinjikyoku) was by Cabinet Act.

Administrative Reform of Hashimoto cabinet reduced ministries and strengthened power of bureaucracy. Ministry of Internal Affairs and Communications(Soumu-sho) revived power as Home Ministry(Naimu-sho) because Ministry of Home Affairs(Jichi-sho), Ministry of Posts and Telecommunications(Yusei-sho) and Soumu-cho ministry had merged.

Cabinet Act and Central Government Reform 2001 strengthened the power of Official Residence beyond the wall of ministries.

Ministry of Finance(Okura-sho) and Ministry of International Trade and Industry(Tsusan-sho) maintained main actor of politics. Home Ministry(Naimu-sho)(1873-1947) which was established by Lords of Home Affairs, Toshimichi Ohkubo, de facto Prime Minister had been strongest actor of Japan politics including police and local government.

Prime Minister Aritomo Yamagata, Taro Katsura, Keigo Kiyoura and minister Judo Saigo built bureaucracy. The Ministry of Agriculture and Commerce (NoShomu-Sho)(1881-1925) was also strong ministry.

From Bureaucratic Leadership to Official Residence Leadership

Katzenstein pointed out that Japanese foreign economy policy is supported by the business, especially big companies to which economic interest serves. He also insisted that Japanese foreign economy policy is facilitated by the high centralization between state and society (Katzenstein, 1978).

Since the 70s, the foreign economic policy is forwarded between the United States and Japan in place of the security and political issues between them. Its beginning is Japan US textile negotiation. In May, 1969, United States Security of Commerce,

Stans, required self-regulation of Japanese textile product export. In March, 1971, Federation of Japanese textile announced self-regulation, and on October, memorandum of understanding of US-Japan textile problem was agreed. Japan government decided emergency loan (75.1 billion Japanese yen) and relief financing (128.7 billion Japanese yen). The resolution by the self-regulation is characterized by the following points. First, the self-regulation of Japanese textile product exports is derived from asymmetry between the United Stated and Japan at that time. Second, the political process of US-Japan textile negotiation is owed to the initiative of Minister of Trade and Industry, Tanaka, but its political process is cooperation between politician and bureaucrats rather than official residence leadership. The self-regulation is a cooperative work of the politician and bureaucrats.

After the US-Japan textile negotiation, the US-Japan car negotiation (ended self-regulation at Japanese side), the US-Japan semi-conductor negotiation in the 80s continued. Triggered by Plaza Accord (1985), the Structural Impediments Initiative (1989-90) and Japan-United States Framework for new Economic Partnership in the 90s continued. In each negotiations, the main actors were bureaucrats.

(Yoshihiro Nagata, Bureaucracy of Power-Dependence in Domestic Politics in Japan and Interdependence of International Relations in the UK, U.S. and EU, ECSS2017Brighton)

Degree of Influence of the Domestic Interest Group to the Bureaucracy

I will explore degree of influence of the domestic interest group to the bureaucracy in the negotiation of the Trans Pacific Partnership (TPP), especially between Japan and U.S. and the negotiation of the Economic Partnership Agreement between Japan and the EU. (Yoshihiro Nagata, Bureaucracy of Power-Dependence in Domestic Politics in Japan and Interdependence of International Relations in the UK, U.S. and EU, ECSS2017Brighton)

Focusing on the tariff of the Japan-EU EPA, I consider the national interest, the interest group and the asymmetry between states. Though Japan guarded the tariff of the cheese in the TPP negotiation, Japan accepted the reduction and elimination of the cheese tariff in the Japan-EU EPA. From this fact, I can obtain the following results of the foreign economy policy. First, Japan and the EU had to make hurry to raise the flag of the free trade against Trump's protectionism. Second, Japan had to set the tariff reduction ration which cannot be accepted more, for the coming bilateral Japan-US FTA. Third, though the asymmetry exists between Japan and the United States, the asymmetry does not exist between Japan and the EU. However, the reason why the import tariff ration of some issue in the Japan-EU EPA is lower than that in the Japan-US agreement of the TPP is due to the above situation of Japan and the EU. Fourth, because this basic agreement is derived from the national interest of Japan and the EU, the domestic agricultural interest group cannot sufficiently influence its allegation and is sacrificed for the national interest of Japan. (Yoshihiro Nagata, Bureaucracy of Power-Dependence in Domestic Politics in Japan and Interdependence of International Relations in the UK, U.S. and EU, ECSS2017Brighton)

Audit Commission

I have researched Audit Commission.

The principles of Audit Commission are applied to not only the UK but also Japan.

Extension of Layfield Committee

The Audit Commission can be addressed as an extension of the Leyfield Committee which published the Leyfield Report in 1976, which evaluated the finance of the local government in comprehensive manner and gave advice to the central government. The Leyfield Committee raised a question whether the central government or local government should take responsibility for the local finance reform, In response to this question, the Green Paper 1977 concluded that the local government should take responsibility (Hepworth, p.293, Travers, pp.71-78).

Value for Money strategy

The Audit Commission inherits its strategy, Value for Money, from the rationalization strategy by Macfarlane Report in 1980. Based on the rationalization of the education in the 1970s, the Macfarlane Report (Education for 16-19 year Olds) emphasized rationalization and cost effectiveness of the education at the local authority (Ranson, p.188). Furthermore, the background of Value for Money strategy is increasing total spending, in addition to the increasing spending of the social security, which mainly consists of the welfare, health care and education. For example, the welfare spending increased from £6.6 billion (1975) to £17.9 billion (1981) and the total spending increased from £51.5 billion (1975) to £116.1 billion (1981)
(Yoshihiro Nagata, The Audit Commission of Local Government in the UK, ACEID2016)

Limitation of the Circular

One of the reasons why the Audit Commission was established is considered due to the limitation of the Circular. The Circular is the control tool for the administration by the central government. The role of the Circular is the recommendation by the central government for the administration. However, it is clear that the Circular is not effective especially in the financial policy. In the 1980s, the Conservative Administration intended to take financial control using the block grant to reduce expenditure of the local government. Though this measure was exercised using the Circular and the legislation (Local Government, Planning and Land Act 1980, Section 48), the result was not effective. The rate-capping was newly legislated in the Local Government Finance Act 1982, but it was abolished in 1985 (John, p.11).
(Yoshihiro Nagata, The Audit Commission of Local Government in the UK, ACEID2016)

Balance of Power in the Diplomacy

In 1648, The Peace of Westphalia was signed by Westphalian sovereignty, and the Balance of Power occurred. Cardinal Richelieu, Cardinal Armand Jean du Plessis made the Balance of Power.

The Peace of Utrecht in 1713 made the Balance of Power as Soft Law and Norm. Treaty of London, Quadruple Alliance, the Alliance between Great Britain, Austria, the Habsburg Monarchy(Holy Roman Empire), France and Netherlands in 1718 and the Peace of Vienna, the Anglo-Austrian Alliance in 1731 were Alliance and the Balance of Power. I think that Quadruple Alliance by Vienna System in 1815 was reincarnation of Quadruple Alliance in 1718.

In 1756, Diplomatic Revolution, the Alliance between France and Austria was signed by the Treaty of Versailles. Prince of Kaunitz-Rietberg and Friedrich Wilhelm von Haugwitz achieved Diplomatic Revolution.

King Frederick II developed Oblique Order in the Seven Years' War(1756-1763).

As Gaius Julius Caesar in Battle of Alesia, Gallic Wars and Battle of Pharsalus, Great Roman Civil War, the Peace of Westphalia, Peace of Utrecht, Diplomatic Revolution had influenced Balance of Power.

In 1795, Jay Treaty was signed.

In 1815, Vienna System, the Concert of Europe(Metternichsches System) was settled by Prince von Metternich-Winneburg. The Balance of Power in Vienna System, the Concert of Europe included the Holy Alliance, Quadruple Alliance and Quintuple Alliance. The Balance of Power in Vienna System made Soft Law, Norm.
The Holy Alliance, Quadruple Alliance and Quintuple Alliance by Prince Metternich-Winneburg, Habsburg Monarchy, Talleyrand-Périgord and Castlereagh in Vienna System made peace and stability.
I think the Balance of Power is very artistic theory. I think that the Balance of Power is based on legitimacy, legitimacy of the Absolute Monarchy.

The Dual Alliance, Austria-Germany Alliance in 1879 and the Triple Alliance, Austria-Germany-Italy Alliance in 1882 were signed.

Japan-United Kingdom relations remains de facto alliance or quasi-alliance traditionally. In 1902, the Anglo-Japanese Alliance (Japan-UK alliance) was signed and started in London. In the present era, Japan and UK started to strengthen linkage and partnership in diplomacy, economic fields and cultural fields.
(Yoshihiro Nagata, Bureaucracy in the Power-Dependence of Domestic Politics and Linkage in Foreign Policy, IICSS2017Dubai)

In 1902, the Anglo-Japanese Alliance was achieved by Lord Lansdowne. The Balance of Power of Vienna System and Japan-UK Alliance was artistic. I like the Balance of Power of Vienna System and Anglo-Japanese Alliance. My family and I live in Kyoto and once lived in Vienna (Wien), Austria.

In 1904, The Entente Cordiale was signed. In 1907, Japan and France signed Franco-Japanese Treaty. In 1920, League of Nations was founded by Treaty of Versailles, and League of Nations was characteristics of collective security. Before League of Nations, the Balance of Power by Great Britain and Austria has brought peace of the world.

In Washington Naval Conference, US-UK-France-Japan Treaty was signed on December 1921. I think US-UK-France-Japan Treaty 1921 is alliance, quasi-alliance. In 1975, G6 Summit was held. I think G6 Summit includes alliance, quasi-alliance of collective security as reincarnation of US-UK-France-Japan Treaty 1921.
(Yoshihiro Nagata, Bureaucracy of Power-Dependence in Domestic Politics, and Diplomacy of Linkage, Interdependence and Soft Law between U.S., U.K., EU and Japan, ECSS2018Brighton)

I think that G6 Summit is reincarnation of US-UK-France-Japan Treaty 1921.

G6 Summit is de facto new US-UK-France-Japan Treaty 1921.

By Atlantic Charter in 1942 and Dumbarton Oaks Conference in 1944, the United Nations was founded. Prime Minister Winston Churchill and President Franklin D. Roosevelt contributed to the United Nations.

In 1947, the Treaty of Dunkirk, UK-France Alliance was signed. In 1948, the Treaty of Brussels was signed, and Western Union(WU) was signed. I think that Western Union(WU) is linked with NATO(OTAN), the North Atlantic Treaty Organization. After Western Union, WU(1948-1954), Western European Union(WEU) was founded in 1954. WU and WEU have characteristics of both alliance and collective security.

The North Atlantic Treaty Organization, NATO(OTAN) was founded by The Treaty of Brussels(1948) and The North Atlantic Treaty on April 4 1949. NATO(OTAN) is typical collective security and brings peace.

Japan-U.S. alliance is essential for Japan-U.S. Diplomacy. Security Treaty Between the United States and Japan on September 8 1951 were achieved by Secretary of State John Foster Dulles. President Dwight David Eisenhower signed Treaty of Mutual Cooperation and Security between the United States and Japan in 1960.

In 1951, the European Coal and Steel Community(ECSC) was founded by the Treaty of Paris. ECSC was interdependence of Coal and Steel of the Europe. French Foreign Minister Robert Schuman stated the Schuman Declaration on May 1950. French Foreign Minister Robert Schuman, British Prime Minister Winston Churchill and U.S. Secretary of State Dean Acheson contributed foundation of ECSC. The Treaty of Paris in 1951 was signed. The political institutions of ECSC was founded, (1) High Authority, The European Commission, (2) Parliamentary Assembly, The European Parliament, (3) Council, The Council of the European Union, (4) Court of Justice of the European Union.

I think the relations between the United States, UK, France and Germany in 2010s are reincarnation of relations between the U.S., UK, France and West Germany from 1950s to 1960s. I think that the relations between the U.S. President Donald Trump and French President Emmanuel Macron are reincarnation of the relations between President Dwight David Eisenhower and President Charles de Gaulle.

In 1952, Treaty establishing European Defence Community(EDC) was signed, and vetoed by Gaullism. I think that European army by French President Emmanuel

Macron is reincarnation of European Defence Community(EDC), de facto new EDC.

Hungarian Revolution(1956) and Berlin Crisis(1958-63) changed the U.S.-UK-France relations. The U.S. and UK strengthened U.S.-UK Special Alliance and agreed Nassau Agreement in 1962. President de Gaulle decided withdrawal from NATO integrated military command in 1966. France returned NATO integrated military command in 2009.

Franco-German Treaty on January 22 2019 is reincarnation of Elysee Treaty 1963.

The Treaty of Rome(The Treaty on the Functioning of the European Union, TFEU) was signed on March 1957. The objectives of Treaty of Rome were establishment of single market, common market, economic development in EEC and unified Europe.
The Treaty of Rome came into force on January 1 1958. The European Economic Community(EEC) and The European Atomic Energy Community(EURATOM) were established. The European Coal and Steel Community(ECSC), The European Economic Community(EEC) and The European Atomic Energy Community(EURATOM) shared Parliamentary Assembly.

The Merger Treaty called Brussels Treaty was signed on April 8 1965. ECSC, EEC and EURATOM were merged and called The European Communities(EC). After Veto by Charles de Gaulle to the UK's membership of EEC in 1963, Participation of UK to the European Community in 1973 was achieved.

European Political Co-operation(EPC) was adopted in 1970.

Nye's belief about power of the sovereign is the military power, economic power and soft power. Nye proposed the soft power by the warning that the use of force might jeopardize economic objectives (Nye, 1986, p.10). In this context, Keohane and Nye called the concept of the interdependence the overall structure approach which does not differentiate among issue areas in the world politics. These issue areas includes not only the political issue, for example the nuclear disarmament negotiation resulted in the Strategic Arms Limitation Talks 2 (SALT II), which was signed in 1979 between USA and USSR but not ratified, but also the global environment issue represented by a report 'Limit to Growth' published by Club of Rome in 1972.
(Yoshihiro Nagata, Power-Dependence of British Central-Local Government Relations and Interdependence of International Relations in the EU, ACPEL2016)

The European Council Copenhagen(1982), the European Council Fontainebleau(1984) and Delors speech in parliament(1985) were Internal market as EC grand strategy.

The Single European Act(SEA) was signed on February 17 1986. SEA was Constitutional foundation. The Single European Act(SEA) revised the Treaty of Rome, strengthened the authority of the European Parliament and introduced Qualified Majority Voting.

The Treaty of Maastricht (The Treaty on European Union, TEU) was signed on February 7 1992. The Treaty of Maastricht founded the European Union (EU). The Treaty of Maastricht consists of the three pillars of European Union. The first pillar is

European Communities. The second pillar is Common Foreign and Security Policy. The third pillar is Cooperation on Justice and Home Affairs.

The Common Foreign and Security Policy was related with European Political Co-operation(EPC).

The Treaty of Amsterdam was signed on October 2 1997. The Treaty of Nice was signed on February 26 2001. The Treaty of Nice was Reform of European Parliament and European Commission.

Kyoto Protocol was signed in 1997.

The Treaty of Lisbon was signed on December 13 2007. The Treaty of Lisbon strengthened empowerment of European Parliament and established of the term of President of the European Council.

(Yoshihiro Nagata, (2013), Policy-Making Process of Education and Politics in the EU focusing on the Norm and Legalization, the Master's Degree Paper of Osaka Kyoiku University 2013)

On February 1 2019, President Donald Trump and Secretary of State Mike Pompeo announced suspension of Intermediate-Range Nuclear Forces Treaty(INF).

Japan-EU EPA was basically agreed on July 2017 and signed on July 2018.

I hope U.S.-U.K.-EU-France-Austria-Japan strong interdependence, linkage and alliance.

Soft Law

Snyder defines Soft Law as "Among the most important of these means is Soft Law, rules of conducts which, in principle, have no legally binding force but which, nevertheless, may have practical effects. Such measures are frequent in Community Law. For example, according to Article 189 EEC, recommendations have no binding force." (Snyder, 1993)

Abbott and Snidal define Soft Law as "The realm of 'soft law' begins once legal arrangements and weakened along one or more of the dimensions of obligation, precision, and delegation. This softening can occur in varying degrees along each dimension and in different combinations across dimensions." (Abbott and Snidal, 2000)

The principle of subsidiarity and the Open Method of Coordination are linked with Norm and Legalization.

(Yoshihiro Nagata, (2013), Policy-Making Process of Education and Politics in the EU focusing on the Norm and Legalization, the Master's Degree Paper of Osaka Kyoiku University 2013, pp1-115)

Comparison of Bureaucracy in the History

	The UK	The U.S.	France	Japan	Austria
Characteristics Of Bureaucracy	Party Politics by politicians	Party Politics by politician and interest groups	High Bureaucracy	High Bureaucracy	High Bureaucracy
Degree of bureaucracy From 17th century to 19th century	Middle	Low	High	High	High
Degree of bureaucracy 20th century	Middle	Middle	High	High	High

Table 5 Comparison of Bureaucracy in the History made by the author
(Yoshihiro Nagata, Bureaucracy of Power-Dependence in Domestic Politics in Japan and Interdependence of International Relations in the UK, U.S. and EU, ECSS2017Brighton)

Conclusion

I think Diplomacy and Domestic Politics are related each other.

I have researched the similarity and common factors between power-dependence of domestic politics and interdependence of foreign policy.

I have researched Power-dependence, Interdependence, Linkage, Linkage Diplomacy, Soft Law and Balance of Power and Bureaucracy.

I think that Soft Law, Norm of the Balance of Power is very important for modern politics.

I have researched the U.S.-U.K.-EU-France-Austria-Japan relations, for example Japan-EU EPA, Japan-EU SPA, TPP, Japan-U.S. Alliance, Japan-UK Foreign and Defence Ministerial Meeting(Japan-UK 2+2) and Japan-France Foreign and Defense Ministers' Meeting(Japan-France 2+2).

The UK-Japan relations, EU-Japan relations and France-Japan relations are de facto alliance, quasi-alliance in diplomatic, political, legal and cultural areas.

I think that Japan-UK Foreign and Defence Ministerial Meeting(Japan-UK 2+2) is reincarnation of the Anglo-Japanese Alliance(Japan-UK Alliance). Japan-UK Foreign and Defence Ministerial Meeting is de facto Anglo-Japanese Alliance(Japan-UK Alliance). Japan-France Foreign and Defense Ministers' Meeting is de facto Japan-France Alliance.

I hope the U.S., the U.K., EU, France, Germany, Austria and Japan make strong interdependence, linkage and alliance in diplomatic, political, legal and cultural fields.

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Japan-U.S. Security Treaty

Gov.UK

Ministry of Foreign Affairs

NATO(OTAN)

European Commission

CNN(February 1 2019)

BBC(November 6 2018, January 22 2019)

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Survival vs Traditions: How Georgia Fights Against Economic Crisis The Economic Issues of the 21st Century Family are a Direct Responsibility of a Woman

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Abstract
Georgia is identified for its national historical culture where gender balance was always playing a significant role in formation of the entire society. This paper presents findings how Georgian nation makes choices in the way and process of survival of its spirit within our global community through immigration and how a female part undertook the responsibly for fixing the family's economic crisis, switching the family supporting role of male to female. We compare and analyze the recent statistics collected on Georgian immigrants around the globe. The results exhibit that a female immigrant is better fighter, and suitable for a new environmental atmosphere than a male one. According to socioeconomic factors such as gender and age differences, life experience, marital status, immigrants have different emotional difficulties but in overall females are more survivors than males. Gender balance was always recognized as a key in building the Georgian society. Both academic and practical observations proved that female workers have been increasing over the past few decades. Recent research shows that immigrants focus on the positive side of corporate social issues management, explaining why and how a family put responsibilities on female activities and how such engagement influences on Georgian culture. In this study, we focus on Georgian economic reality and explore the ways how family chooses the further responsibilities based on gender in the economical fight. We discuss the implications of our findings and the contributions of this study to the research based on our case study, which illustrates the challenges of our research on the Georgian community in the United States.

Keywords: Georgia, traditions, economic issues, survival

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Introduction

Cultures globally are characterized by different attitudes toward female part of world. The beliefs on female's role, opportunity, rights and designation are different. This ideological difference leads to formation of mentality. Notable concept is that, while formation of certain mentality, the main role comes ion religion, which is accepted and believed by a certain culture; religious outlook is kind of a unity of moral codes and principals on which a society's life style is based. Mentality is the phenomena defining the lifestyle, gender role, legal aspects and casual life specifics. Cultural mentality is characterized by stereotype thinking. Even epochs are characterized with mentalities; an epoch influence on mentalities, though this is not an unpainful process. In different epochs society faces different challenges and the role of a woman in these challenges is an issue of an interest. The trail of contemporaneity influences on human psychology and thus is reflected on mentality. The present work discusses the contemporaneity of the survived ancient cultures and the selected country on observation is Georgia. Georgia is distinguished with ancient history, unique culture, stereotypical attitudes, traditions and most notable concept, which is the eminent talent of national and cultural self-survival.

The article analyses the problems of contemporaneity, main accents are on an increased responsibility of women's role at the examples of Georgian culture. The research is focused on problems persisting in Georgia, on transformation of historical women's role and increased responsibility at the background of the economy crisis of the country.

Woman and a contemporaneity

A woman's role and its definition in especially relevant in our contemporaneity. World is facing great challenges and the gender balance as well. Over cages, due to masculine orientation, the asymmetry between of women and men was set as a rule. The main designation of a woman was defined as of a mother, providing the offspring and a housewife. The obligation of a women was the upbringing of children and obedience to her husband.

But the contemporaneity demanded the transformation of women's role and society faced the beneficial usage of an unspent intellectual and emotional potential.

Historic outline

Georgia, as the culture of ancient history, has passed the difficult stages of development. The epoch of Georgian culture is characterized by archaic and Christian influences. The impact of the Christian religion on the formation of a Georgian woman is still remarkable. Traditional ideas about women's dependence and Georgian mentality are still considered under the influence of Christianity.

Georgian woman's historic stereotype is Christian. The woman should be gentle, helpless, weak, and obedient to her husband. Its main purpose is the upbringing of children. Today's picture is diagonally different.

Through history rich with wars and due to permanent absence of man as soldiers, a Georgian woman obtained the new functions. Her direct obligations were the preservation of family's Christian ethnical identity, the care and management of household, including the care on younger and older generations within the family. Thus a Georgian woman gained a certain social value and respect from the society as a mother.

One of the significant feature of a Georgian woman, is the specificity of her functions as of a mother. As mentioned above, the basic function of parents is the demographic growth of the nation and this aspect is especially valuable for the small nations like Georgians, which was constantly involved in blood wars with enemies. Also the function/responsibility of "Mother woman" is defined as a child's caregiver. Historically a woman had realized the male's functions, and during the absence of him she - mother/wife was the family head and caregiver at the same time This served to the increase of mothers role in upbringing, which is revealed in full tolerance and forgiveness toward children, and specific emotional connection, special emotional connection with the child, symbiotic chaining of the mother-child, but at the same time the upbringing process included the father's characterizing line - respect, responsibility, justice, principle, and obey to law. Under such circumstances, the mother gained a special value in the Georgian mentality and was established as a cult. The specialty of a woman's role in reflected in Georgian language as well, a word "deda" - mother is a main part of certain composed words, e.g. "Dedamista" = mother earth - earth; "Dedakalaki" - mother city – capital, "Dedabodzi" - mother pillar - main pillar of a building and etc.

A unique place in the history of the world is the personality of Tamar of Georgia. The Georgian nation was proud of the historical merits and personalities of Tamar, who is mentioned as a King rather than queen. King Tamar would have met herself to the Georgian army gathered for war and checked their readiness. His foreign policy, diplomacy, was similar and decent, but the most important was the domestic policy she led. (King Lasha George's historian).

We can list a number of examples of proving the women's role though history of Georgia. A Georgian woman always played a major role in the history of Georgia but the leading role of the Georgian woman has been less highlighted over recent decades. But present days unveiled the new gender balance with increased responsibilities carried by women. Today we face a new gender balance. This paper puts focuses on the balance thematic.

Georgian Woman and a Today

While this article was under elaboration, an unexpected historical event has happened - Georgian population has made a difficult political choice and elected the first woman president in the history of Georgia. By electing woman as a president the Georgian people made a progressive step. Today, such a choice is still an exception globally, where only 11 women are elected as presidents. With this choice Georgia has proved that Georgia is now one of the oldest, traditional countries with its ongoing epochal development. The election of a female predecessor is a kind of declaration to the world that women's role in Georgia is getting stronger. This is the

first statement to prove to the world that equality is the country that is distinguished by stereotypical traditions of Georgia, is not a foreign word.

Georgia faces big challenges today. Economic problems are strict in Georgian reality. For the past two decades, women's responsibilities have doubled due to the country's crisis. Georgian women have proven that they are more struggling to deal with the economic crisis than men. This is a clear example of Georgian women's emigration. Today, only a small part of women's creative potential is used in Georgia. In this background, the number of women emigrated to work abroad has increased.

The fact is that the condition of changing this situation is the advancement of the country's economy, recovery of economic environment, and strengthening the material situation of the population. The government, society, should be more sensitive and should be able to improve the economic environment, elimination of unemployment which equally bothers women and men.

Georgian women are facing more and more new problems every day: difficulties related to education of children (their transition to paid studies), their health condition (difficulties in paid treatment), catastrophic immigration of young people from Georgia (to solve the problem of learning and work) and others. The uncertainty of these unsolved issues will be fateful for the future of the country.

Historically, the Georgian woman has had to undertake the responsibility during difficult situation in the country. The Georgian woman has maintained her creative talent over centuries as a guarantor of the purity and coziness of the family. Today Georgian woman faces new challenges.

In Georgian mentality historically mother is a cult. Despite this hierarchy suggestion „Woman-Man" defines the oppositional right levels, as far as the right of choice if more inclined to man and in Georgia there are notions like: "a woman should wait for her married future", - she has to wait until she is choose by a man. So, WHO IS CHOSEN? This" natural" privilege is determined by a gender asymmetry providing to a man the privilege of choice…

This is the Georgian reality today and this is the modern gender problem of Georgia. Specific value of status and prestige in Georgian mentality ("Dignity is over all other things"), in certain conditions neutralizes the gender asymmetry, determined position is weakness and provides the opportunity of right of choice – when a family is not able to solve the financial problems, woman becomes the family supporter and she takes the hardest actions, she takes a risk. She leaves her home and heads to emigrations… By her own will she undertakes the responsibility of supporting the family and thus the roles within the family are switched. A man becomes the caregiver for children and a woman finances the family from far abroad. This reality contradicts to Georgian cultural stereotypes, but this is an epoch's triumph over tradition. This is a Georgian reality and the contemporary gender problematic is revealed in this way.

Historically underestimated woman's abilities and role have radically changed and a woman becomes the main financial supporter of the family, through the toughest and risky ways of emigration.

How did the country of ancient culture and traditions come to such a balance of gender balance? Georgia is characterized by a variety of compensational and adaptive machinations that have been developed through strong traditions and historical restlessness, but the reality is that the epoch breaks stereotypes or changes traditional styles. Historical circumstances require a need to react to certain moments in life-style, putting them in the foreground, and strengthening the value. One of the moments was the establishment of a mother's cult in the country, which in the course of time provided Georgia as an ethnic autonomous phenomenon. Because of this, mentally "woman" and "mother" are mixed in Georgia. The value of the mother's value is the fact that women are living, but it does not mean that there is no respect for a woman in general, but the massive emigration of women has led to the deviations of these traditional values.

Results of Social Survey

A survey conducted in 1998 was dedicated to the identification of certain problems on women. The target group of survey were 400 women with the age range of between 16 and 60. They were asked to answer 4 questions on: designations of a woman, a woman as a supporter of a family, a woman's social status and having a profession.

The data analysis showed that the answers in most cases were different according to the age difference, in particular, the data from the age group of 16-30, 30-45, and 45-60 year in some cases differed significantly from each other.

It was found that respondents first thought of motherhood, but the function of the mother is to provide financial support for the child and the family. Such response was received from 38% of respondents. 13% of respondents considered that a major responsibility should be taken by a man while responsibilities on the domestic work (keeping the household, maintain peace and mutual support in the family, family care) was considered as woman's priority; 7% - noted children's upbringing. Some responses were mentioned word: "Femininity," "Men's Partnership", "Love", "Men's Fun", "Virtue", etc.

The functional purpose of women is revealed in the frame of the mental value orientation, by the respondents' response.

Answer on question: - "Should a Woman have a source of income?" 64% of respondents answered positively, 28% negatively, 8% did not indicate the position. In this case there were some variations. When a majority of 16-30 age groups indicate that the majority of women have a tendency toward financial independence.

Despite this, after mathematical processing of the resulted data, was revealed the significant correlation between the designation of a woman and necessity of marriage: those who consider the motherhood as the primary designation of a woman while answering the first question, on the second question they answered that marriage is necessary. Therefore, quotidian consciousness still connects this two phenomena and considers that a woman should have a family otherwise she will not be able to become a mother. It is paradoxes, but they consider the woman's primary designation is motherhood. Despite the fact that marriage does not provide the hope for a woman

to be free from financial responsibilities for supporting the family, as it was in previous epochs.

Thus, the resulted data our culture is based on the traditional role stereotypes.

Respondents think that women should have social status. This answer is provided by the 78% of the respondents (the majority of respondents came to an uncertain position and the negative response was only 1%). One more interesting situation was revealed: "Is the Profession and professionalism are needed for women?" 94% of respondents replied "Yes" 2% - "No", 4% - "I do not know". In addition, more positive answers were in the age group of 16-30 years (98%).

Relevantly, according to the resulting data, we can consider that the common consciousness suggests the mentality oriented beliefs on woman's functions and it depicts the patriarchal ideals.

According to the results of the survey, the trend of feminist stereotypes reflected on the self-determination of women's social status in the imagination of interviewed women.

It should be emphasized that these two aspects are very important for the female personal liberty, because only material independence is not enough for the personal freedom of a woman. In this way, not only the struggle against social stereotypes, but also she needs the change of her traditional orientations and attitudes, obtaining the psychological strength and real liberation that will enable her energy potential. In order to achieve this goal, priory she needs to deal with herself.

Historically proved fact is that Georgia's current difficulties are hardest burden for Georgian women. Women of different professions experienced the double pressure: career failure and household management difficulties.

In this regard, the only thing, where the gender equality principle can be applied is the economic problem – poverty, for the representatives of all classes, despite insignificant exceptions.

Day by day, the problems of Georgian woman are increasing, added by the difficulties related to children's education (transitions to paid educations system), health issues (problems related to paid medical care system), catastrophic level of emigration of youth (for solution of education and employment problems) and others. Irresolution of these issues will be fatal for the country's future.

We did not touched accidentally the role of woman in Georgia in the past when she had her worthy contribution in almost every sphere of life. Over centuries that he was able to serve his country, which could serve his future. The Georgian woman has brought this her ability to date and she must be given the ability for revealing her potential. Female worker, female scientist, female housewife, woman – the art creator is the basis for the country, the country's future. The founder of the country is the foundation of her future. The Georgian woman maintained her creative charge over the centuries. It is therefore essential to use the woman's energy, her rare active nature, for the country's benefit.

Emigration from Georgia

Sociologist Ernest Tru Hoffmann, a professor at Washington Wilson Center, wrote in his recent study that "women are a victim of maternal culture in Georgia, where society lives in traditions where female migration is considered as incompatible with the role of a wife and mother." Migration of women seeking job has increased and these ideals had lost their influential power. Is Emigration of Women a Clean Georgian Phenomenon?

Does the survival instinct contradict the traditions? The UN and the government statistics are as follows: In 1994-98, migration of women increased by 39%, and then, from 1998 to 2010, 57%. There are no data in recent years.

There is no precise statistical data available by the Emigrants world league.

According to the 2017 Georgian emigration profile, 55% of the emigrants are females and 45 males.

According g to 2014 census, the amount of emigrants amounted 88 541persons. Most part of them are living in Turkey and Greece.

According to 2017 migration profile data, the majority of the emigrants, 75 are of the 20-54 age category.

In 2016, the volume of money transfers in Georgia was 8% of GDP.

Emigrants' money transfers play an important role in family welfare.

This is a very complex problem where not only the child's rights but also the rights of these women, because in most cases emigration is not their choice. They are forced by extreme necessity and I understand that this is a social problem. But it is very difficult to determine the price of it.

The socio-economic situation of Georgia has led to the fact that the mothers and women become family supporters. Adapting the role of the financial supporter, somehow weakens the "Georgian-national" patriarchate and the status of the woman in the family. All contemporary statists consider this as a sad fact. All modern statistics are the fact that this is a sad reality. When a woman becomes a family supporter, this means that the burden she had before she had to be distributed (e.g. her home works). But it did not happen in Georgia. The woman actually maintained the responsibility she had. This was added to the status of a family supporter, and this her life even harder. When a woman takes an active role of a family supporter while other family members are not helping her in distributing her duties as of a housewife and thus make her life easier. To summarize the extra burden for the woman, she could not get rid of the previous duties and responsibilities, but her load has been doubled and stress multiplied. In some cases women are not able to deal with so much stress and the percentage of divorcees reaches high level.

Historically there existed a lot of positive stereotypes around a mother in Georgia. Today this can be added by a stereotype of a virtual mother, as far as real mother

character is absent. The main question one asks is - what kind of image is suggested by the current situation of mother to a child's consciousness? Current technologies somehow provided the condition of dealing tough reality. Despite this the motherhood and relation between a mother and child is hard. An emigrant mother cannot replace the mother aside. Eventually, how this distant relations will reflect on a child, we will see in future. This virtual relations has positive sides, it is better than no relationship at all, but this cannot replace benefits of the live contact for a child. There are cases when a society judges the mothers living abroad, while a woman has doubled her work load and tripled her responsibilities. These women live with constant feeling of being guilty, though emigration was a forced decision. This is completely unacceptable and unfair towards these women and children. Generally, the justice and fair attitude is a serious deficiency in the country.

Gender Socialization, Emigration and Positive Attitude

Female gender socialization in Georgia is in compliance with the patriarchal norms. Family and educational institutions are less likely to prepare women for paid work.

Teachers of so called "covered educational program" (unofficially) teach to girls that their academic success will threaten their popularity. The main concern, in Georgian reality, was the "successful" marriage for the girl and her formation as of a mother.

The social construct of a successful woman can only be considered in the context of a good mother and an obedient wife. Even when a woman is an employed professional, part of the domestic affairs does not transit her husband's commitment, because the patriarchal tradition does not love a man with a broom. Gender socialization of men serves to increase their status in society and to strengthen the privilege. They are responsible for the welfare of their wives and families. On the other hand, the "broom" is the fiery enemy of the Georgian man. The shocking masculinity reputation does not promise the privileges to a man.

Taking into consideration all this, emigration of Georgian women in search of economic or personal wellbeing constitutes deviation from gender norms based on the patriarchal tradition in the society. Their primary commitment - a good mother / obedient wife - is already in the chaotic gender definitions and almost disappears. Consequently, phenomenon of migration of women is the basis for the complete breach of gender stratification of society. At the same time the gender roles are reversing where women are acquainted with men's biological features and skills, as sometimes is described just as self-preserving instincts. In reality we forget that is there is much more biological similarity than the difference between these two genders.

The Patriarchate has deeply rooted in the Georgian society and possibly it is due to old rules and religious practices. As we have mentioned, the husband in the patriarchal family is recognized as a breadwinner. The woman has only the status of a spouse's assistant. Homework and children's care is a woman's responsibility. Religious dogma only strengthens such public perception and completely ignores the reality of an immigrant women. The family in the patriarchal thinking, with its numerous defects, is a non-existent phenomenon for Georgian immigrant women.

While working on this research, I have relied on my personal experience, personal relationship with the Georgian diaspora in America and the history of Georgian emigrant women and their experiences.

First of all, it should be noted that Georgian immigrant women represent a very diverse social group. However, it is still possible to generalize some demographic signs.
Majority of Georgian immigrant women migrate to improve economic conditions in the United States, the main part is Georgian-American first generation. Most of them have arrived without a partner or spouse, a family left in Georgia.

Majority of Georgian immigrant women migrate to improve economic conditions in the United States, the most part is Georgian-American first generation. Most of them have arrived without a partner or spouse, they have left their families in Georgia with the purpose of financial support.

It is difficult to talk about the psycho-social condition of Georgian immigrant women, as there is no survey that would allow us to evaluate their psychological or social environment. However, from private conversations we can reveal that they have gone through the process of establishing the social support system – friendships, partners, overcome the language barriers, unemployment and fear of deportation, as well as immigration status and lack of cultural connections make it difficult to assimilate with the American society.

In terms of inter-culture, most part of immigrant women have difficulties with national identity and American norms, which is a source of additional “culture absence” stress. This may be a side effect of the liberation from the gender role based on patriarchal tradition. However, it should be noted that the successful solution to the ethnic identity conflict is a prerequisite for the development of personal liberty and bi-culture identity.

Despite the enormous complications, it is necessary to note the achievements of Georgian emigrant women abroad and furthermore in the United States of America. Despite the obstacles, Georgian immigrant women manage not only reassertion in a foreign country but they will cope with the stress that is the result of the abovementioned gender socialization. Georgian women achieve incredible level of personal development and economic sustainability abroad and this is still a characteristic of the Georgian woman's strong and hard work.

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A Solution for the Educated Cosmetic Choice to Reduce Cosmetics Waste and Replacement Cycle

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Abstract
There are increasing international concerns in reducing plastic waste. Although cosmetic companies proclaim environment-friendly marketing strategies, it seems to be still hard to replace the plastic cosmetic containers with dissolvable materials. Also if the purchased cosmetics do not fit for customer's demands, they are likely to be thrown away. Eventually it causes significantly shorter life cycle of cosmetics and plastic wastes. This study intends to prolong the life cycle of cosmetics by exactly informing consumers what their skin conditions are, thereby what cosmetics they should select. Therefore, this study introduces an application that accurately diagnose the skin condition by Big Data analysis, and also helps customers select the right cosmetics. First of all, a device with diagnosing functions periodically measure customers' skin conditions, and then the measured data are analyzed to search for appropriate chemicals and ingredients. Based on the analytics, customers are eventually educated concerning the cosmetics appropriate for my skin type among numerous types of cosmetics. The more the customer accumulate historical skin data and their purchase, the more refined choices of cosmetics would be recommended. Additionally, when customers purchase cosmetics, the application indicates whether or not the cosmetics of interest fit for customer's skin condition intuitively and quickly using the AR (Augmented Reality) based ingredient analytics. In short, this paper purpose to promote the educated choice of cosmetics with which customers are satisfied for a long term and reduce the plastic wastes due to the wrong choice of the cosmetics.

Keywords: Augmented Reality (AR), Cosmetics, Personal, UI/UX, Service design

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Introduction

Today's cosmetics have become fundamental consumer goods for modern people. So, the cosmetics market is growing explosively every year. However, due to the contents, containers, etc. of cosmetics that are discarded each day, the current environmental pollution is getting worse. It has been changed to not an eco-friendly era, in which we just need to keep our existing environment, but a Green Survival which is necessary for us to survive. Efforts to reduce the amount of plastics being discarded globally are evident throughout the world, and moreover, there are movements like ‘"Not Using Plastics", etc. The cosmetics industry is also pursuing its eco-friendly marketing strategy in keeping with such trends, but actually it is not easy to lower the disposal rate of cosmetics.

Users need to use all the contents of cosmetics to reduce the disposal rate of cosmetics a little, but they have difficulty in finding cosmetics that fit their skin condition. Chloromethylisothiazolinone (CMIT) and Methylisothiazolinone (MIT) ingredients have been detected in the humidifier disinfectant which has become a social issue in recent years, so it sent shock waves through the nation. In addition, the news that household items, such as sanitary pads, wet wipes, toothpastes, etc., contain ingredients similar to those mentioned earlier have impacted the society greatly. At the same time, Chemophobia is spreading gradually, a phobia of chemicals detected in everyday goods, including cosmetics.

As a result, consumers' needs for safety of ingredients of cosmetics have been increasing recently. Famous cosmetic brands are launching their products with the title of ‘good cosmetics’ with good ingredients. The number of consumers who buy cosmetics is increasing after searching for information about their ingredients. Also, books covering cosmetic ingredients are being published, consumers can search for cosmetic ingredients on the Internet website, and a variety of online services are widely provided so that consumers can register the information they know online to share it with others. It can be said that consumers' needs wanting to know cosmetic ingredients appear in various places.

In fact, the point of view of consumers who are going to purchase cosmetics is simple and clear. It is a question of ‘what products are best for my skin’ among a number of cosmetics in the world. It is common for people to purchase certain products by sticking to famous brands, but put cosmetics on their vanity tables or eventually throw them away without using them a few times due to skin problems after use. According to actual surveys, there were 92% of people who had cosmetics that were only partially used on their vanity tables. The reason was that the cosmetics had not been suitable for their skin, seasons had changed, or the expiration date had passed. Consumers are constantly worrying about ‘what ingredients in cosmetics are adequate to and safe for their skin’. However, all ingredients marked in cosmetics are difficult for consumers to understand because of the low readability and understanding of them.

Therefore, the purpose of this study is to provide consumers with mobile applications that allow them to purchase the best cosmetics for them intuitively through a design that fuses applications and devices that help them purchase the cosmetics intuitively by utilizing data on their respective skin conditions and augmented reality technology and to ultimately help them consume all the cosmetics they purchased while reducing

cosmetic containers or contents, which are waste materials that are discarded due to a wrong choice in selecting the cosmetics. And furthermore, it aimed at organizing a platform optimized for the cosmetics business.

Relevant studies

It is now easy to check information on cosmetic ingredients with the recent appearance of mobile applications that can easily identify them with smartphones in order to solve such problems. The representative application is 'HWAHAE' meaning 'interpreting cosmetics', which provides 20 essential ingredients, EWG(Environmental Working Group) Grade,[1] skin type-specific ingredients, etc. by searching for consumers' desired cosmetic ingredients. However, there are various limitations that it is not able to absolutely have blind faith in the safety of the EWG's green grade along with the cumbersome of searching the cosmetic ingredients every time consumers buy cosmetics.

It is due to the fact that the EWG grade is determined by the number of articles. For the green grade, if there is no study result of the harmfulness of any ingredient in the paper, it is regarded as a safe one. Despite the fact that there is no study to test for the harmfulness of ingredients, they are considered as ingredients with safe grade 1, that is to say a 'green grade'. Rather, substitute ingredients are used to avoid substances widely known as harmful ingredients of cosmetics, but they can be more dangerous to consumers because they have not been tested yet. In addition, ingredients that need users' attention, among cosmetic ingredients, are in an obscure category called not an ingredient that does not fit each individual but 'dangerous for most people', so there are many people throwing away cosmetics or storing them on the vanity table because their ingredients are not actually suitable for their skin although they have purchased them with the idea that they are the right ingredients for them. To put it more simply, 'bad ingredients for most people' can be identified through Internet search or apps, but there is no recommendation for cosmetics appropriate for each person's skin, or a way to intuitively purchase them suitable for each individual, which causes the repetition of buying and then discarding cosmetics, and more seriously, some people have skin diseases such as folliculitis, contact dermatitis, skin troubles, etc. which results in economic loss.

Therefore, in order to go a step further from existing services, this paper had a purpose of identifying the skin environment with a device accurately and then trying to show the ingredients that are appropriate or not for each user's skin as an indicator. In addition, it was intended to help consumers increase the success rate of their cosmetics purchase intuitively, quickly and accurately through 'Augmented Reality-based cosmetic recommendation mode' at the moment of purchasing the cosmetics. Moreover, it tried to proceed with this study while focusing on accurate skin diagnosis, big data, and proper purchasing to improve the technical usefulness of the mobile application covered in this study. Eventually, it is expected that it will realize a sustainable convergence design that will help reduce the number of cosmetics discarded due to wrong choice of cosmetics and completely consume all purchased cosmetics and, by extension, that it will also give consumers economic advantages.

[1] Environmental Working Group. https://www.ewg.org/ewgverified/about-the-mark.php.

The purpose of the study

The purpose of this study is to make it easier for consumers to purchase cosmetics suitable for them when they purchase cosmetics by proposing augmented reality-based cosmetic application and device after investigating and analyzing the skin care methods and the process of selecting cosmetics for women in their 20s and 30s who are familiar with the application. As an experimental method, it was carried out through quantitative research, an online questionnaire on behavior when purchasing existing cosmetics, and qualitative evaluation, an in-depth interview. And, it will be performed with literature review, definition of research scope, user research, UI (User Interface) prototype design for the mobile app, and usability evaluation in order.

First, through the literature review, it analyzed the perception level of cosmetic ingredients at home and abroad, the importance of cosmetic ingredients, and the symptoms of using cosmetics that are not suitable for one's own skin and investigated the applications and services with regard to cosmetics that are being operated based on prior researches. In addition, it will apply user experience design and service design process and methodology to UI design by collecting recent data.

Second, it will derive the need and considerations of the mobile interface by comparing and analyzing the examples of mobile apps that are currently in operation.

Third, it will conduct a survey of women in their 20s and 30s, targets for this study, by preparing questionnaires about the behavior of purchasing cosmetics, based on the above research methods.

Fourth, in order to refine a survey and understand users' exact needs, it will analyze their current awareness of cosmetic ingredients, skin care, the way they purchase the cosmetics, and difficulties and derive features to meet their requirements by conducting in-depth interviews.

Fifth, it will suggest the final design with the supplemented prototype reflecting improvements in qualitative and quantitative assessments. Finally, this research will be done with the suggestion of significance and use possibility of the application and product that will help users purchase cosmetics that fit their skin intuitively, quickly and accurately while describing the conclusion and future task.

Research results

1) Literature review and evaluation of prior research

As a result of conducting literature reviews and analyzing prior researches, it was found that the patent data were more dominant than the paper. There is 'HWAHAE(interpreting cosmetics)' that is most preferred by people while currently helping to buy cosmetics in Korea. The HWAHAE is an application that is favored by users in a short time and analyzes cosmetic ingredients, launched in 2013, developed by a domestic developer, and it is currently ranked No. 1 in cosmetics-related applications in Korea and is extending its sales channel worldwide. In the beginning, Korean Dermatological Association and EWG(Environmental Working Group) of the U.S. nonprofit organization related to cosmetics, which give the criteria for cosmetic

ingredients marked, analyzed cosmetic ingredients based on EWG grades, but in recent years, it is creating a community with the users of the application while offering consumer review service and ranking, followed by a commerce service in which users can purchase cosmetics on the spot with viewing reviews.

Its advantage not only makes it easier for us to understand unfamiliar chemical terminologies, but also allows us to know what factors are dangerous in cosmetics at a glance. It explains cosmetic ingredients minutely and easily so that consumers, who do not know what is in cosmetics even though they try to analyze cosmetics ingredients, can understand the unfamiliar things easily. Previously, users were able to find harmful ingredients of cosmetics through Korea Cosmetics Association(KCA) and Food and Drug Association(FDA), but the process was cumbersome and difficult to understand, so there was a limit to the user's understanding of cosmetic ingredients. The HWAHAE also added a function to review used cosmetics and a commerce service. It has created a structure where users are asked to write reviews on the advantages and disadvantages of the cosmetics, and they need to write their own reviews first to see other people's ones to filter out commercial reviews and less reliable reviews. Along with those two guidelines, it has created not advertising but an information community that consumers can trust, having the great advantage of making it available for the consumers to buy their favorite products immediately after reviewing them.

However, the HWAHAE is still inconvenient in that consumers have to search for cosmetics one by one when purchasing them offline. Furthermore, it provides information on the harmful ingredients of cosmetics, which have been settled only by the labeling system of all ingredients carried out by the government and by groups such as Korean Dermatological Association and EWG(Environmental Working Group) of the U.S. nonprofit organization, so it does not tell users about harmful ingredients of cosmetics that are not suitable for each of them although their skin conditions are all different.

2) Evaluation of currently used devices for measuring the skin

2-1) Purpose of the survey

This study had a purpose to develop a service that can measure users' skin and help them to buy cosmetics that are effective on their skin. Devices that measure skin conditions are not popular now, but a service that analyzes skin conditions and then recommend cosmetics for the analysis result is being offered to consumers to sell specific company's cosmetics at several cosmetics shops.

2-2) Survey method

The measurement method is to select whether to use cosmetics or not first, to choose the type of cosmetics in use, worries about the skin, etc., to take a picture of the skin with the camera equipped with the device, and to measure moisture, elasticity, pores, freckles, and sensitivity. After that, it recommends the cosmetics suitable for the skin condition and sends the measured information to the users' cell phone by a text message. Town Watching performed the task of measure the skin of five graduate

students while asking them to visit the cosmetics store four times between the 15th and the 20th.

Figure 1 : Town watching. (Source: Gayoung Kang, 2018)

2-3) Results

The measurement results showed that measuring the skin only with the device was less accurate. In fact, all five subjects had different skin types from what they knew, the results also changed dramatically depending on the area to be measured, and the measured values changed greatly each time they visit, so recommended products also changed each time. As shown in Figure 2, the figure of freckles was 1 on September 15, but 68 on November 6. It exceeded the average value of 35 in about two months, confirming that the skin was in a very bad condition. Then, it was measured again after 13 days from the original measurement, and it appeared 32 slightly lower than the average value. It has been evaluated that the device alone was not sufficient to exactly measure the skin because it was confusing users' skin types. It was concluded that users are more likely to get more objective information about their skin if they use the device at the same time with self-survey and making data about their cosmetics after surveying themselves for their skin, such as cosmetics currently in use, etc.

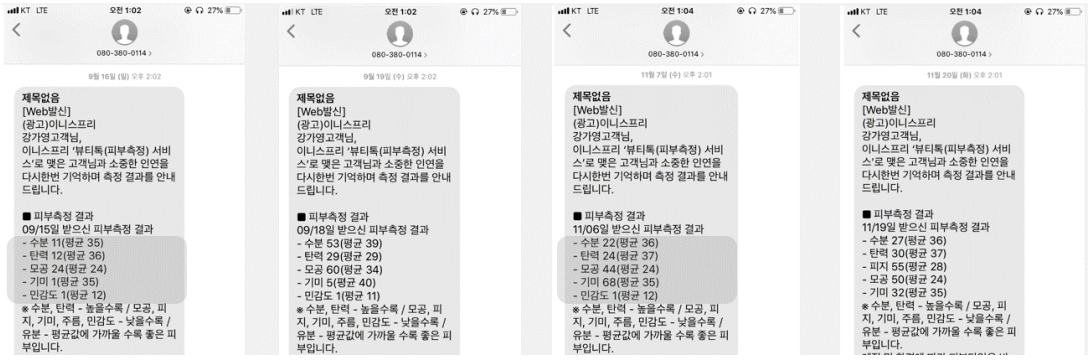


Figure 2 : Text messages sent for 'measurement results'

3) Online survey on cosmetics purchase by users

3-1) Purpose of the survey

It was intended to understand behaviors at the time of purchasing cosmetics for women in their 20s and 30s, who are skilled in using smartphones and applications, by analyzing the perception level of cosmetic ingredients, the importance of cosmetic ingredients, and the symptoms of using cosmetics that are not suitable for their skin.

3-2) Survey method

The questionnaire was created on Google, the gender of all subjects is female, and 51 people, including 30 people in their 20s and 21 people in their 30s, responded to the questionnaire. It consisted of 13 questions in total, including the understanding of their skin and propensity to purchase cosmetics(7 questions), the perception level of cosmetic ingredients(3 questions), and the experience of using cosmetics that do not fit their skin(3 questions).

Table 1 : List of questions in the online survey

Item	Question
Understanding of one's skin and propensity to purchase cosmetics	○ Do you think you know about your skin type well? ○ When you buy cosmetics, do you usually search for what you want to buy in advance? ○ How many fundamental cosmetics do you use? ○ Have you ever purchased cosmetics after being recommended by a sales staff? ○ If so, Did the cosmetics work for you? ○ Do you see the ingredients of cosmetics when you buy them? ○ How much do you usually spend on cosmetics each month? ○ Where do you buy cosmetics, offline and online?
Perception level of cosmetic ingredients	○ Do you now how cosmetic ingredients affect your skin? ○ Do you know what cosmetic ingredients are good or bad for your skin? ○ Do you use an application that analyses cosmetic ingredients? (or do you search for cosmetic ingredients?)
Experience of using cosmetics that are not suitable for one's skin	○ Have you ever been fooled by false advertising about cosmetics? ○ Have you ever had skin troubles or other skin problems when using cosmetics that are not suitable for your skin? ○ Do you have experience of throwing away or leaving cosmetics somewhere even though you used them a little after the purchase? ○ If yes, what did you do with the cosmetics?

3-3) Results

For the question of 'Do you think about your skin type well?', 45% of the respondents answered, 'I know it well', and on the other hand, 55% of them answered, 'I am not sure', meaning that their understanding of the skin was generally low. There were more people to search for the cosmetics in advance before the purchase. In addition, 85% of the respondents have ever purchased cosmetics after being recommended by a sales staff, but there were more people who answered, 'I am not sure about the effect of cosmetics on my skin that I bought by being recommended from sales staffs'. For the confirmation of all ingredients of cosmetics when purchasing them, there were 13.3% for Yes and 20% for Normal, confirming that the positive and negative responses were 33.3% and 66.7%, respectively. Based on the results of the in-depth interviews conducted after the online survey, it was confirmed that many people have purchased cosmetics due to the reviews and word-of-mouth of actual buyers, and advertisements, rather than confirmation of their all ingredients. In addition, the number of users knowing what cosmetic ingredients are good or bad for their skin was 40%, which was a low portion, and that of users knowing how cosmetic ingredients affect their skin was 45%, meaning that there were many people with a low perception of cosmetic ingredients. And, the number of users who have ever had skin troubles or other skin problems when using cosmetics that are not suitable for their skin was 80%, confirming that most of them have experienced them. In addition, 73.3% of users answered that they have ever been fooled by false advertising about cosmetics, showing that most of them have purchased the cosmetics while seeing the advertisements. Also, from an environmental point of view, 80% of users have had experiences of throwing away or leaving cosmetics somewhere even though they used the cosmetics a little after the purchase, meaning that the disposal rate of the contents and containers of the cosmetics is quite high. Users' perception of harmful ingredients was low, but most of them have had skin-related experience with cosmetic ingredients, such as stacking cosmetics somewhere by skin troubles or other skin problems due to their harmful ingredients, etc.

Table 2 : Responses to confirmation of ingredients of cosmetics

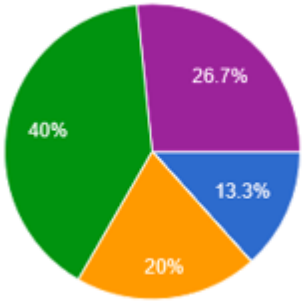
Do you see the ingredients of cosmetics when you buy them? (51 responses)		
	Very likely	13.3%
	Likely	0.0%
	Normal	20.0%
	Unlikely	40.0%
	Very unlikely	26.7%

Table 3 : Responses to the occurrence of troubles caused by cosmetics

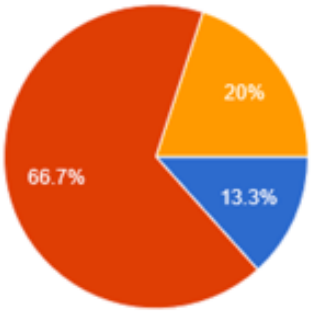
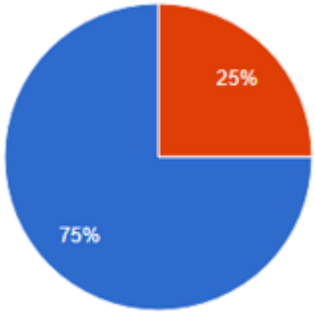
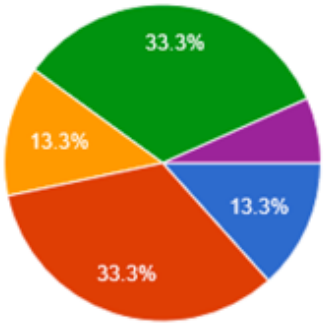
Have you ever had skin troubles or other skin problems when using cosmetics that are not suitable for your skin? (51 responses)		
	So often	13.3%
	Yes	66.7%
	Not really	20.0%

Table 4 : Responses to disposal of cosmetics

Do you have experience of throwing away or leaving cosmetics somewhere even though you used them a little after the purchase? (51 responses)		
	Yes	75%
	No	25%

In addition, with regard to monthly average cost for the purchase of cosmetics, there were 33% for 10 to 30 thousand won and 33% for 70 to 90 thousand won, which both were the same. Users who buy 10~30 thousand won worth of cosmetics each month mainly buy them at the road shops, and on the other hand, those who buy 70~90 thousand won worth of cosmetics each month mainly buy them at the department stores or skin care shops. These are the users who responded to the question 'Throw away cosmetics if they do not fit your skin' of the above-mentioned questions, indicating that they already spend a lot of money on cosmetics. There were also users who answered, 'I would like to find cosmetics suitable for my skin and then use only them to the end, rather a variety of cosmetics' in an in-depth interview after the online survey.

Table 5 : Responses to monthly average cost for the purchase of cosmetics

How much do you spend on cosmetics each month? (51 responses)		
	Less than 10 thousand won	13.3%
	10~30 thousand won	33.3%
	40~60 thousand won	13.3%
	70~90 thousand won	33.3%
	Over 100 thousand won	6.8%

4) In-depth interviews

4-1) Purpose of the survey

In order to refine a survey and understand users' exact needs, it analyzed their current awareness of cosmetic ingredients, skin care, the way they purchase the cosmetics, and difficulties and derived functions to meet their requirements by conducting in-depth interviews.

4-2) Survey method

In-depth interviews were carried out for each of five women in their 20s, who responded to the above questionnaire, during about one hour. The interviews began after explaining them enough in advance about what will be covered in the interviews, such as what devices and applications will be created, etc. To be as objective as possible, two graduate students and one professor selected interview questions that they thought were important. The survey was organized with the addition of the intensified questions shown in Table 1 and the survey results. It asked them various questions while focusing on the difficulties in purchasing cosmetics and then derived functions that meet their requirements.

4-3) Results

As a result of the interviews, all respondents said they rarely see all ingredients of cosmetics because they do not know what they mean by looking at them. They said it is not only time consuming to search one by one, but also difficult. They also said that they have ever bought the cosmetics after searching their ingredients, but eventually threw them away as they did not fit their skin conditions after use. In addition, they answered that when purchasing cosmetics, they usually found and then purchased the cosmetics that became famous through word-of-mouth, rather than looking at ingredients difficult for them to understand. So, there were many responses that I had been pooled by false advertising regarding cosmetics and then abandoned them due to skin troubles.

Also, some respondents said they felt uncomfortable because they did not know what cosmetics are appropriate for their skin, whether or not cosmetics are famous. The

cost of purchasing cosmetics was the largest among the criteria for selecting the cosmetics. All of the interviewees answered the monthly average cost for cosmetics was 70,000 to 100,000 won. In fact, some people answered that they have ever abandoned or put cosmetics on other parts of the body, except for the face, when they proved to be unsuitable for their skin, showing that cosmetic disposal is serious. In addition, in case of the response to the skin measuring device, it was able to find the needs of users who said they would be happy to be able to easily observe changes in their skin by constantly measuring their skin at home because it is actually wonderful and good to be able to know their skin type at cosmetic shops, but there are a lot of pressure for product recommendations from sales staffs, and time restrictions for them to visit the stores continuously.

Discussion, implication, and future research

Based on the above results, it was able to analyze the awareness of cosmetic ingredients, skin care, the way they purchase the cosmetics, and the resulting difficulties of women in their 20s and 30s. In fact, it has been more than 10 years since cosmetics sold on the market were prescribed by law to include all ingredients in containers. The purpose of the 'labeling system of all ingredients of cosmetics' is to allow consumers to choose the right cosmetics for their skin condition by displaying all the ingredients used in the manufacture of the cosmetics and to respond promptly with any side effects on their skin, but unfortunately, it is still not well utilized. The biggest problem, among the reasons for not confirming all ingredients of cosmetics, was the low readability and understanding of them. Therefore, it tried to create a device that can measure skin every day when consumers buy cosmetics and an application that can connect to it through the results of the above-mentioned literature review, questionnaires and in-depth interviews. The biggest function of the application is a service that helps intuitive purchasing of cosmetics suitable for consumers' skin through 'augmented reality'. It was intended to focus on the function.

The future research is to create a user scenario based on the above results, organize the menu according to the preliminary analysis results, design UI prototypes that meet consumers' needs, based on augmented reality and form the workflow diagram by combining the results obtained by understanding the usage by the user environment and the networks and technologies studied. Then, it has a plan to conduct a prototype evaluation by grouping the users who received the in-depth interviews conducted earlier after designing the UI prototypes.

It will suggest the final design with the supplemented prototype reflecting improvements in qualitative and quantitative assessments. Finally, this research will be done with the suggestion of significance and use possibility of the application and product that will help users purchase cosmetics that fit their skin intuitively, quickly and accurately while describing the conclusion and future task.

Conclusions

There is a growing international interest in reducing the amount of plastic that is discarded. The cosmetics industry is also actively promoting eco-friendly marketing, but it is practically impossible to lower the disposal rate of cosmetics. In addition, if the cosmetic is not suitable for the type of skin after purchasing it, it is left as it is and

eventually abandoned, which not only shortens the life cycle of the product, but also increases industrial wastes such as plastics.

In order to solve the problem, it aimed to conduct a study for increases in the replacement cycle of cosmetics as much as possible by making it available for users to accurately identity their own skin environment and choose the cosmetics suitable for them. The process should be carried out intuitively. It is because consumers do not want to purchase products while studying them inconveniently. If consumers have no choice but to connect to the Internet website with a computer as in the past, enter the ingredient information as keywords, and then check the alternative product one by one, it is undesirable because it actually means that they have to study to purchase a product that fit their needs.

This study aims to develop products focusing on the cosmetics purchase service based on the cosmetics market, which is attracting much attention now, and the usability of UI design of the application applying augmented reality that is rapidly emerging as a core technology. It also aimed to proceed with research on accurate skin diagnosis, big data, and appropriate purchase. First, users are required to measure their skin periodically with a device that can accurately diagnose the skin, and the measured data is transmitted to the application. The application measures how cosmetics are making changes to the skin. And, it determines which ingredients of cosmetics are suitable for each user through long-term accumulated data. This recommends cosmetics suitable for the user's skin for each type of them, ultimately increasing the success rate. The more users use the device and application, the more sophisticated it will be. Also, when they purchase products at the cosmetics store, it will be available to increase the purchase success rate intuitively and promptly with AR(Augmented Reality)-based cosmetics recommendation mode. In addition, this study will suggest methods to effectively offer a variety of information for the enhancement of the mobile application's technical usefulness.

Eventually, it is expected that it will realize a sustainable design that will help reduce the number of cosmetics discarded due to wrong choice of cosmetics and completely consume all purchased cosmetics and, thereby giving consumers economic advantages.

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