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QuaesitUM is a peer-reviewed annual publication that provides an academic forum where University of Memphis undergraduate students can showcase research from all disciplines.

Editorial Board

To Our Readers

Last year, we embarked on a mission to create a forum where undergraduate students across campus could publish their research and make it available to the campus community. The result was the inaugural issue of Quasitum (kwah-zee-toom), a multi-disciplinary endeavor showcasing research by students from a wide array of departments, including Chemistry, English, Engineering, History, Philosophy, and Political Science. The breadth of research represented in those papers reflects the exploration taking place across the University and aims to foster awareness of the type of research being done within the University community at large rather than focusing on only one department or college.

This second volume continues that endeavor, encapsulating the mission outlined in our name: Quaesitum (v. to think; to ask). The papers contained here represent the quality scholarly work that emerges from asking new questions and exploring new perspectives.

As we finalize this second volume, there are many people whose contributions were instrumental in its completion. First, I would like to offer my sincerest thanks to the Director of the Helen Hardin Honors Program, Dr. Melinda Jones and the Technical Editor, Mr. Baxter Buck. Their hard work and commitment to the project was pivotal in bringing it to fruition.

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Thanks also go to Dr. Gary Golightly for the cover design and layout and Assistant Vice President for Technology Transfer Dr. Kevin Boggs for funding the prizes for the best paper in each submission category.

We would also like to express our gratitude for the faculty sponsors who encouraged their students to submit their work. Without their encouragement, the students would not have begun the projects that are represented in this volume.

Finally, we would like to express our appreciation to the students themselves. It is difficult to submit your work for inspection and risk the possible criticism that that may bring. The students whose work appears in this volume, however, overcame that fear in order to allow their work to become part of the scholarly conversation that is the foundation of the academy. For that we offer our congratulations and thanks.

Dr. Sage Lambert Graham
Editor-in-Chief

Table of Contents

Humanities

Math, Computer, and Engineering Sciences

Social and Behavioral Sciences

Submission Process

Melissa Pankuch graduated Summa Cum Laude with University Honors with Thesis from the University of Memphis in May 2014, with a major in Art History and a minor in Theatre. Melissa currently attends the City College of New York in pursuit of a Master's Degree in Museum Studies. While completing her graduate studies, Melissa has pursued her passions for Egyptology, Museology, and Archaeology through internships with the Children's Museum of Manhattan, the Brooklyn Museum, and the Metropolitan Museum of New York. In her free time, Melissa is a volunteer for Past Preservers, a historical consultant agency, and the proud creator/writer of "Stories My Mummy Told Me," a blog dedicated to sharing the secrets and unraveling the mysteries of the Ancient Egyptian world.

Melissa Pankuch

The Royal Women of Armana: Faces of a Revolution

Faculty Sponsor
Dr. Chrystal Goudsouzian

Abstract

This paper examines the role of the royal women in the Amarna period and the necessity for a female presence in the Amarna religion. It analyzes the traditional Egyptian concept of duality and the myths regarding creation and rebirth, as well as the adaptations made to these myths, in particular the Heliopolitan cosmogony, during the Amarna revolution. Through the evaluation of the art mediums of sculptures and reliefs depicting Nefertiti, the minor queen Kiya, the daughters of Akhenaten and Nefertiti, and the entire royal family, it is clear that the female entity was essential to the acceptance and growth of the Amarna religion. The Amarna religion elevated the role of the royal woman from a pharaoh's counterpart to the living embodiment of a deity, aiding in the subjugation of chaos and supporting the creation and rebirth myths understood by the citizens of ancient Egypt.

Introduction

When delving into an investigation of ancient Egypt, the religion of this civilization is a topic that has fascinated historians, and the world, for centuries. From the pantheon of gods to an intense focus on the afterlife, the religion of ancient Egypt has immense intrigue, and its unique, almost equal roles for women and men within religion, creation, and rebirth present a concept not often seen in a religious context. From an analysis of the creation myths of ancient Egypt, it is clear that both the concepts of birth and rebirth are core principals of the religion. In addition, the concepts of duality seen within these creation myths not only express the formation of the world, but reveal the importance of both male and female power to maintain the balance of the world, promote order, and subjugate chaos.

The traditional religion of ancient Egypt was tightly woven into day-to-day life, making it essentially impossible to identify oneself as a non-religious Egyptian. As observed by Emily Teeter and Douglas Brewer, practically every aspect of Egyptian culture and civilization, including astronomy, medicine, geography, art, and civil law are manifestations of religious belief.[1] These aspects of culture and civilization, no matter how large or small, had an overlying deity, creating a polytheistic structure best identified by R. J. Spencer in two categories, "The Great Tradition" and the "Little Tradition."[2] The "Great Tradition" included aspects of religion such as creation myths, the concept of rebirth, the subjugation of chaos, etc., while the "Little Tradition" included tasks of daily life and individual academic disciplines. The fact that tasks ranging from baking bread to worshiping the gods were categorized as either the "Great Tradition" or the "Little Tradition," makes it clear that most aspects of the Egyptian religion can be tied to the Egyptian's interpretation of their environment.[3]

As the environment of the ancient Egyptians widened with the implementation of new technologies, interactions with foreign civilizations,and the refinement of Egyptian law, their religion began to encom

[1] J. Douglas and Emily, *Egypt and the Egyptians* (Cambridge: Cambridge University Press, 1999), 6.

[2] C.J. Bleeker, *The Rainbow: A Collection of Stories in the Science of Religion* (Leiden: Brill, 1975), 113.

[3] Douglas and Teeter, 6.

pass newer concepts and ideas. During the reign of Amenhotep IV/Akhenaten, religious focus shifted entirely from the standard, polytheistic worship of the gods to a worship of the Aten. In the Aten religion, the role of royal women was elevated, past the traditional female counterpart of the pharaoh to an essential female counter part to the Aten; a necessity to the creation and continued prosperity of the world. Nefertiti, Akhenaten's wife, was a strong supporter and performer within the Aten religion, but it is not solely through her efforts that women gained such a pivotal role in the Amarna period.

A unique female religious role was developed, creating a counter-part for the great Aten and Pharaoh Akhenaten in order to fulfill the needs of the religion. In contrast to the queen being a female counterpart to the pharaoh and fulfilling the Egyptian need for duality in leadership, the role of the queen was promoted the manifestation of a living deity on Earth. Through the investigation of the portrayal of all royal women of Amarna, this paper uncovers the true, definitive role of women within the Amarna religion, and how a strong female presence of any form, not simply Nefertiti, was necessary to fulfill the traditional concepts of duality, rebirth, and femininity that were merged into the Aten religion.

Creation Myths in Egyptian Religion

Before analyzing the role of women in the Aten religion, it is vital to understand the founding principles of the traditional ancient Egyptian religion, and the roles and rights of women within it. Perhaps the most pertinent of these is the idea of duality. As previously mentioned, the citizens of ancient Egypt lived based on "a relationship to a series of oppositions." [4]

All of Egyptian society was structured around pairs of complimentary entities. This juxtaposition is seen at the very basics of Egyptian thought, from geographical division into Upper vs. Lower Egypt (and the separation of the government of each), to language consisting of the ideas of ntt "what is" [6] and jwtt[7] "what is not." [8] In its most basic form, duality

[4] Lana Troy, *Patterns of Queenship in Ancient Egyptian Myth and History* (Uppsalal: [Universitetet] 14, 1986.), 7.

[5] Frédéric Servajean, "Duality," *UCLA Encyclopedia of Egyptology* (Los Angeles, 2008) 3.

[6] Raymond Faulkner, *A Concise Dictionary of Middle Egyptian* (Oxford Griffith Institute, 1962), 142.

[7] Ibid, 114.

[8] Servajean, 2.

can be seen in the idea of male and female. In order for the world to be created and to continue to create/be reborn, both male and female entitiesare necessary. In order to express these oppositions that surrounded their environment, the people of ancient Egypt formulated creation andresurrection myths that indicated the need for both these male and female beings. Whether the myth contains an androgynous deity or a pair, the interaction of male and female is a prerequisite for creation/recreation. In this sense, the royal women of the traditional Egyptian religion stood as the female counterparts to the pharaoh, the descendant of Horus and the creator himself.

The most popular of the creation myths was derived from the Heliopolitan Cosmogony, whose foundations lie in the Old Kingdom period. This cosmogony begins with the Nun, the primordial ocean that represent unorganized chaos and nothingness;[9] a lake of both chaos and darkness.[10]According to Utterance 527 of the pyramid texts,

> Atum is he who (once came into being)[11], who masturbated in ON. He took his phallus in his grasp that he might create orgasm by means of it, and so were born the twins Shu and Tefnet. May they put the king between them and set him before the gods in front of the Field of Offerings.[12]

Atum, in this case, exemplifies the combination of opposing genders by not only claiming he is both male and female,[13] but also in his creation of the first two divinities, Shu (male, air) and Tefnut (female, humidity).[14] This thought continues in the procreation of the rest of the founding gods and goddesses, each being born under the jurisdiction of gender duality.

The need for gender opposition in the creation myth not only illustrates the requirement of both genders for creation purposes, but also gives a glimpse into the pivotal role that royal women played as the symbolic

[9] Alexandre Moret, *The Nile and Egyptian Civilization* (London: Routledge and Kegan, 1927), 374.

[10] Nicholas Grimal. *A History of Ancient Egypt*. Translated by Ian Shaw, (Oxford: Blackwell Publishers, 1992,) 265.

[11] El-Sayed el-Aswad, "Archaic Egyptian Cosmology" *Anthropos Institute* (Anthropos, Bd. 92, H. 1./3. 1997,) 70

[12] Raymond Faulkner *The Ancient Egyptian Pyramid Texts* (Oxford: Clarendon Press, 1969), 194.

[13] De Buck 1929, *The Egyptian Coffin Texts Volume 2: Texts of Spells* 76-163, OIP 49. Coffin Texts spell II, 161a.

[14] Servajean, 3.

embodiment of their divine counterparts. Beginning with Atum, the Heliopolitan cosmogony continues with separate male and female children born as complements to one another until the arrival of the Pharaoh, a direct descendant of the creator god. However, in order to continue the genetic line of Atum, the pharaoh must have a female companion, and the royal queen fulfills this role. Therefore, the royal women of the standard Egyptian religion are held in high esteem, for they are half of the reason the divine, royal line can be continued and provide an integral part of the balance of the cosmos for the ancient Egyptians.

The pharaoh, and by association, the royal women of Egypt, had a responsibility to continue the genetic line of the divine through creation, giving them immense power, status, and responsibility to all of Egypt. The Pharaoh and his female counterpart, moreover, were critical to the development Amarna religion because they were more relatable to the common man and his environment, making gender distinction necessary. Yet this distinction only enhances the respect and power given to royal women, because without them, the continuation of the creation cycle of divine kings would be halted.

Analysis of Rebirth Myths in Traditional Egyptian Religion

A second category of myth in the traditional Egyptian religion, the cycle of rebirth further solidifies the importance of the royal female relationship with the creator. It is clear that the purpose of this royal feminine prototype is to generate new life, and to provide the renewal of life force in the family context, not only propagating the line, but also resurrecting it if necessary.[15] In the Osiris myth of rebirth, this role of the female entity becomes most clear. This myth is the continuance of the Heliopolitan cosmogony, and tells the story of Osiris and Isis, who rule alongside their siblings Seth and Nepthys.[16] Seth became jealous of the power Osiris had, and killed his brother, cutting his body into many pieces and distributing them throughout Egypt. Isis set out to find all the pieces of Osiris' body and with the help of Nepthys, collected all the parts. Once reassembled, Isis breathed life into his body, resurrecting him, and they were together again. Isis became pregnant soon after, giving birth to Horus the hawk-

[15] Troy, 50.

[16] Steven Snape, *Ancient Egyptian Tombs: The Culture of Life and Death* (West Sussex, Blackwell Publishing, 2011,) 8.

god, and Osiris descended into the underworld, becoming lord.[17] This story attests to the truly essential role of the royal woman in the traditional Egyptian religion. Here, Isis claims the title as immediate protector of the divine king, collecting Osiris' body parts, ensuring his return and the continuation of his genetic line.

Through the analysis of the mythology of the standard Egyptian religion, it is clear that the royal women held a great position in the religion of the period. Troy encapsulates the reasoning for women's presence in these myths, claiming that:

> The expressions of the mythic pattern have three basic functions in the life of man. They convey to him the principles of the organization of the cosmos. They describe the relationship between his own life and that organization. And finally they show him how to participate in the powers inherent in that organization." [18]

At its true essence, the royal women of traditional Egyptian religion fulfilled the inner need of ancient Egyptians to utilize duality and myth, to understand the role they played, and be able to interpret the royal women as the embodiment of the divine women of the creation and rebirth myths. Thus, the citizens of ancient Egypt understood through these myths that a female entity is vital to the perseverance, continuance, and success of Egypt, and that the royal women of the time represented the continuance of their success as a world power.

Overview of Amarna Religion

With the revolution that was the Amarna, Akhenaten brought about an attempt to replace the polytheistic concepts of traditional religion with a "sole god, with no other except him." [19]: a new "solar theology" [21] - with the reign of Amenhotep IV. At some point between Year 8 and Year 12 of Amenhotep IV's reign, this sun-god gained sole supreme status, the names of past gods, and the term 'gods' itself were erased from all monuments.[21] This year span also marks the period in which Akhenaten reframes the

[17] Bettina Knapp, "The Archetypal Woman Fulfilled: Isis, Harmony of Flesh/Spirit/Logos." *Symposium* 50.1 (1996), 28.

[18] Troy, 7.

[19] Maj Sandman, T*exts from the Time of Akhenaten: Bibliotheca Aegyptiaca 8* (Brussels: 1938,) p.9.

[20] Jan Assman *Ägypten. Theologie und Frömmigkeit einer frühen Hochkultur. Kholhammer* Urban-Taschenbucher 366 (Stuttgart: 1984) pp.235-4.

[21] Ibid., Allen 4.

name of his god, from Re-Horakhty to Sun, ruler of the Akhet "who becomes active from the Akhet in his identity as the light that comes in the sun disk." [22] This distinction in word choice in the translation of the name of his god proves that Akhenaten's true religious focus was on light itself, and disregarded the previous views on duality with the dark.

Another important aspect of the Amarna religion that distinguishes it from the previous tradition is the focus on the present. Akhenaten maintained a strong hold on his seemingly "open" religion. He, along with Nefertiti, were the sole intercessors for the citizens of Egypt to speak to their Aten; stating strictly in texts that "there is no other who knows you except your Nefer-kheperu- re wa-en-re (Akhenaten)." [23] The people were meant to worship Akhenaten and Nefertiti, since "everyone that hurries on foot… you sustain them for your son…Akhenaten…and the chief queen, his beloved." [24] Through these texts, it is clear that Nefertiti, as well as Akhenaten, had the highest status and most power, forging a new and incredibly high role for a royal woman.

Analysis of Creation Myths in Amarna Religion

In this intercessor-sole god relationship that was promoted through the Amarna religion, it became the responsibility of Akhenaten and Nefertiti to modify the old Egyptian religious and "mysterious" concepts into ideas that aligned with their present- focused, single god state of mind. While a shift away from the traditional ancient focus on duality could potentially undermine the power and influence of women within the new religion, the concept of duality was still consistently represented in the traditional Egyptian The Aten is, in a well-known hymn, identified as an androgynous being, standing as both "father" and "mother" of his creation.[25] This identity as both mother and father is not often mentioned within textual sources, but can be seen in the images of Amarna. In particular reliefs from the rock cut tombs of Amarna (Fig. I)[26] the hand of Nefertiti functions as the consort of the Aten, taking on the role of female consort.[27]

[22] Ibid.

[23] Ibid., Sandman, 95, 1. 16.

[24] Ibid., 96.

[25] Ibid., Sandman, 15.

[26] Davies, Norman de Garis, and Seymour de Ricci. *The Rock Tombs of el Amarna*. (London: Sold at the Office of the Egypt Exploration Fund 1905.) See note 35.

[27] Ibid., Troy, 21.

With the Aten's male form manifested in the rays of the sun, the "ultimate creator" forms his children, Akhenaten and Nefertiti. This myth allows the royal couple to be divinely tied to the Aten, and the only gods outside of the Aten. Further, it allows the royal female figure to not only become a part of the creation myth itself, giving her ultimate power, but a life source for the continuance of the world.

With regards to reliability, the citizens of Egypt were not simply able to connect this idea of creation to their present environment; the world began with Akhenaten and Nefertiti, their present rulers, and the concepts of this creation could easily be understood. However its deterrence from the mythical, mysterious ideas of the traditional religion created confusion and potential failure of the religion, due to the citizens "lacking of such romantic hindsight…only viewing Amarna theology in the context of their own religious traditions." [28] The "limitations" created by the lack of creativity in the citizens of Egypt gave Akhenaten no choice but to utilize a mythic structure that was familiar to them.

Analysis of Rebirth Myths in Amarna Religion

The quick formation of the Amarna religion is exemplified in the lack of depth in the myths of rebirth, arguably the most important aspect of the life for an ancient Egyptian. With his strong aversion to the traditional pantheon, Akhenaten essentially eliminated the entire myth of rebirth, and the importance of Isis (and the role of royal woman) within it. In its place, Akhenaten provided a ritual much like tradition, including mummification, canopic jars, and the deposit of grave goods.[29] Yet in the place of an eternal life in the realm of the gods, Akhenaten provides an empty void; a place untouched with the light of the Aten.[30] Eliminating the female role in rebirth completely, the afterlife revolved solely around the king, the dispenser of life after death:

> May your corpse be firm, may your name last…May you inhale the breezes of the north wind. May you be given offerings and provisions, and may you revive-sacrificial food which is the king's to give [with] bread, beer, and food in every place of yours…May you occupy your place which is the king's to given in the necropolis of Akhet-Aten [Tell el Amarna.][31]

[28] Allen, *The Religion of Amarna*., 3.

[29] Cyril Aldred, *Akhenaten, Pharaoh of Egypt*. (New York: Thames and Hudson, 1988.), 234.

[30] Ibid. Brewer and Teeter, 190.

[31] Kelly Simpson, *The Literature of Ancient Egypt*. (New Haven: Yale University Press, 1973.), 13.

This is further exemplified in the tomb of Kiya, who much more poetically calls on her lover to take care of her in the afterlife:

> May I breathe the sweet air that issues from thy mouth. May I behold thy beauty every day—that is my prayer. May I hear thy sweet voice in the North wind. May my body grow vigorous with life through thy love. Mayest though give me thy two hands bearing thy sustenance, and I receive it and live by it. Mayest thou ever call upon my name and it shall not fail on thy lips.[32]

In the royal tomb of Amarna, the instructions to the citizens of Egypt are clear:

> Worship the king, unique like Aten, without another who is great except for him, and he will give you a lifetime of tranquility with food and provisions which are his to give. How prosperous is one who carries out his teachings, for he shall reach the district of the favored ones [the necropolis].[33]

This instruction intentionally omits not only the female aspect of rebirth, but any other deity, proving that Akhenaten was the only being on earth that could grant eternal life due to his qualities that were "unique like Aten." However, even with this elimination of the female role in myths of rebirth that Akhenaten implemented during Amarna revolution, he has to maintain the female presence in the creation myth and balance of the universe; through Nefertiti's role as an intercessor for the Egyptian people, she is showered with admiration and love, and therefore becomes an essential asset in convincing the Egyptian people that the Aten was the new and true power, with foundations not much different from the traditional pantheon of the gods they had once worshipped. Nefertiti was an outlet for the citizens of Egypt to worship and achieve the favor of the king, implying that although she may not have had a direct mythical connection to the afterlife in the Amarna religion, Nefertiti's favor was essential to the rebirth of an Egyptian citizen.

The single deity basis of the Amarna religion dealt a huge blow to the citizens accustomed to the polytheistic beliefs of ancient Egypt, and reduced the power of his female citizens through his adaptations on traditional myth, yet Akhenaten could not undermine the importance of a female higher-power. His maintenance of the concepts of duality (seen in his reliance upon Nefertiti), the reformation of the traditional Heliopolitan Ennead to include light, and conformity of his family to the traditional

[32] Ibid., Aldred, 247.

[33] Davies, Norman de Garis, and Seymour de Ricci. *The Rock Tombs of el Amarna*. (London: Sold at the Office of the Egypt Exploration Fund 1905.) See note 35.

myth are all symbols of Akhenaten's acknowledgement of the importance of women in religious power. The persistence and elevation of royal females' importance through the Amarna period proves that royal women could not only be viewed as an essential component to the continuance of the royal lineage, but to the continuance and prosperity of the world; in Amarna, women stand as ultimate creators.

Artistic Analysis

Nefertiti: Divine Queen

The vital presence of the royal females of the Amarna period as symbols of creation, rebirth, and duality is promoted significantly through the artistic works of the Amarna period and most significantly in the artistic representations of Queen Nefertiti. Nefertiti is known as one of the strongest women in the history of Ancient Egypt; her representations within the art of Amarna not only reveal her political power and prestige during the Amarna revolution, but the vital nature of a female entity of power in the Amarna religion. As seen in the creation myths within and outside of the Amarna religion, the female and male deities are equally responsible for the formation of the world. The Aten, defined as a male being, has no direct female consort, much like the creator god Amun.[34]

As previously discussed, Aten is the direct father of Nefertiti and Amun, giving them a divine lineage. One clear representation of Nefertiti's divine status is a Fragment from Akhenaten's sarcophagus from the Royal Tomb at Amarna. This particular fragment is from the corner of the sarcophagus, illustrating a woman, arms outstretched and wearing an elaborate headdress, accompanied by the rays of a sun,[36] and a section of text in both sunken and unusually high relief. Through the collection of fragments from the sarcophagus of Akhenaten, inscriptions have been translated which identify the female figure as Nefertiti.[37] The iconographic tradition of women with outstretched arms on the corner of a sarcophagus is prominent in the post-Amarna period, with its foundation coming

[34] See Note 35.

[35] Geoffrey Thorndike Martin, T*he Royal Tomb at el-'Amarna*. (London: Egypt Exploration Society, 1974.), 15-16.

[36] Not depicted in this fragment, but confirmed from other fragments of the sarcophagus at the Egyptian museum in Cairo.

[37] Ibid., Martin, 6-9.

from the sarcophagus of Akhenaten itself. On other sarcophagi with these female forms, the corner figures are reserved for the four goddesses and divine protectors of the dead: Nepthys, Neith, Isis, and Selket.[38] Therefore, the representation of Nefertiti within this revered space adds the title of Goddess to her repertoire, and places her as the only person other than Akhenaten who could play the role of intercessor with the Aten.

However, this elevation of Nefertiti to the rank of goddess is not universally accepted. L. Green has most recently argued that many of the iconographical attributes that are seen in representations of Nefertiti are intended to convince the viewer of her role of divine pharaoh being shared with Akhenaten, not giving her individual divinity.[39] In a society such as Ancient Egypt, where there was no line of separation for the worldly and the divine, any figure, animal, or even object could represent a god, without being an identical entity.[40] The clarification of whether Nefertiti represented a shared or individual divine being is unnecessary in this paper; in either instance, this representation of Nefertiti (or any female deity) on Akhenaten's sarcophagus, his vessel to the afterlife, proves that a female presence was vital and a necessity in the process of rebirth in the Amarna period.

In both the traditional Egyptian and Amarna religions, the concept of duality is necessary in the cosmic power of the gods, and Nefertiti is the prime example of this female entity. With representations such as the sarcophagus of Akhenaten that include images of Nefertiti in a divine nature, it is acknowledged that she, as deity and human, can stand as a consort to the male ruler or a male god. This is illustrated in a depiction of the royal family under a baldachin found in the tomb of the Overseer of the Royal Quarters, Meryre, at Amarna.[41] At first glance, it is easy to interpret the image as one of a single figure. Upon further investigation, it is clear from the multiplied foot outlines that the large seated figure is actually two, representing both Akhenaten and Nefertiti. According to Dorothea Arnold, this visual technique is utilized so the viewer interprets the royal couple as twins, with the figures sharing the palanquin to the festival grounds,

[38] John Wilson, "Akh-en-Aton and Nefert-iti" *Journal of Near Eastern Studies*. 32 (January-April 1973. 235-41.

[39] L. Green "Queen as Goddess: The Religious Role of Royal Women the Late Eighteenth Dynasty." *The Amarna Letters*. 2 (San Francisco: 1992) 28-41.

[40]Cyril Aldred, *The Royal Women of Amarna: Images of Beauty from Ancient Egypt*. (New York: The Metropolitan Museum of Art, 1996.), 96.

[41] Drawing by Norman de Garis Davis, 1903.

indicating their religious status as children of the divine. The depiction of the throne also represents the forum where they would receive representatives from foreign countries, illustrating their political power.[42]

This image is unique in the fact that Nefertiti is named, but the twin iconography deems it impossible to identify her by physical characteristics. This unidentifiable form helps promote the idea of duality that was familiar to Egyptians. The illustration of the royal family at the tomb of Meryre at Amarna proves that it is not solely because of her power and presence that Nefertiti held such a prominent role in the Amarna religion, but the responsibility to fulfill the concept of duality; that in order for the subjugation of chaos to occur, the dual nature of the Aten (and Akhenaten respectively) had to be counteracted with a female form, held most prominently by Nefertiti.

Minor Queen Kiya: A Major Player in Amarna Religion

Although Nefertiti was the most prominent royal women in the Amarna period, she was not the only royal female to be represented in a way that complimented Akhenaten and fulfilled the needs of the Amarna religion within the concepts of duality, creation, and rebirth.[43] One such royal female figure is the minor queen Kiya, titled as "the wife and great beloved of the King of Upper and Lower Egypt" on artifacts within the British and Metropolitan Museum.[44] Her name was eradicated from monuments in the last years of Akhenaten's reign (and replaced with the name of a daughter of Nefertiti, either Meretaten or Ankhesenpaaten), and to this day her exact position and disappearance from the Amarna court remain a mystery to scholars.[45]

Through one particular artifact, it is clear that Kiya was not simply a consort of Akhenaten, but had enough importance to be represented in the same positions as the divine queen Nefertiti. In a fragment from Hermopolis found in Copenhagen,[46] a female figure identified as minor queen Kiya is shown represented in a form identical to the relief in the tomb of

[42] Ibid., Arnold *Royal Women of Amarna*., Fig. 78, 88.

[43] Ibid, 105.

[44] William Murnane, *Texts from the Amarna Period in Egypt*. (Atlanta: Scholars Press, 1995.), 90.

[45] Rainer Hanke, *Amarna-Reliefs aus Hermopolis: Neue Veroffentlichungen und Studien*. (Hildesheim: 1978.), 188-96.

[46] Ibid., Aldred, *The Royal Women of Amarna*., 88.

the Overseer of the Royal Quarters, Meryre, at Amarna.[47] Although this image is highly damaged, it is clear that Kiya is given the same "divine twin" status as Nefertiti. There is no evidence that Kiya maintained power within the Amarna religion equal to Nefertiti, but this image does endorse the argument that Nefertiti does not have her strong religious and political power because of her personal intelligence or importance, but for the more basic fact that she is a female entity who is necessary to create duality. The personal identity did not matter, Nefertiti, Kiya, or one of Akhenaten's daughters; all that was necessary was a female counterpart.

A second artifact that promotes the importance of a female in the Amarna religion is a relief showing the purification of the minor queen Kiya, which was also changed at a later date to be a relief of Princess Meretaten.[48] This relief from the Metropolitan Museum represents Kiya in a purification scene, with the zigzag lines incised around her representing water being poured over her head. From small details of the relief around the portrait image of Kiya remain, the overall image can be hypothesized as an altar-offering scene. The direction of the ray hands of the Aten as well as an unidentified curved object (sometimes identified as the neck of a duck)[49] are best explained if the viewer interprets this fragment as Kiya standing in front of an altar or offering table, presenting gifts to the diety.[50] In either case, Kiya is performing a respected priestly function, an honor not bestowed on many citizens of Egypt, let alone women of Amarna. Yet this task is bestowed upon Kiya, as well as examples illustrating Nefertiti and the daughters of Nefertiti and Akhenaten, performing similar tasks, proving that the royal women of Amarna were given superior priority and responsibility within the religion.

Daughters of the Royal Couple: Promises of the Future

These two queens of the Amarna revolution clearly indicate the importance of a female deity within the religion, but the artists of Amarna solidify these ideas through their interpretations of the daughters of Nefertiti and Akhenaten. One of the most controversial artistic qualities of the art

[47] James Allen, "Akhenaten's 'Mystery' Coregent and Successor." *Amarna Letters*. 1 (San Francisco: 1991.), 74-85.

[48] Ibid., Aldred, *Royal Women of Amarna*., 106.

[49] Ibid.

[50] Ibid., Hanke, 128-129.

of Amarna, and in particular the royal family, are the egg-like heads that are illustrated in relief and sculpture. In particular, the heads of princesses found in the Agyptisches Museum of Berlin are prime examples of these bare, egg-shaped heads included in this discourse.[51] Ricardo Caminos ties this egg- shaped cranium to the Hermopolitan cosmogony, replacing the symbol of the lotus flower with an egg, which hatched to birth the sun-god Ra.[52] As previously discussed, the Amarna religion has its own interpretation of the creation myths, but none such as a lotus flower or an egg. However, in The Great Hymn to Aten, we are provided with a description of a chick hatching from an egg as an allegory to the divine origin of life:

> When the chick is in the egg, speaking in the shell, you [Aten] give him breath within it to cause him to live; and when you have made his appointed time for him, so that he may break himself out of the egg he comes out of the egg to speak at his appointed time and goes on his two legs when he comes out of it [the egg].[53]

These egg-shaped heads are most likely the Thutmose artists paying homage to this creation myth. In the context of Amarna creation myth, the daughters of Akhenaten played the important role of the symbolic children of Shu and Tefnut (represented through Akhenaten and Nefertiti), embodying the "Seed/egg" of creation placed by Aten as the creator of all things.[54]

A relief from Hermopolis with two princesses, a fragment of which is displayed at The Metropolitan Museum of Art, illustrates both the vulnerability of youth and the promise of eternal life.[55] In this relief, the two princesses are turned towards each other, an attribute that both isolates them from the rest of the image, but also creates the idea that these princesses, gazing at each other, are not personally involved in the action happening within the rest of the scene.[56] As Dorothy Aldred discovered, these princesses are characterized as belonging to a world of youth and beauty, which is not only treasured by society, but is also an indicator of what they all will return to in the next life.[57] It may have been that Akhenaten utilized

[51] Ibid., Aldred, *Royal Women of Amarna*., 54.

[52] See note 35.

[53] Ibid., Murnane, 114.

[54] Ibid., Aldred, *Royal Women of Amarna*., 108.

[55] Ibid., Aldred, *Royal Women of Amarna*., Fig. 111.

[56] Ibid., 114.

[57] Ibid.

his beloved daughters in artistic relief to remind the people of Amarna that the only way they would be able to return to this state of youth and beauty was through the worship of him and the Aten. As the sole judge of the next life, Akhenaten held all of the power, and these representations of his daughters may have served as a reminder and inspiration to continue worship of the Aten/Akhenaten in order to achieve the ultimate afterlife.

Specifically for Akhenaten's daughters Meretaten and Ankhesenpaaten, the symbols of youth and the divine power of Akhenaten were not the only benefits they were given. After Kiya left the Amarna court, her images were struck out and replaced by one of these two princesses. A relief of Kiya from Hermopolis[58] is a prime example of an image of Kiya superimposed with the qualities of a princess, in this case Princess Meretaten. In the two columns of texts to the right of the figure, there are two legible lines of text. The first (clearer) inscription indicates the figure is "daughter of the king of his flesh, his beloved... Meretaten." The second, more difficult inscription reveals that the figure used to be "the wife and [great] beloved of the King of Upper and Lower Egypt, who lives on [Maat]", which is known to be the beginning of Kiya's titulary.[59] The depiction of her hair indicates the identity switch; originally a Nubian wig, the hair was modified by an added layer of plaster to be transformed into a broad side lock that signified the figure was a princess.[60]

This change from Kiya to Meretaten does not simply signify the decline of Kiya's favor with Akhenaten and the court of Amarna. It is speculated that perhaps this re-appropriation illustrates the death of family members from a plague that may have struck Egypt.[61] No matter the exact reason for Kiya's descent from the king's favor, this re-appropriation of images occurred around the time of Nefertiti's controversial elevation to the role of coregent.[62] With this promotion, the role of the Great Royal Wife would be empty. Within the religion of Amarna, this role would be vital to the fulfillment of the concepts of duality. A co-regency between Akhenaten and Nefertiti, making one being, both male and female, would

[58] Ibid., 105.

[59] Ibid., Hanke 140.

[60] Ibd. Figs. 60, 61: B 1-4.

[61] Rita Freed, *Pharaohs of the Sun: Akhenaten, Nefertiti, Tuthankamun*. (Boston: Museum of Fine Arts in Association with Bulfinch Press, 1999.), 3.

[62] Ibid.

give the earthly, pharaoh-king a female counterpart. With Akhenaten and Nefertiti both potentially holding the role of pharaoh, Nefertiti's appropriation of divine androgynous role (alongside Akhenaten) would off-balance the concept of mythic duality; the role of Great Royal Wife would have to be filled to continue the divine myths and allow the citizens of Egypt to understand the new religion due to the traditional duality between gods and goddesses in both creation and rebirth myths.

These representations of the daughters of Akhenaten and Nefertiti represent not only the continuance of the divine line, created directly from the Aten, but the promise of eternal life given through Akhenaten's omnipotent power. Furthermore, the daughters of Akhenaten and Nefertiti stand as symbols of fertility, not only for the king and the continuance of his family, but representing the great "fruit" that is given unto the people of Egypt under the reign of Akhenaten. The abundance of children represent the fertility of the Nile, giving the citizens of Egypt better crops, and through that greater wealth and quality of life. His daughters are living examples of his creative power, the fertility he provides, and their constant presence in the art of Amarna is yet other way of the Amarna artists to connect the new Aten religion to the environment in which the people of Egypt inhabit.

The Royal Family: Myth Come to Life

Another vital component to be considered are the images of the royal family as a whole. Perhaps one of the most popular depictions of the royal family in its entirety is the Berlin Stela, from the early phase of Amarna relief art.[63] The Berlin stela serves as a physical reminder of the creation myth according to the Amarna cosmogony. The stela shows triad illustrated through Atum and his children, Shu and Tefnut.[64] As previously stated, the roles of Atum, Shu and Tefnut were recast during the Amarna revolution, and the triad exemplified within the Berlin stela illustrate the Aten, Nefertiti, and Akhenaten as the divine triad of creation.

A shocking attribute found in the Berlin stela are the pointing fingers of the princess who sits upon the lap of Nefertiti. Most representations that illustrate children pointing are found in fishing and fowling

[63] Ibid., Aldred, *Royal Women of Amarna*., Fig. 88, 98.

[64] See note 35.

scenes.[65] The pointed finger was interpreted as a magical gesture utilized to divert evil, often used when herdsmen were crossing a canal known to have crocodiles or when a calf was being born.[66] In the same way, this image of the princess, a divine being, pointing to Akhenaten who embraces one of his children, provides protection for those created from Akhenaten, and therefore created by the Aten.[67]

Within this image, the royal women play copious roles. Most fundamentally, Nefertiti stands as the divine female counterpart to Akhenaten, because of who the world and all within it are created. She is the beginning of all Egyptian creation, and serves as an intercessor for the citizens of Egypt. Furthermore, the princesses not only illustrate the great quantity of life that has been formed because of these two divine figures and the ultimate Aten, but serve as a symbol of protection over those created by the divine triad, and a reminder of the only living figures able to connect with the Aten, passing judgment for the afterlife.

Analysis and Conclusion

The art of Amarna clearly exemplifies the crucial importance on Akhenaten's female relatives and consorts on a personal level, but it is not the main reason for their elevated role within the Amarna revolution; the female presence was a necessity to the basic structure of the Amarna faith and logic.[68] The ancient Egyptian's perceived their reality in terms of oppositions. The complimentary nature of Upper and Lower Egypt, birth and rebirth and the ebb and flow of the Nile are all essential to ancient Egyptian logic and thinking.[69] With this interpretation of the world through oppositions, it is no wonder that Akhenaten chose to raise that status of royal female women and incorporate them in to the most elite levels of his religion and society. His adaption to the Heliopolitan creation myth to incorporate the Aten as well as his entire lineage not only exemplifies his promotion of his divine origin, but his acceptance of the importance of duality with the Aten religion. Without the female counterpart, he cannot

[65] Gay Robins, *Women in Ancient Egypt.* (Cambridge, Mass.: Harvard University Press, 1993.), 185-186.

[66] Geraldine Pinch, *Magic in Ancient Egypt*. (Austin: University of Texas Press, 1994.), 59-60, 121.

[67] Ibid., Aldred, *The Royal Women of Amarna*., 100.

[68] Ibid., Aldred, *Royal Women of Amarna*., 118.

[69] Ibid., Troy *Patterns of Queenship*, 7.

truly fulfill the creation myth and maintain his power.[70]

Although his interpretation of the myth of rebirth implies that only he is the sole judge of who may join the Aten in the afterlife, Nefertiti is promoted to the role of co- intercessor with Akhenaten. As seen in the relief in the tomb of Meryre,[71] Akhenaten and Nefertiti are illustrated as a merged entity, representing the primeval twins Shu and Tefnut.[72] This representation gives Nefertiti equal divine power to Akhenaten, and reveals her high status as a component of the creation myth, the continuer of the divine line, and the only other intercessor to the Aten.

However, Nefertiti is not the only royal female within the Amarna period to be elevated to such a high status. Through reliefs such as the fragment from the Metropolitan Museum, Kiya is also seen as a women with a particularly high status within the Amarna revolution.[73] The analysis of this particular art of Amarna exemplifies the true nature of the prominence of femininity under the rule of Akhenaten: that it is not solely sourced from the greatness of Nefertiti, but from the necessity of a female entity to maintain a cosmic balance. Kiya's images are also seen re-appropriated to represent the daughters of Akhenaten and Nefertiti.[74] This consistent change of the identity of the female counterpart in images depicting rituals, ceremonies, and celebrations illustrate the female as a "guarantor of life, fertility, and rejuvenation." [75]

However, there is no particular scene that is reserved for a particular royal woman alone. Reliefs of both Nefertiti, Kiya, and the daughters of Akhenaten and Nefertiti are shown performing various rituals and ceremonies that are reserved for the highest female title. The interchangeable nature of these images prove that it is not because of the greatness and admiration from the pharaoh that these women possessed that allowed them such privilege within the Amarna revolution (although the favor of pharaoh was certainly not a hindrance). It was the assurance of the truth of myths, the fulfillment of the myths of creation and rejuvenation, which gave them such an important role in society. Without the women of

[70] See note 35.

[71] Ibid., Allen, "Akhenaten's 'Mystery' Coregent and Successor." *Amarna Letters*. 74-85.

[72] Ibid. Allen, *Genesis in Egypt*, 44.

[73] Ibid., Aldred, *The Royal Women of Amarna*., 88.

[74] Ibid., 105.

[75] Ibid., 118.

Amarna, the divine lineage of the Aten would not be continued, ensuing chaos within Egypt. In the role of creator and counterpart of Akhenaten, the sole essential quality was the factor of femininity, meaning that one royal woman could fulfill this role as equally as another. Nefertiti may have held a specific, higher status due to the role she held with the Amarna cosmogony, but the female role within creation and rejuvenation could be played by any one of the royal women, and Akhenaten's dependence on duality and these myths made the royal women of Amarna essential to his success and continued reign.

This importance of female entity is further exemplified within the depictions of the royal family of Amarna. Particularly in the Berlin Stela,[76] the royal females are represented as the primeval illustration of the promise of creation, fertility, and rebirth. As seen in the "Twin image" of Akhenaten and Nefertiti, we are shown the creation myth illustrated through the divine triad of Akhenaten, Nefertiti, and the Aten.[77] The daughters further stand as a testament to the creation of multitudes of people, all deriving from the primeval pair. However, the presence of the royal princesses with pointed fingers also stands as an assurance of Akhenaten as the protector of his creations (his children) and his connection with the Aten.[78] This gives the female role an added element: a signifier of the power of Akhenaten. Whether it is through the magic insinuated by the pointed finger gesture or the affection shown by Akhenaten to his female companions, the female counterpart further represents the protecting power that Akhenaten has over his people. The female women of Amarna stand as a vehicle for Akhenaten that allow the citizens of Egypt to connect with his logic and religion, and serve as symbols to the world of his creative power, in life and in the afterlife.

It is clear, through in-depth research of the royal women of Amarna, that femininity was an essential asset to the reign and religion of Akhenaten. Although the driving feminine force derives from his Chief Wife Nefertiti, both his children and minor wife Kiya contribute to the balance of the Aten religion. Without a feminine counterpart to the male Aten, the religion, and through that, Egypt herself, would fall into chaos. It is

[76] Ibid., Aldred, *Royal Women of Amarna*., Fig. 88, 98

[77] Ibid., Assman, *Egyptian Solar Religion in the New Kingdom*, 80.

[78] Pinch, *Magic in Ancient Egypt*., 59-60, 121.

only through the establishment of a strong female presence that Akhenaten finds success, however short-lived it may have been. Each royal woman of Amarna provides an essential service to the Amarna religion, allowing Akhenaten to maintain power throughout his reign.

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Artwork

Fragment with the head of Queen Nefertiti from Akhenaten's sarcophagus, the Royal Tomb at Amarna. Granite. Agyptisches Museum, Berlin.

Pillars from colonnade in Mansion of the Ben-ben, Karnak. Redford, Akhenaten, The Heretic King, page 77.

Bust of Nefertiti from the Thutmose workshop at Amarna. Painted limestone with gypsum plaster layers. Agyptisches Museum, Berlin.

The royal family under a baldachin during the presentation of tribute. Drawing by Norman de Garis Davies after a relief in the tomb of the Overseer of the Royal Quarters, Meryre, at Amarna.

Fragment with the faces of Akhenaten and the minor queen kiya (as changed into Princess Meretaten) Tell el-Amarna, Limestone. Ny Carlsberg Glyptotek, Copenhagen (A.E.I.N. 1797)

Relief showing the purification of the minor queen Kiya, later changed into Princess Meretaten. Limestone. The Metropolitan Museum of Art, New York.

Head of a princess from the Thutmose workshop at Amarna. Brown Quartzite. Agyptisches Museum, Berlin.

Torso from the statuette of a princess, excavated at Amarna. Reddish brown quartzite. Petrie Museum, University College, London.

Shrine stela with relief showing Akhenaten, Nefertiti, and Princesses Meretaten, Meketaten, and Ankhesenpaaten. Limestone. Agyptisches Museum, Berlin.

Fragment of a stela excavated at Amarna showing Akhenaten with Nefertiti and the children on his lap. Limestone. Musee du Louvre, Paris.

David Arellano has been working in the Embedded Systems lab in the Electrical Engineering Department since Spring 2014 and plans on attending graduate school after receiving a bachelors degree. He also plans to stay involved with the research community after graduation. With a passion for travel, he hopes to see as much of the world as possible. Free time is spent studying theology, philosophy, and enjoying movies, music, art and nature. Family, friends, and religion have all been incredible influences in his life, and he owes all of his success to these blessings and the continuing support of loved ones.

David Arellano

Wireless Analog Passive Sensors for Small Bioelectric Signal Measurement Through Load Modulation

Faculty Sponsor
Dr. Bashir Morshed

Abstract

Fully-passive wireless body-sensors open the possibility for unobtrusive physiological signal capture and monitoring in natural settings. While capacitive analog passive wireless sensors have been developed, we present an alternative solution for signal capture based on load modulation using resistive transducers. The passive sensor is composed of a loop antenna, a tuning capacitor, and a resistive transducer suitable for the type of physiological signals to be measured. The interrogator transmits a carrier RF signal at 11.776MHz whose amplitude is modulated based on the resistive loading by the transducer. In this study, in place of a resistive transducer, an N-Channel Enhancement MOSFET is used to modulate the carrier signal with an applied small signal voltage. In previous studies, the sensor was characterized for various resistive loads of 1.2? to 82K? with an interrogator of low quality factor (Q_F). We demonstrate the effect of raising the QF of the interrogator, which increases sensitivity and allows for small signal voltage sensing at very low power levels (0dBm to +5dBm). The results demonstrate the viability of developing body-worn fully-passive sensors for small bioelectrical signal capture.

Introduction

The convenience and advantage of wireless sensing is undeniable. When monitoring multiple signals, wired sensors eventually become complex and unmanageable. However, traditional wireless sensors can themselves be ineffective due to restrictions such as battery power and size. A solution can be found in the battery-less nature of fully-passive sensors. Fully-passive sensors have already demonstrated the potential to be body worn and unobtrusively collect physiological signals [1]-[3]. It is important at this point to distinguish the two different types of passive sensors. Passive sensors are commonly separated into two distinct categories: wireless digital passive sensor (WDPS) and wireless analog passive sensor (WAPS). WDPS contain an ASIC chip that receives power from the scanner, turns on the circuitry, and wirelessly retransmits a digital identification code or digitized signal. WDPS can collect analog signals by sampling the analog data with data acquisitions chips [4], [5]. WAPS; however, do not contain any digital ASIC chip, and can communicate via purely analog signals. WAPS have the advantages of simpler circuitry, lower cost, less complexity, extremely low power wireless transmission, and very fast response time. On the other hand, some disadvantages are higher amounts of artifacts and lower data quality and security than compared to WDPS. WAPS based on varactor and Surface Acoustic Wave (SAW) resonance have been sucessfully used for a multitude of remote signal capture applications [6],[7],[8],[9]. These WAPS use LC resonators, which utilize capacitive changes to modulate signals based on resonant frequency shifting [8], [9]. The SAW delay line is used for delayed backscattered signal [7].

In this paper, we demonstrate the capture of small signal voltages using a novel WAPS system based on resistive load modulation (rWAPS). Our passive sensor is a parallel RLC resonator tank circuit with damping factor (QD) set by the load resistance. By using resistive transducers to capture physiological signals, the resistive load can be changed, which alters the damping factor (QD) and, in turn, amplitude modulates the carrier RF signal. This amplitude modulation can be captured by a signal analyzer with an envelope detection scheme. For this paper, in place of a resistive transducer, we've used a MOSFET to convert voltages to a resistive variation of RSD. In doing so, we demonstrate that body-worn passive sen-

sors could allow for remote capture of bioelectrical signals such as those utilized in Electrocardiography (ECG), Electromyography (EMG), and Electroencephalography (EEG). These proposed rWAPS still maintain the advantages of simple construction and low component count. Ultimately, this makes the body-worn sensors extremely inexpensive to fabricate and even disposable, once monitoring sessions have ended.

Hardware Description

For prototype development, three identical sized boards have been designed using the Cadence PSPICE tool (Cadence Design System, Inc., San Jose, CA, USA). Fig. 1 shows the schematic for the interrogator device, and two different layouts for the rWAPS sensors.

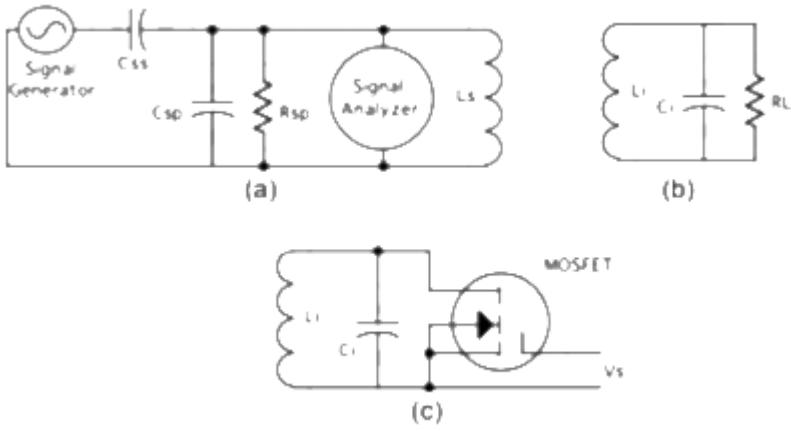

Fig. 1 (a) Schematic of WAPS Interrogator (b) Schematic of transducer based sensor (c) Schematic of MOSFET based sensor

Fig. 1(b) shows the board, which implements a resistive transducer for signal sensing. Fig. 1(c) demonstrates a sensor board that was designed for a MOSFET in place of a transducer. The antenna design was inspired by similar designs from [10]. The interrogator board has two SMA connectors, one for the carrier input V1, which delivers carrier signals at 11.776MHz, and the other one for the signal analyzer. The capacitor C_{SS} is used to match the antenna to 50 Ω. The second capacitor C_{SP} is used to adjust the resonant frequency of the circuit, with the loop antenna (L_S) designed as a planar inductor. The terminal resistor (R_{SP}) is used to raise the Q_F of the interrogator for maximum sensitivity. The passive sensor has

a matching coil L_I and a capacitor C_I to tune the antenna for a matching resonant frequency. In Fig. 1(b) a resistive load R_L is shown that represents a resistive transducer. In Fig. 1(c) the MOSFET is used to convert input voltage (V_S) to a correlated resistive variation of R_{SD}. Another SMA connector is used on this board to deliver a noise reduced signal from the signal generator to the MOSFET via coaxial cable.

Printed Circuit Boards (PCBs) were designed using Cadence Allegro SPB 16.6 (Cadence Design Systems Inc., San Jose, CA, USA). The sensor and interrogator boards are identical in size, measuring 6.89cm x 4.19cm. Fig. 2 shows the PCB layout of the three boards. Fig. 2 (Left) demonstrates the PCBs for both the interrogator device and resistive transducer based sensor. These boards share identical circuitry, but are populated differently, based on Fig. 1(a) and Fig. 1(b). Fig. 2(Right) is the new PCB fabricated for the purpose of voltage sensing using a MOSFET.

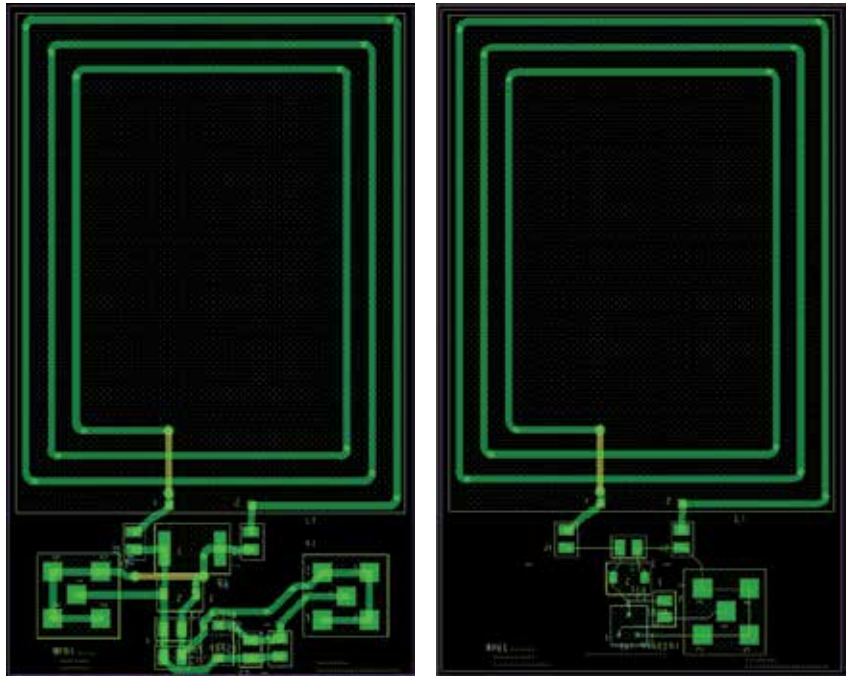

Fig. 2 (Left) PCB layout of interrogator and transducer sensor
(Right) PCB layout of MOSFET based sensor

The PCBs were fabricated by Advanced Circuit (Aurora, CO, USA).

The test fixture in Fig. 3 keeps the boards in parallel at a fixed co-axial position.

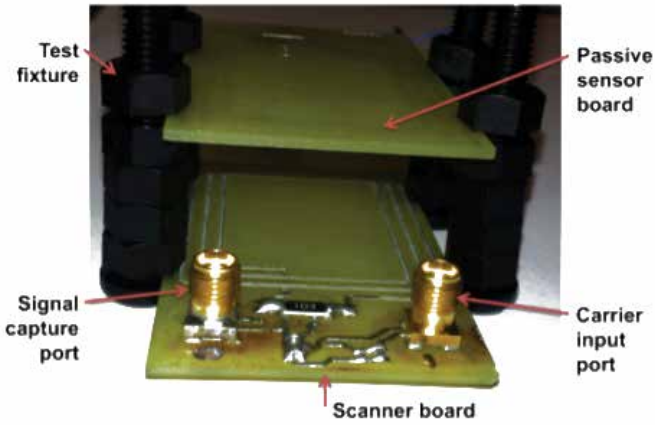

Fig. 3 Sensor Test Setup

Method

A Rigol DG4062 (Rigol Technologies Inc., Beijing, China) signal generator is used to capture the sensor characteristics in the Frequency Spectrum with the new high Q interrogator. A 0dBm signal is chirped from 9MHz to 14MHz.

For signal modulation, a 10Hz signal is applied between the MOSFET gate and source by the same signal generator producing the carrier frequency. The lower limit of the signal generator is only 2mV so a 20dB attenuator was used to achieve smaller voltages. The carrier frequency is set to 11.776MHz at +5dBm. This frequency and power level were chosen based on the data collected from the high QF interrogator characteristics. The MOSFET used is an Enhancement mode N-Channel MOSFET from Diodes Incorporated.

The output is connected to a DSO-X 2024A (Agilent Technologies Inc., Santa Clara, CA, USA) Oscilloscope. The oscilloscope is AC coupled with Peak Detect as the acquisition mode, and ASCII X-Y as the output option. Data from the oscilloscope is saved as a .cvs file, and then analyzed and plotted in Matlab.

The scanner and the passive sensor maintained a separation distance of 22mm position for all measurement by using the testing fixture (Fig. 3).

Results

Fig. 4 shows the sensor characteristics in the frequency spectrum using the high QF interrogator and the sensor board depicted in Fig. 1(b).

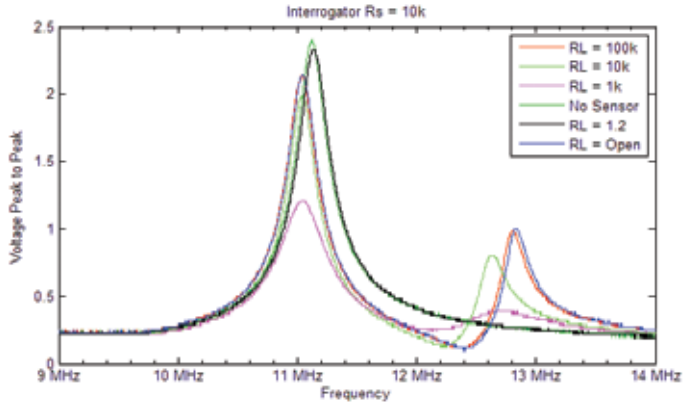

Fig. 4 Interrogator Frequency Characteristics RSP = 10k

It is important to note the modulation potential seen near 12.5MHz. The amplitudes at this frequency between resistive loads 100kΩ and 1.2Ω demonstrate a response sensitivity analogous to a 9.8x magnitude difference. This is a considerable improvement from previous experiments, which demonstrated response sensitivities of 3x or less [11]. This increase in sensitivity is vital for detection of the small signals being sensed by the MOSFET.

Fig. 5 and Fig. 6 show the positive envelopes of the reflected signals corresponding to 1mV and 400μV input signals to the MOSFET (Vs) respectively. When a voltage is applied to the MOSFET between the gate and the source, the reflected signal is modulated accordingly due to the resistive response of the MOSFET. Fig. 5 and Fig. 6 show the modulated envelope of the 11.776MHz carrier signal captured by the interrogator. A 1mV sine wave modulation is clearly visible in Fig. 5. Additionally, the 400uV sine wave seen in Fig. 6 was found to be the lowest discernable signal achievable with our current set up.

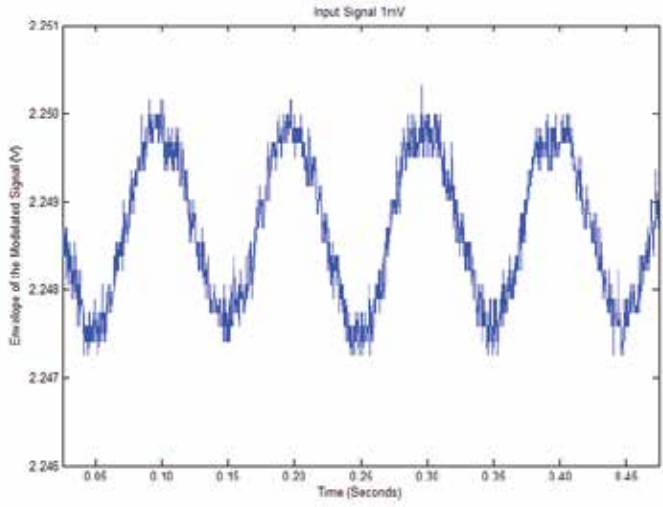

Fig. 5 VS = 1mV

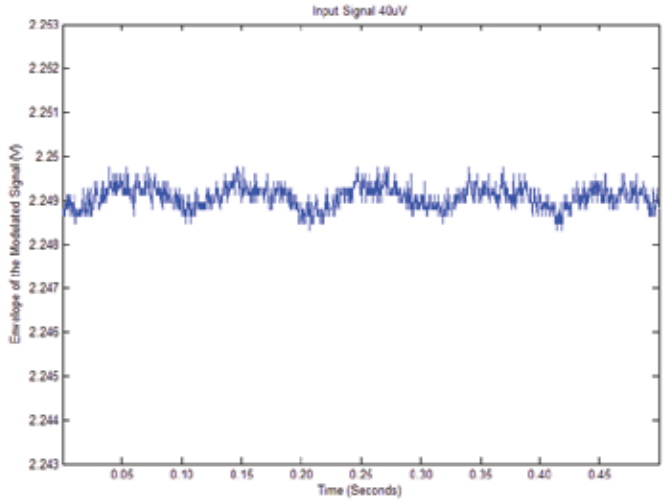

Fig. 6 VS = 400uV

Fig. 7 shows the voltage response of the rWAPS sensor, seen in Fig. 1c, with an enhancement type N-MOS. The region near the origin is amplified in the inset for comparison with the second order polynomial curve found in the drain current response of a typical N-MOS transistor.

Figure 7 illustrates the response expected from our set up in this experiment. As the figure demonstrates, we are operating in a region comparable to the ohmic region described by typical MOSFET characteristic curves, and are using the MOSFET as a voltage controlled resistor.

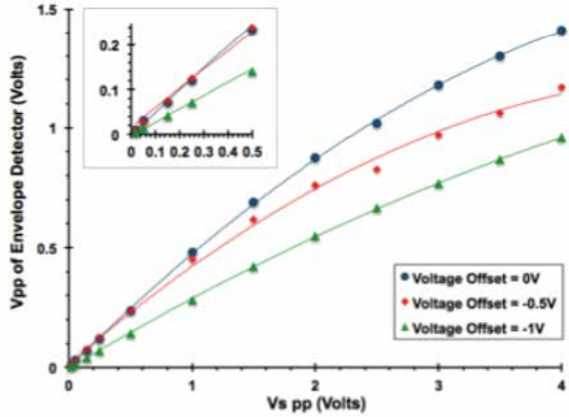

Fig. 7 Voltage response of WAPS Fig. 1c with an enhancement MOSFET along with second order polynomial trend lines

Conclusions

In this paper, we have investigated a novel method for wireless small signal voltage sensing using purely passive components. By using a MOSFET without DC bias on our passive sensor to convert voltages into a respective resistance, we have demonstrated the ability to modulate an 11.766MHz carrier signal visible at the interrogator. Through experimentation we have shown that our wireless analog passive sensors have the ability to capture voltages as small as 400μV. Such sensitivity could allow for the rWAPS sensor to capture bioelectrical signals such as ECG and EMG that exist in the milli- and sub-millivolt range. There is still much improvement to be done on coil design, and a wider variety of MOSFETs must be examined in order to fine tune transistor characteristics beneficial for our purpose of voltage controlled resistance.

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Kayla Grieme was born and raised in Memphis, TN. She will graduate from The University of Memphis with Honors in spring of 2015 with a Bachelors of Science degree in Computer Science. She has always loved computer science, especially data mining, data fusion, and sensor networking. Her other interests include fitness, choir, St. Jude Children's Research Hospital, and music of all kinds. She loves Memphis and will soon begin her graduate degree in fall of 2015 at The University of Memphis.

Kayla Grieme

On a Triangulation-Based Approach to Radiation Source Detection

Faculty Sponsor
Dr. Chase Q. Wu

Abstract

Among many terrorism threats faced by our nation, the release of radiation at a low but dangerous level in densely populated areas is probably one of the most horrifying and devastating attacks. Unfortunately, detecting low-level radiation sources is difficult due to varied background noise and probabilistic measurements with inherent randomness. Significant efforts have been made using single or co-located sensors, but only met with limited success. The recent advance in sensing technology has made it now possible to deploy a large number of smaller and less expensive detectors to achieve quality through quantity. Such networks of detectors are expected to provide faster detection with higher accuracy than their constituent detectors. We propose a triangulation-based data fusion method for radiation source detection using a network of distributed detectors through rigorous algorithm design and analysis. The performance superiority of our method is demonstrated by extensive experimental results in comparison with existing methods.

Introduction

For the past several years, our nation has been facing various terrorism threats. One of these, which is the release of radiation at a low but dangerous levels in densely populated areas is considered to be a potentially horrifying and devastating type of attack. Unfortunately, detecting low-level radiation sources is extremely challenging because i) the radiation levels that are only slightly above the background noise may appear to be normal background variations; and ii) the radiation measurements are probabilistic in nature with inherent randomness, typically following Poisson process. In the past decades, many analytical or experimental methods have been developed using single or co-located sensors, but these efforts only yielded limited success.

The recent advance in microelectronics and sensing technology has now made it possible to deploy a large number of smaller and less expensive detectors, resulting in an achievement of quality through quantity in practical monitoring applications involving urban areas, special events, and border crossings. In general, a large-scale sensor deployment would cover a wide geographical area and hence result in a large collection of sensor data, but the speed and accuracy of detection still largely depends on the underlying method used to fuse or integrate the sensor data. Research efforts on the design of such data fusion algorithms are still quite limited, especially in the domain of radiation source detection.

In this work, we propose a triangulation-based data fusion method for radiation source detection, referred to as TriRSD, using a network of distributed detectors through rigorous algorithm design and analysis. One salient feature of TriRSD is that it makes a detection decision based on the source location estimate, which is obtained by solving a system of equations using a closed form. This localization-based detection method is in sharp contrast to conventional "detect first and then localize" approaches employed for radiation source detection. Indeed, localization by the network has an inherent advantage over individual detectors. With multiple estimates of the source location generated based on the measurements from the subnets, or groups of sensors, if a source is present, these estimated locations would form a single dominant cluster; otherwise, they would be dispersed. This property is exploited in TriRSD to improve the detection performance of individual detectors. The performance superiority of

TriRSD is demonstrated by extensive experimental results in comparison with Sequential Probability Ratio Test (SPRT), a widely adopted method for radiation source detection.

Related Work

A detection algorithm basically infers the presence or absence of a radiation source given sensor measurements from a single or multiple sensors. The general detection problems have been studied extensively over the past several decades, and include areas of classification, estimation, identification, and tracking, under various formulations.

Detection of radiation sources is typically accomplished by looking for sensor measurements that are dissimilar to the background radiation profile. In absence of noise and measurement errors, this can be done by triggering a detection alarm when sensor measurements differ from the background radiation profile. However, in a realistic setting, the variation in the sensor measurements may be due to a statistical variation of the intensity, or changes in the background radiation profile. According to extant literature, many methods have been developed for radiation source detection in different problem spaces according to the number of sources, i.e., single or multiple sources, and the state of sensors, i.e., static or moving sensors.

Fehlau proposed a time-smoothing filter technique and compared different detection methods using exponential smoothing filter and moving average filter. The detection method in [2] and [3] is based on a geometric model of the time difference of arrival (TDOA). Many other detection methods use statistical techniques, including Maximum Likelihood Estimation (MLE) [4], [5], [6], [7], [8], [9], [10], [11], [12], Akaike's Information Criterion (AIC) and Bayesian Information Criterion (BIC) [13], [14], Bayesian Estimation [15] [16] [17] [18], Grid methods [19] and Particle Filter [20]. As one of the most commonly used method, Sequential Probability Ratio Test (SPRT) employs a recursive hypothesis testing method to decide on two hypotheses or inconclusive given a series of sensor measurements [21],[22],[23],[24],[25].

In contrast with the traditional detection methods as mentioned above, the proposed TriRSD takes a novel approach to first derive the source location by fusing the data from a subset of sensors and then making a detection decision based on the clustering of source estimates.

TriRSD: Triangulation-based Radiation Source Detection

We propose a triangulation-based method for Radiation Source Detection, referred to as TriRSD. This method is intended for detecting all levels of radiations, although it becomes more effective as the level of radiation increases and the background noise decreases. The principle idea[1] of this method is to compute the source location by solving a system of nonlinear equations based on a d^2 signal attenuation model using three sensors that form a triangle, as follows:

$$\begin{cases} \dfrac{A}{d_1^2} = \dfrac{A}{(x-x_1)^2+(y-y_1)^2} = m_1(t), \\ \dfrac{A}{d_2^2} = \dfrac{A}{(x-x_2)^2+(y-y_2)^2} = m_2(t), \\ \dfrac{A}{d_3^2} = \dfrac{A}{(x-x_3)^2+(y-y_3)^2} = m_3(t), \end{cases} \text{ or } \begin{cases} A = d_1^2 \cdot m_1(t), \\ A = d_2^2 \cdot m_2(t), \\ A = d_3^2 \cdot m_3(t), \end{cases}$$

where $m_i(t)$ and (x_i,y_i) are the count (sensor reading) at time t and the location of the i-th sensor (=1,2,3), which are known, A and (x,y) are the intensity and the location of the radiation source, which are to be solved, and d_i is the Euclidean distance between the source and the i-th sensor, i.e. $d_i = \sqrt{(x-x_i)^2+(y-y_i)^2}$. Note that this d^2 attenuation model has been validated using real radiation measurements and could be used for an accurate estimate of radiation attenuation in real-life application scenarios.

Theoretically, with an accurate model and perfect measurements, if there is no source present, the computed or estimated source location $(\hat{x}, \hat{y})$ would be the centroid of the corresponding triangle; otherwise, it would be the actual source location (x, y). In practice, with an inaccurate model and imperfect measurements (caused by randomness in the noise and signal), if a radiation source exists, the solutions from different triangles are expected to appear in close proximity and form a compact cluster (possibly around the actual source location). Therefore, we may measure the level of compactness of the cluster and compare it with a threshold to make a detection decision.

Algorithm 1 TriRSD(n, g, cct, l, t)
n: the total number of sensors
g: the percentage of sensors being considered for detection
cct: a given cluster compactness threshold
l: the number of triangles constructed
t: the current time

1: $m = n \cdot g$;
2: Choose m sensors with the strongest accumulated signal (counts) up to the current time t;
3: Construct a set of l triangles, each using 3 sensors randomly selected from the top m sensors;
4: **for** each triangle **do**
5: Solve the equation system (triangle) in Eq. 2 for an estimated source location $(\hat{x}, \hat{y})$ using a closed-form method;
6: **if** $(\hat{x}, \hat{y})$ is an imaginary solution **then**
7: Ignore $(\hat{x}, \hat{y})$;
8: **end if**
9: **end for**
10: Calculate the center $(\bar{x}, \bar{y})$ of the cluster as the average source location among all the real estimated source locations $(\hat{x}, \hat{y})$;
11: Calculate the distance $\hat{d}$ between each estimated source location $(\hat{x}, \hat{y})$ and the cluster center $(\bar{x}, \bar{y})$, i.e. $\hat{d} = \sqrt{(\hat{x} - \bar{x})^2 + (\hat{y} - \bar{y})^2}$;
12: Calculate the cluster compactness cc as the standard deviation σ of all the distances $\hat{d}$, i.e. $cc=\sigma=\sqrt{\frac{\sum_{i=1}^{r} (\hat{d}_i - \bar{d})^2}{r}}$, where r is the number of real estimated source locations, and $\bar{d}$ is the mean value of all the distances $\hat{d}$;
13: **if** $cc \leq cct$ **then**
14: Claim a source detected;
15: **else**
16: Claim no source detected;
17: **end if**

Figure 1.

The key steps of TriRSD are described in Alg. 1. Since the detection performance of TriRSD relies on the "quality" of constructed triangles, we only consider a subset (controlled by the percentage *g*) of sensors with the strongest signal (the highest count). If the number *m* of sensors being considered for detection is small, we may simply exhaust all the combinations of triangles, i.e. $l = C_m^3$.

There are two main issues in solving the equation system of a triangle:

- Imaginary roots: imaginary roots do not contribute to the estimated location, and hence are simply ignored.
- Two real roots: a quadratic equation may produce two real roots, one of which is considered as a "true" solution while the other is considered as a "phantom" solution.

Note that "true" solutions are likely to form a cluster, but "phantom" solutions may be scattered as outliers. However, at the time of solving the equation, there is no sufficient information to discern whether a solution is "true" or "phantom". Therefore, we apply an outlier detection method before making a detection decision based on the compactness of the cluster.

Outlier Detection

Outlier detection is a technique in statistics, which is largely used for data mining. There are three commonly used methods for outlier detection [1] 1) statistical distribution-based outlier detection, 2) distance-based outlier detection, and 3) density-based local outlier detection, which is employed in our work.

For the sake of completeness, we provide a brief introduction to the density-based local outlier detection method. We first define several terms as follows.

Definition 1: k -distance: the k -distance of an object p, denoted as k -distance (p), is the maximal distance from p to its k -nearest neighbors.

Definition 2: k -distance neighborhood: the k -distance neighborhood of an object p, denoted as $N_{k\text{-distance }(p)}(p)$ or $N_k(p)$ for short, contains every object whose distance to p is not greater than k -distance(p).

Definition 3: Reachability distance: the reachability distance of an object p with respect to object o (o is among the k -nearest neighbors of p), is defined as
$\text{ReachDist}_k(p,o) = \max\{k\text{-distance}(o), d(p,o)\}$, where $d(p,o)$ denotes the Euclidean distance between p and o.

Based on the above definitions, we further define the local reachability density (LRD) as:

$$LRD_k(p) = \frac{|N_k(p)|}{\sum_{o \in N_k(p)} \text{ReachDist}_k(p,o)},$$

and we calculate the local outlier factor (LOF) to decide if a data point (object) p is an outlier:

$$LOF_k(p) = \frac{\sum_{o \in N_k(p)} \frac{LRD_k(o)}{LRD_k(p)}}{|N_k(p)|}.$$

According to the above definition, $LOF_k(p)$ should be close to 1 if an object p is not a local outlier. Generally, the larger $LOF_k(p)$ is, the more likely p is a local outlier.

In TriRSD, to avoid introducing an additional threshold for outlier detection, we incorporate $LOF_k(p)$ into the calculation of the standard deviation σ of all the distances between the estimated source locations and the cluster center (Line 12 in Alg. 1) as a weight coefficient, i.e.

$$\sigma = \sqrt{\frac{\sum_{i=1}^{r} LOF_k(p_i) \cdot (\hat{d}_i - \bar{d})^2}{\sum_{i=1}^{r} LOF_k(p_i)}},$$

where p denotes the i -th estimated source location $(\hat{x}, \hat{y})$, and the value of k is typically chosen within the range $[\frac{r}{4}, \frac{r}{2}]$.

Performance Evaluation

To evaluate the performance of TriRSD, we utilize the datasets from Domestic Nuclear Detection Office's (DNDO) Intelligence Radiation Sensors Systems (IRSS) tests, wherein 17 detectors were arranged in two concentric circles and a spiral. In each run, the first 60 seconds had the background measurements, and the source was present during the next 120 seconds.

Effect of Outlier Detection

To evaluate how effectively the outlier detection method improves the detection performance of TriRSD, we apply TriRSD with and without outlier detection to the IRSS dataset and plot the standard deviations of distances, as shown in Figures 2 and 3.

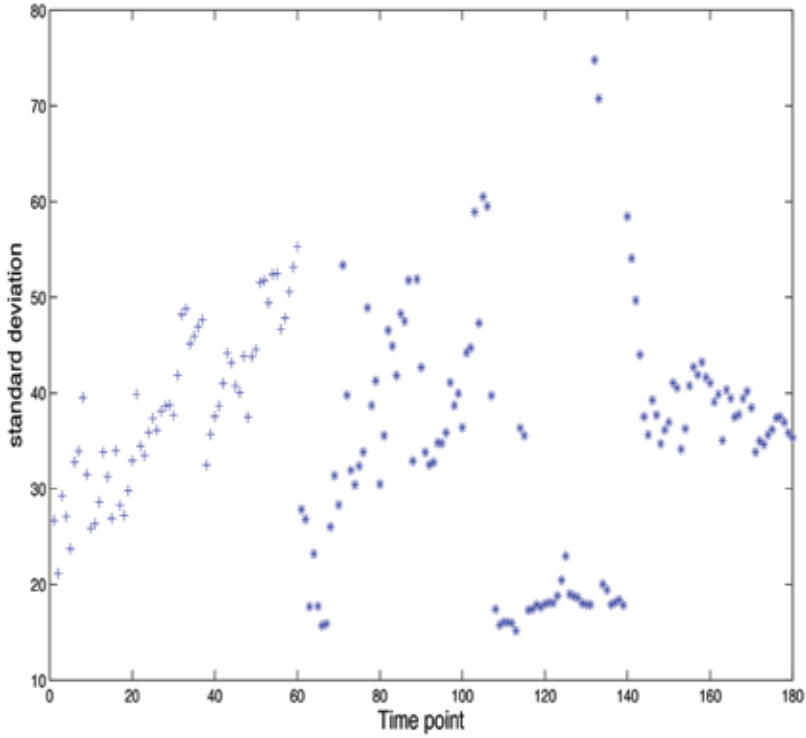

Figure 2.

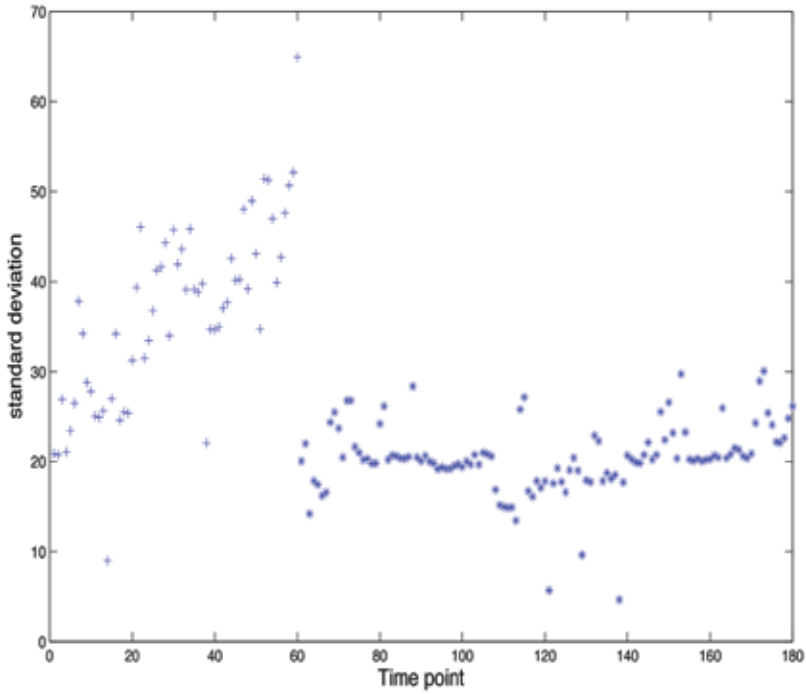

Figure 3. The distribution of standard deviations of distances over time. Fig. 2: before using outlier detection, Fig. 3: after using outlier detection. The symbol "+" represents the standard deviation in the first 60 seconds and the symbol "*" represent the standard deviation in the last 120 seconds. x -axis is the time point, and y -axis is the calculated standard deviation.

Without outlier detection, it is rather difficult to decide a meaningful cluster compactness threshold for source detection; but with outlier detection, we are able to choose an appropriate threshold (a horizontal line) that divides the standard deviations between the first minute (marked by "+") and the last 120 seconds or 2 minutes (marked by "*").

Performance Comparison

We run both the proposed TriRSD method and SPRT in comparison on multiple runs of the IRSS datasets. Since SPRT is very sensitive to its parameters, we calculate and apply the average measured intensity of signal and noise to improve its performance. False alarm rate is the percentage of runs which provide a false positive decision. Missed detection rate is the percentage of runs which provide false negative decision and miss the source. We tabulate the false alarm rate and missed detection rate of both methods in multiple runs in Table 1, which shows that TriRSD exhibits an overall better detection performance than SPRT. The results in other runs are qualitatively similar.

Table 1. The detection performance of SPRT and TriRSD.

Performance measurements / Runs	False alarm rate (%)		Missed detection rate (%)	
	SPRT	*TriRSD*	*SPRT*	*TriRSD*
Run 1	0	1.6	25	1.6
Run 2	0	1.6	9.2	0
Run 3	0	1.6	29.2	0
Run 4	0	1.6	14.2	5.8
Run 5	0	1.6	15	1.6
Run 6	0	1.6	6.7	0.8

A Visual Illustration of TriRSD Detection Process

We provide a visual illustration of the detection process of TriRSD on one typical run. Figures 4, 5, and 6 show the layout of the estimated source locations at 6 different time steps in the first minute, at the first 6 time steps in the last 2 minutes, and at 6 different time steps in the rest of the last 2 minutes, respectively. We observe that the estimated source locations converge to the true source location (the origin) as more counts are accumulated over time.

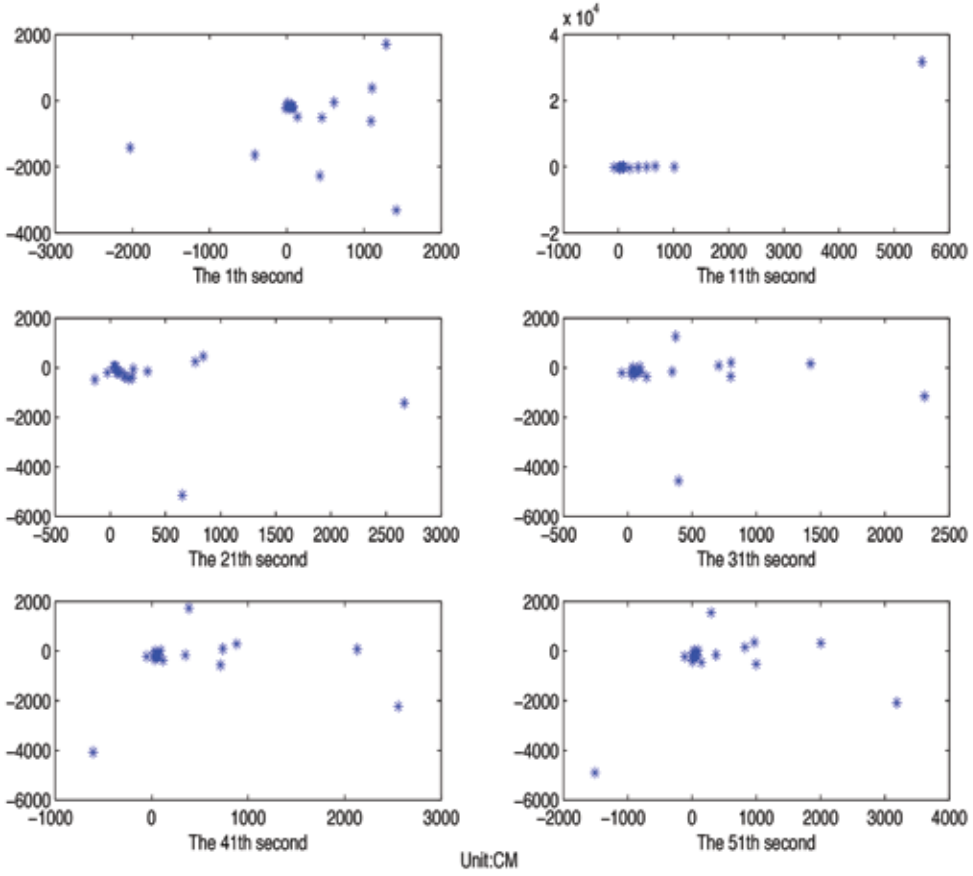

Figure 4. The layout of the estimated source locations at 6 different time steps in the first minute.

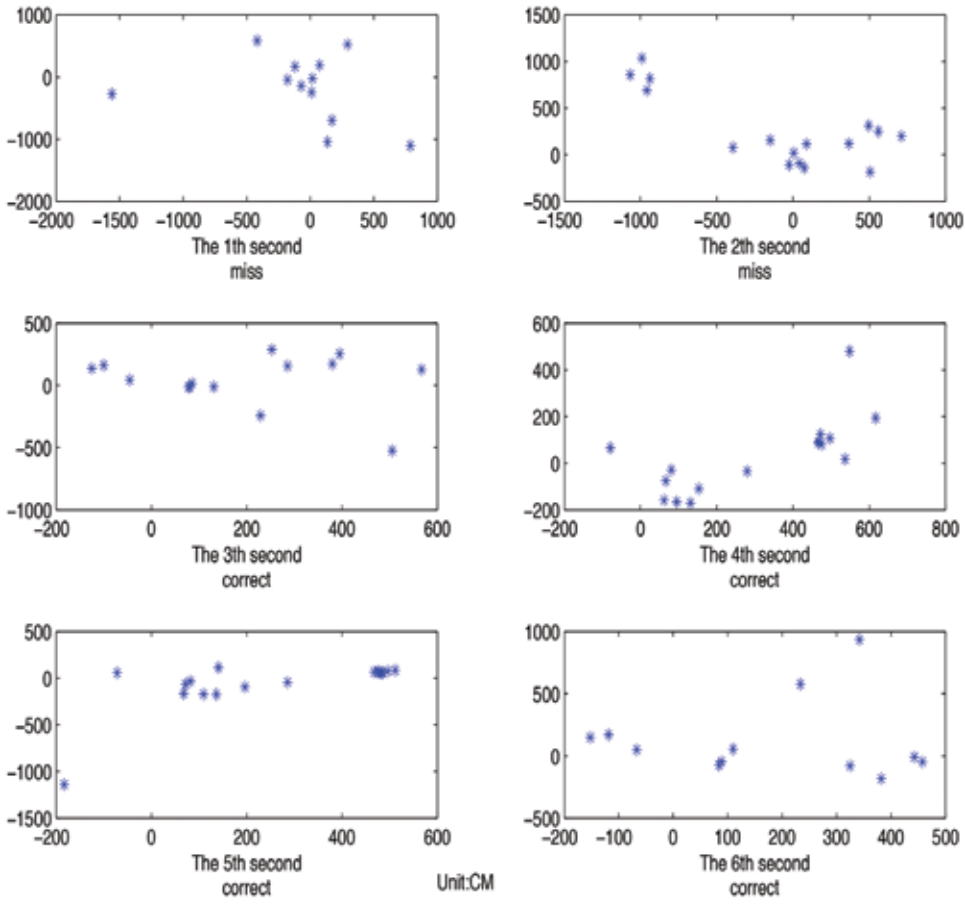

Figure 5. The layout of the estimated source locations at the first 6 time steps in the last 2 minutes.

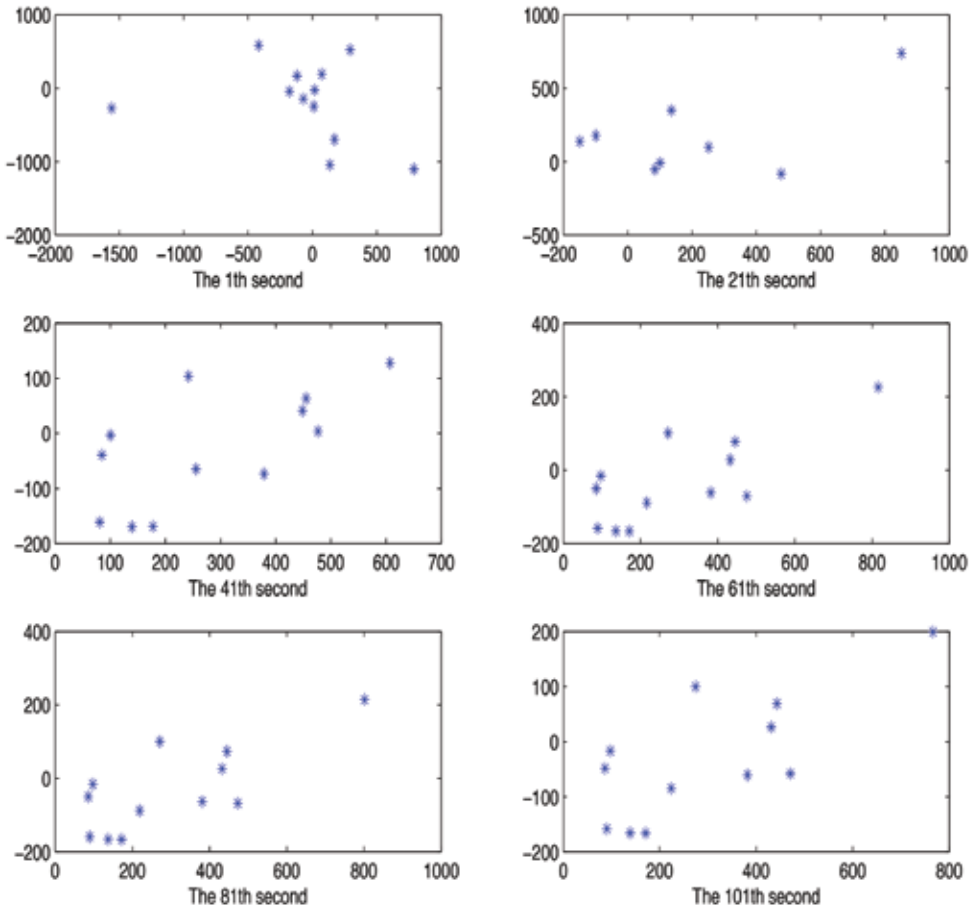

Figure 6. The layout of the estimated source locations at 6 different time steps in the rest of the last 2 minutes

Performance Impact of Threshold

To investigate the impact of the cluster compactness threshold on the detection performance of TriRSD, we vary the threshold value in the range from 10 to 28, and plot the corresponding false alarm rate and missed detection rate, as shown in Fig. 7. We observe that the best detection performance with both rates less than 5% is achieved with a threshold around 19.2 cm.

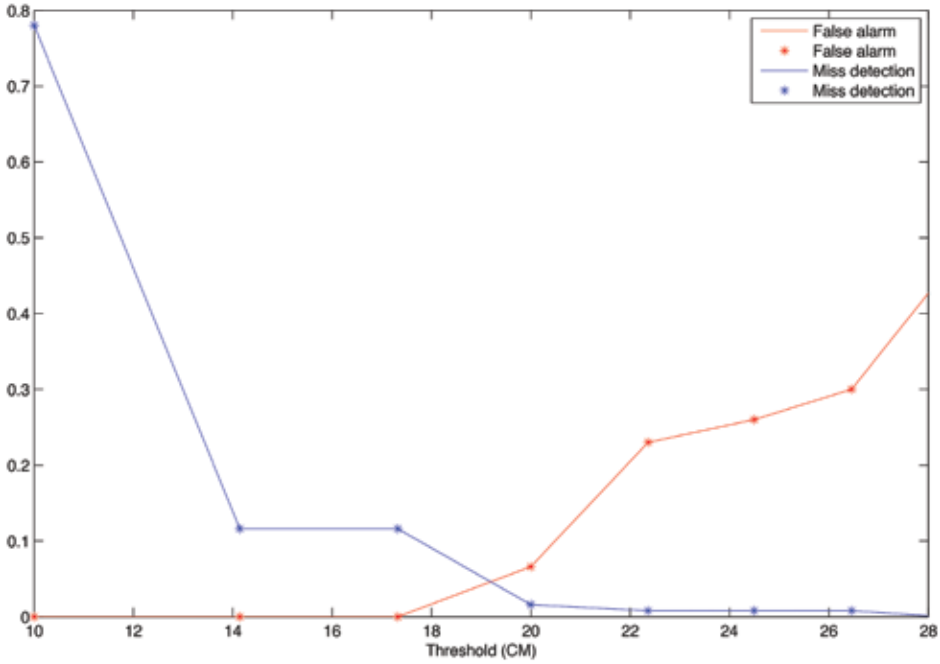

Figure 7. The impact of the threshold on the detection performance of TriRSD.

Conclusion

Detection of low-level radiation sources is an important but challenging problem. Detecting high-level radiation is easy, but it becomes much more difficult when detecting low-level radiation due to the similar measurements of background noise. Low-level radiation detection is important, because some security threats may not have as high levels of radiation. Unlike traditional geometrical or statistical approaches, we proposed a triangulation-based method for radiation source detection by estimating the source location using a rigorous closed-form solution. Extensive experimental results confirmed the performance superiority of the proposed TriRSD method over existing methods. These results will help expand the way security systems are implemented in public settings.

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Alex Evan Galbraith

The red Dragon: Urban Sprawl in China

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Abstract

Low-dense, spatial distribution of land use in China can be attributed to urbanization. This thesis culminates by perforating the challenges associated with city growth as seen through the lens of urban sprawl. In China, the foundation for economic prosperity has been rooted in the industrial progression of its cities; however, the phenomenon of urban sprawl elucidates a myriad of negative externalities Urban growth is the cause of environmental vulnerability in Shenzhen, road congestion in Shanghai, and air pollution in Beijing. In order for China to remain prosperous in the twenty-first century, it must address and find solutions to mitigate the effects of current and future sprawl.

Introduction

Winding from the Yellow Sea to the South China Sea is the Red Dragon's backbone – the Eastern Sea Coast of China. Its meandering shoreline connects Beijing, Shanghai, and Shenzhen with the pulse of millions of people. The Red Dragon is China's symbol for prosperity, fortitude, and its auspicious nature of becoming great, of becoming worthy of a global audience that will recognize China's responsibility, obligation, and dedication to its people. Red in Chinese culture signifies prosperity. In fact, during the Chinese New Year elders will give their younger generation a red envelope to bid good fortune on their future.

For the past two decades, China has been the world's most rapidly growing economy. The recent rapid growth in cities like Shenzhen, is the culmination of an ongoing transformative process that was instilled by Mao Zedong in the 1960s. The country has shifted from a predominantly poor rural economy to an industrialized and urban economy, from a government-planned economy to a market economy (which is evident through private ownership, central planning, and reduced government control over the economy today), and tried to develop a modern information economy (Jeckstein, 2011).

Economic prosperity may come at the cost of other resources, however. As cities grow, there is a potential loss of green space, compromised air quality, and increased congestion. In these cases, the Red Dragon of prosperity, while beneficial, also comes at a cost.

This thesis expounds on the effects of urban sprawl as it affects human welfare in China, specifically in the cities of Shenzhen, Shanghai, and Beijing. The phenomenon of urban sprawl not only changes behavior, but also challenges current economic models that use urban development and industrialization as a means for increasing welfare. Operating under the assumption that states pursue economic development as a means of prosperity, the consequences associated with that development through urbanization are paradoxical because of the compromise in amenities that individuals value most (i.e. green space, clean air, etc.). The building of cities helps to create economic prosperity, but when amenities become too dissolved, we see a tipping point for welfare.

In examining the development of each of the target cities, three factors emerge as having the greatest influence: 1) ecological vulnerability, 2) road congestion, and 3) air pollution. While each of these factors exists to some degree in each city, some are affected more greatly by a single phenomenon. This study will therefore focus on the following: 1) ecological vulnerability in Shenzhen, 2) road congestion in Shanghai, and 3) air pollution in Beijing. The next sections will describe the way(s) in which each factor has affected city dwellers and their urban amenities in the respective cities and identify current and future solutions to mitigate the effects of urban sprawl.

The Case of Shenzhen: Ecological Vulnerability

The idea of the Red Dragon emerged from Mao Zedong's vision in the 1960s, and it began with Shenzhen – China's fastest growing city. Without the rapid egression of Shenzhen as China's first Special Economic Zone, urbanization might not have spread to Shanghai or to Beijing, and the current economic status of China would be much different today. Shenzhen has experienced low-dense, spatial growth at an unprecedented rate, yielding a high concentration of commercial and industrial areas. As an area of land expands to accommodate population and economic growth, however, the direct result is a potential loss of green space. The effects of sprawl in Shenzhen include farmland depletion, environmental degradation, and rural population displacement, each of which can be attributed to the rapid growth of the city.

As population increases, a city can either grow up or grow out. As the term urban sprawl suggests, the issue is when there is too much growing "out" and too little growing "up". Sprawl largely demands a high level of economic activity in an area, and more land is allocated to accommodate sparser populations. Sprawl also allows denizens to live relatively long distances from destinations because of low travel costs (O'Sullivan, 2007). In general, more prestigious jobs yield higher wages and more income, which then make people demand more land. This low-dense development at distant locations over time has been a topic among Chinese policymakers within the past decade. Of the many factors contributing to urban sprawl, consumer choice demands scrutiny because consumers are capable of choosing (or not choosing) more land at the expense of other products (O'Sullivan, 2007). Consumer choice, in this case, has contributed to an imbalance between economic and ecological sustainability, which

has led to a more susceptible environment. The case of Shenzhen is an example of how the ecosystem can become vulnerable as a result of urban sprawl. In every city, the economy and ecosystem form a symbiotic circle – what affects one will affect the other. As China's population grows, officials must take action to form synergies between the economy and the ecosystem.

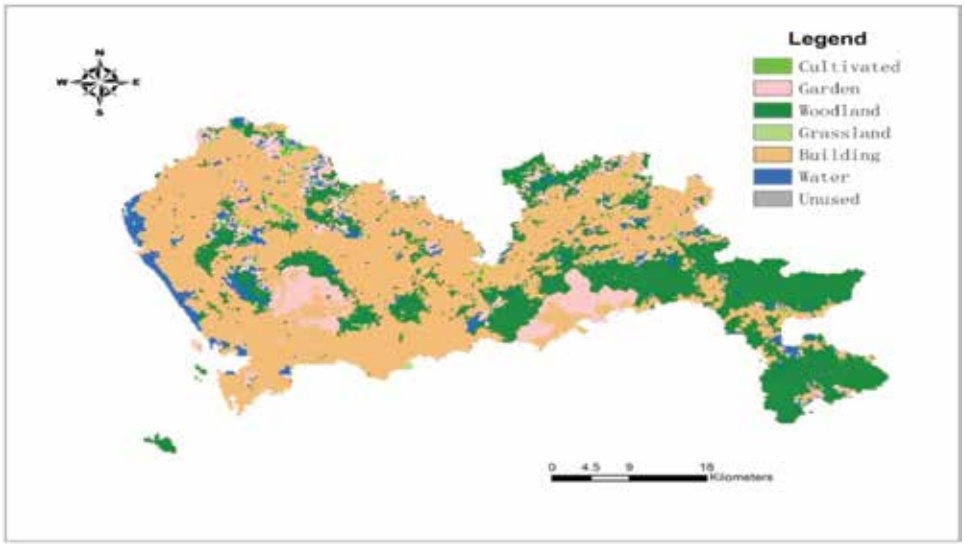
Shenzhen is located in the Guangdong Province, adjacent to the Pearl River Delta and surrounded by other major cities, such as Hong Kong, Macau, and Guangzhou. In the 1980s, the Guangdong Province served to pioneer China's modernization and reform. Shenzhen was established as China's first Special Economic Zone by China's premier – Deng Xiaoping – in 1979 to battle certain political and socioeconomic challenges (Bergsten, et al., 2009), and was freed from the strict Communist regime governing the rest of the country (Pearson, 1997). Special Economic Zones (SEZ) were extremely controversial to Chinese conservatives in the sense that they were similar to Export Processing Zones (EPZs) of the nineteenth century (Bergsten, 2009). However, these zones were beneficial to foreign investors because policy could be adapted to their needs. Within these zones, special tax incentives and preferential treatment with regard to land, raw materials, and foreign currency controls were granted to foreign investors. Special Economic Zone policies contributed to growth by bringing in technology and investment, and refrained from initially threatening the overall ability of the government to manage and to direct the economy (Buoye, 2002). The Special Economic Zone allowed for the pursuit of private enterprise without much interruption from the government (Pearson, 1997). As the decades have passed, the development of Shenzhen as a Special Economic Zone has surpassed any forecasted measure of economic indicator relative to any other area in China. Shenzhen was coined the "instant city" when, in the latter part of the 1980s, six cluster cities were constructed along three major highways. The clusters took full advantage of Shenzhen's long and narrow topography. The ten years following this led to unprecedented growth and urban sprawl, covering land equivalent to 11 islands of Manhattan in New York City (Jeckstein, 2011). Today, Shenzhen exists as the 23rd largest city in the world with 15 million people – more than Hong Kong (7.1 million) and Atlanta (4.7 million) combined (Worldpopulationreview.com, 2014). As the population has increased, land consumption has spread outwards, resulting in the loss of valuable green space.

In China, land is owned and allocated by the government on the people's behalf. Private land ownership does not exist; however, long-term land leases and ownership deeds exist in more developed urban real estate markets like Shanghai, Beijing, and Shenzhen. While the People's Republic aims to industrialize the east coast, the rural west is valued for its farmland and agriculture. Of particular interest is the transformation of agricultural land to industrial parks within a Special Economic Zone. Within Shenzhen, local officials are able to discount farmland and compensate farmers only for the agricultural value. Discounting farmland lures investors from firms to establish commercial and industrial use of land. Compared to the United States and Europe, the cost of transforming land is relatively low, and the time to construct infrastructure short (Bergsten, 2009). Land use in Shenzhen has six characteristics: 1) it must be approved by the Shenzhen government, 2) a leasehold system is established and a land-use fee is levied accordingly, 3) the owner must obtain a land-use certificate, 4) the government carefully maintains that land is used accordingly, 5) there is a time limit for development, and 6) land developers must bear the cost of environmental pollution (Wong and Chu, 1985). The planning strategies employed in the development of Shenzhen have been conducive for foreign investment in housing, industry, and tourism to maximize the use of land, despite the fact that the area of arable land has decreased over the past three decades (Wong and Chu, 1985).

Sustainable Development as a Solution

To track spatial distribution and expansion, many researchers use geographic information systems to observe and simulate land-use patterns and temporal dynamic changes over a period of time. Researchers at Peking University used GIS technology to simulate Shenzhen's land use in the year 2020 (Figure 1). Urban planners and researchers are able to draw conclusions regarding urban sprawl using GIS: 1) urban sprawl quality is high, 2) ecological benefits are low where urban sprawl has a high economic benefit, and 3) policies should be put in place as a safeguard for further development in Shenzhen (Zhang, 2013).

Figure 1. GIS of Shenzhen's land use by the year 2020.



(Source: Zhang, 2013)

When considering land allocation for commercial, residential, or industrial use, it is advisable to determine how to maximize local and natural resources. According to environmental economic theory, human welfare depends to a large extent on ecosystem services. This theory differs from standard neoclassical economics that might define growth as the production of goods and services (Daly and Farley, 2004). In Shenzhen's rapid development, ecosystem services had been sidelined as a means to an end to spur economic growth. At one time, Shenzhen had an abundant supply of firm and flat land that was appropriate for non-industrial use. The space near the city center had been allocated for industrial and commercial use to maximize profits. Due to rapid growth, and poor city planning, parks are next to lower socioeconomic neighborhoods and shopping areas are adjacent to industrially zoned areas. Despite its current state, urban renewal of Shenzhen can be achieved through sustainable development, or development without growth in terms of neoclassical economics.

One consideration in Shenzhen's current situation is population. If China's forecasted population is controlled at 1.4 billion by the year 2020, Shenzhen is predicted to have 800 million people. Its population saw the

most growth from 1994 to 1997, increasing by 236 percent, and from 2001 to 2005 quintupling its population since the 1980s (Jeckstein, 2011). In the past thirty years, the population density of Shenzhen has become less dense and is predicted to increase. The rapid increase in population at the former part of the century was followed by a dramatic increase in the demand for food, water, energy resources and facilities for waste. Officials acted hastily and, as a result, the ecosystem was ignored in an effort to expand economic growth. Rural areas were affected first. Farmlands were depleted until the 1990s, when farming became specialized within the city. Energy resources increased with larger commercial investment and use of Shenzhen's natural resources. In particular, the development of infrastructure created more roads, highways, and railways which increased congestion (Bao, 2013). Congestion poses a particular concern because of ozone-depleting chemicals.

Another factor that must be addressed is industrial development. In Shenzhen, congestion is most prevalent in freight flow patterns; the majority of goods manufactured in Shenzhen pass through Hong Kong for trans-shipment. Transportation by rail and road between Hong Kong and Guangzhou has been convenient; the Shenzhen Reservoir and the Xili Reservoir are able to provide an adequate and stable supply of water to the city. Shenzhen is a comprehensive economic zone, embracing tourism and manufacturing, as well as commercial and real estate development. Overall, industrial growth has been the city's top priority since the 1980s (Bergsten, 2009). Industrial development in Shenzhen has been focused in three areas: a) the Shenzhen Special Economic Zone, b) the Shekou Industrial Zone, and c) industrial districts in other parts such as Kuichong, Buji, Longgang, Longhu and Songgang. The Shekou Industrial Zone has gained status as a separate entity and is managed by the China Merchants' Steam Navigation Co. Ltd. (CMSN) of Hong Kong. Shekou is located on the southwestern end of Shenzhen, and has been focusing on heavy industrial development such as ship breaking, steel refining and rolling, the production of oxygen, acetylene, boat paint and fiber glass, shipbuilding and marine engineering (Wong and Chu, 1985). This has also been the main contributor to a loss of valuable green space. In order for these three areas within Shenzhen to prosper in the future, policymakers must consider the role of sustainable development - "that is, qualitative improvement in the ability to satisfy wants (needs and desires) without a quantitative increase in throughput beyond environmental carrying capacity" (Daly and Farley,

2004).

The negative correlation between infrastructure and pollution in Shenzhen has decreased in the past few years; nonetheless, government contracts with industries monitor the use of certain ozone-depleting chemicals in the production of consumer products. The integration of economic and ecological prosperity had been foreign until the introduction of China's 12th Five Year Plan in 2011. Since then, steps have been taken to create a steady-state subsystem that acknowledge a non-dualistic approach to growth. The idea of a steady-state system, according to Daly and Farley (2004), acknowledges the fundamental necessity of both economic and ecological boundaries - "the main idea...is to maintain constant stocks of wealth and people at levels that are sufficient for a long and good life."

Sprawl creates countless consequences for the environment, but present-day Shenzhen has learned to allocate what green space remains for preservation. Notably, Shenzhen has been labeled as the "City of Parks" with over 680 parks (English.sz.gov.cn, 2014). Greenways encourage more cyclists and reduce time spent driving, and urban gardening inspires the public to find value in green space. In fact, Shanghai and Shenzhen both exhibit examples of artistic and creative forms of green space .Since the population is so dense, it is difficult for individuals to find their own private green space. City planners instead use urban gardening as a means to create a sense of being a part of the environment by growing foliage on the sides of buildings..

In the last decade, Shenzhen officials have condoned courses of action that have helped create a steady-state subsystem to harmonize ecological needs with the growth of the economy. The choices that have made the difference in the twenty-first century are the city's systematic approaches to mitigating the externalities associated with urban sprawl. Notably, present-day efforts to control ecological vulnerability in Shenzhen incorporate measures of sustainable development to moderate the interdependent needs of the ecosystem and of the economy.

The Case of Shanghai: Road Congestion

Shanghai contends to be the world's international financial, trade, shipping, and economic center by the year 2020, according to its 12th Five-Year Plan (National People's Congress, 2011). Due to globalization of the economy and rapid urbanization in the past three decades, Shanghai has grown into a megalopolis, but not without costly externalities that

shape the future of its city's amenities. Shanghai is the most important base for domestic and foreign trade in China – it has been the pumping heart of the Red Dragon, sustaining China as a developing economy. The monocentric city model of urban economics can be a tool used to understand Shanghai's urban growth. The model acknowledges Shanghai's geographic area and renders reasons for its negative congestion externalities. In the future, government officials must take into consideration the market forces that have affected land use within Shanghai in order to pinpoint how to mitigate the effects of urban sprawl. Markedly, the expansion of a city is contingent upon variables like population growth, which ultimately impacts infrastructure.

In the 1980s and 1990s, the majority of Shanghai's residential, commercial, and industrial areas were at the heart of Puxi and Pudong, leaving recreational area along the outskirts of the city. The main areas of Shanghai are separated by its main tributary source, the Huangpu River, which divides the city into Puxi (West) and Pudong (East). Puxi and Pudong are encapsulated by the Inner Ring of Shanghai – an elevated interstate system completed in 1994 and 2009. By 2012, all of the recreational area had been pushed beyond the boundaries of the Inner Ring, leaving only residential, commercial, and industrial use within the city. Currently, the city of Shanghai has a population of approximately 24 million, making it the world's largest city proper (Worldpopulationreview.com, 2014). By 2020, the population is predicted to grow to 26.5 million, with the majority of residents having migrated from other regions or provinces (watchchinatimes.com, 2013). The infrastructural impact of such an increase in population density means urban planners and policymakers must exercise control to match future demand. Its conversion of land use has elicited a myriad of issues concerning population control, pollution, and, of particular concern, road congestion. Planners are using population growth and increasing land space as opportunistic mediums to control for congestion as Shanghai expands. Investment created by the Open Door Policy provided Shanghai with the finances it needed to create an integrated transport system supporting high volumes of carrying capacity. Over the next decade, planners and engineers will develop a more sophisticated transport system that can sustain its carrying capacity (Xiao and Gu, 2012).

Shanghai's current transportation system integrates several types of intermodal services to meet demand. Shanghai's total road network ranks number one in China, covering 12,000 kilometers with a density in the city

of 184km/100km?. Over 1,100 buses are available for surface transit, but only “80% coverage of bus stops are within a 500 meter service radius in the city center” (Xiao and Gu, 2012). The urban rail network was also the first in China to reach over 400km. Today, fourteen metro lines have been established to reach all corners of the city (Figure 2).

Figure 2. Shanghai’s Rail Network Map.

(Source: Shanghai Metro, 2014)

“Based on a 60 meter service station radius calculation,” Xiao Hui and Gu Yu, two Directors of Urban Planning in Shanghai, attest that “one quarter of land in the city center area is covered by rail stations, directly serving 42 percent of all the population in the city center”(2012). The

majority of the population makes primary use of the metro system and surface transit as a means for intermodal transportation. As we have observed through the lens of urban sprawl, increasing traffic congestion puts pressure on the transport system's infrastructure. If there are more drivers using the road network, then congestion increases. If a congestion charge is implemented to curb the effects of congestion, the rail and surface transit systems will also expand. Either way, Shanghai must adapt to its urban development in order to meet future demand.

As many as 3.5 million drivers are predicted to use the road network in 2015. As the city expands, development plans look to build more intercity expressways, expand the railway system, and encourage more environmental policies to help mitigate the effects of 3.5 million drivers (Xiao and Gu, 2012). In August 2014, AutoNavi – a navigation service provider in China – released a traffic congestion report placing Shanghai ahead of Beijing as the most congested city in the country. Data was collected and analyzed from devices installed on taxis and transporters that recorded vehicle speed, location and driving direction. The "delay index" for Shanghai was 2.16, 2.1 for Hangzhou, and 2.09 for Beijing (Table 1). A reading of 2.0 indicates that one would spend twice as much time on a trip as on a normal day. In particular, the highways tend to become most crowded on Monday and Thursday mornings, and on Friday evenings when data shows a peak at 2.28 (China.org.cn, 2014). The cause of such congestion is an amalgamation of several factors including population growth, the growth of consumerism in the middle class, and the rapid sprawl of the city.

Table 1. AutoNavi's "delay index" of congestion in China's largest cities.

Rank	City	Delay Index Extension	Average Trip Length	Average Travel Time (Minutes)	Average Trip Delay (Minutes)
1	Shanghai	2.16	10.58	29.26	15.73
2	Hangzhou	2.10	9.11	27.58	14.47
3	Beijing	2.09	11.39	31.56	16.44
4	Chongqing	2.07	8.73	21.75	11.24
5	Shenzhen	2.05	10.92	26.69	13.67
6	Guangzhou	2.02	11.33	26.31	13.30
7	Fuzhou	1.98	7.60	23.94	11.88
8	Shenyang	1.94	7.84	25.13	12.17
9	Chengdu	1.93	13.63	30.98	14.96
10	Nanjing	1.91	15.91	32.91	15.64

(Source: China.org.cn, 2014)

Shanghai saw drastic changes in its land use with the establishment of the Pudong Special Economic Zone in 1990. The establishment of the Pudong New Area (PNA) created clusters responsible for Shanghai's increased urban development. The area includes centers for industrial production, banking and investment, and imports/exports. In the short-run, the main benefits are being able to provide incomes to Chinese workers and revenues to the Chinese state, while the long-run benefit is to move from a labor-intensive economy to a capital-intensive economy. The Zhangjiang High-Tech Park (ZHTP) lies in the south of the PNA, and is mainly focused on the healthcare industry (English.pudong.gov.cn, 2014). The clustering of these various industries creates urbanization economies, which create larger, even more diverse cities. The lengths of Shanghai's urban sprawl are not completely detrimental, as it has welcomed labor pooling and labor matching. Firms are able to enjoy variance in worker skills, lower training costs, and more worker competition which tends to make workers more productive. Urbanization economies are also able to share knowledge among firms in the form of knowledge spillover. The primary feature of knowledge spillover is that the physical proximity of clusters leads to the exchange of knowledge between people, leading to new and improved ideas (O'Sullivan, 2007). As Shanghai and other cities in China become more international, these regions will become fertile grounds for fresh ideas and new products.

The relevance of growth in these areas of Shanghai has led to Shanghai's growing middle-class. As the majority of the middle class earns higher wages, they will consume more. This means that more individuals have the capacity to purchase vehicles and other luxury items. In China, they call the growth of the middle-class the "China dream" coined after the "American dream". For example, imagine the American dream as an inflated American football. Both ends represent lower and higher socio-economic status individuals, but the majority of the population is a part of the middle class. This example is analogous with the Chinese dream, however the American football is deflated and slowing being filled with air. Shanghai's GDP per capita in 2010 was 76,074 yuan ($11,238 USD) and has risen almost 20 percent to 90,749 yuan ($14,845 USD) in 2013 (Xu, 2014). Individuals are beginning to make more, which will allow them to spend more of their disposable income.

Expansion as a Solution

In order for China's megalopolis to take advantage of being an international haven in the future, government officials must find solutions for the externalities associated with its increasing urban sprawl, such as congestion. As Xiao and Gu (2012) have contended, a more integrated transportation system should increase the capacity of Shanghai's road network, rail system, and surface transit. China's population in 2014 is predicted to rise to 1.4 billion and will continue to rise until mid-century. Urban planners can use the expansion of the city to breed fresh infrastructure ideas and to determine realistic steps towards finding solutions. Urban planners must take into consideration variables such as population when structuring the future of Shanghai's urban development. In particular, Shanghai's 12th Five Year Plan seeks to create three new main downtown areas by 2020 (Figure 3). As depicted, the infrastructural changes will impact the entire district. To control its congestion issues now, Shanghai has not only begun placing limits on the number of vehicles on the road, but also has considered congestion taxes at peak travel times.

Figure 3. Shanghai's 2020 Development Plan.

(Source: Urban Development Plan, 2014)

In 2013, approximately 3 million vehicles were on the road in Shanghai. Government officials have taken measures, such as being the first to cap the number of vehicles distributed each year by auctioning license plates. The average price for a Shanghai plate soared to 75,000 yuan ($12,000USD) in 2013, roughly equal to the retail price of a mid-range sedan (Yue, 2014). In addition to Omega, Gucci, and Emporio Armani brands, license plates in Shanghai have also become a luxury item. When conversing with Shanghai denizens, the average person would consider buying a license plate as being equivalent to buying a house or getting married. Only the upper socioeconomic status individuals tend to drive vehicles. The growth of the middle class is changing that statistic.

During peak hours of the day, traffic in Puxi and Pudong areas is in total gridlock. An increased amount of traffic means an increased amount of traffic pollution. Government officials seek to implement a congestion charge to mitigate pollution and reduce the number of drivers on the road. The city has also pledged to cut its PM2.5 rating by 20% by the year 2017. PM2.5 is fine particulate matter in the form of toxic organic compounds and heavy metals that stems partly from driving automobiles. Bloomberg News (2013) stated that Gao Yiyi, an official with the Shanghai Municipal Transport and Port Authority, has said, "Vehicles are a big reason behind the increase in PM2.5." Shanghai is similar to cities such as Beijing and Shenzhen, where traffic pollution is a main concern. Any implementation of a tax or charge would help to rectify a portion of the pollution problem.

According to standard neoclassical economics, as people's income increases so should their welfare and quality of life. People are able to use their income on products such as automobiles. In the case of Shenzhen, the city has become more vehicle-oriented as it has acclimated to higher energy consumption, congestion and pollution. Low-dense, spatial expansion generates longer travel times to destinations, which increases per capita consumption of petrol, contributing to air pollution. The ecological impacts are substantial, making green space more vulnerable. The city is doing more about creating an environment conducive for more cyclists. Only a small percentage of Shenzhen's denizens are registered car drivers; however, the number of drivers per square foot is comparable to the amount of taxi drivers in Manhattan, NY (Qi and Lu, 2008). In the case of Shanghai, officials have followed suite by creating bike-sharing programs that encourage more citizens to bike instead of drive.

Both cities have pledged to cut the number of drivers on the road

and have even shut down schools after three consecutive days of serious air pollution. In terms of air pollution, China is the world's biggest carbon emitter with smog levels that surpass World Health Organization recommendations by almost 40 times. Carcinogens in outdoor air pollution have been found to cause lung cancer and are linked to an increased risk of bladder cancer. Bloomberg News (2013) quoted Gao Yiyi on the situation:

> As part of its anti-pollution plan, Shanghai will focus on building infrastructure to promote the use of alternative-energy vehicles led by public transportation, consider raising emission standards and provide incentives to companies that use cleaner vehicles. […] The city also plans to introduce new environmental standards, expand the use of cleaner-burning energy in homes and companies, and close polluting projects.

Shanghai's pollution problem is bearable most days, but the issue is almost comparable to the air pollution in Beijing. As the world becomes more reliant on cities such as Shanghai, policymakers must find efficient and productive ways to mitigate these types of negative externalities.

The 2020 Shanghai Development Plan is strategic planning for the majority of issues to come as a result of urban expansion. Namely, if the congestion charge is implemented, more drivers will be off the road and will take other forms of modal transportation. The city already has a complex underground subway system consisting of fourteen lines. The 2020 development plan looks to expand fourteen lines to twenty-one lines (Urban Development Plan, 2014). As the subway lines push outside of Puxi and Pudong, the government plans to develop new cities to help lessen urban sprawl within the Inner Ring. In particular, the three main new cities will be Jiading (Northwest Shanghai), Songjiang (Southwest Shanghai), and Luchaogang (Southeast Shanghai), with other towns spread throughout Shanghai that include Chengqiao, Baoshan, Qingpu, Minhang, Nanhui, Fengxian, and Jinshan. According to the 2020 development plan, these cities will follow the monocentric city model as a form of development with the heart of employment at the center of the cities.

The creation of these new cities should also include a public goods provision similar to the Puxi and Pudong areas with healthcare and education. The expansion plan should also detail more green space area locations. Within the Puxi and Pudong areas are public parks choked by a heavy population, which makes it difficult to find value in the space. Urban economics acknowledges that space such as the areas between

houses and public spaces like parks are valuable; thus, it is important that the 2020 development plan establish more space to increase overall individual utility. With the expansion of these new cities, the increase in metro lines will help mitigate congestion within the Puxi and Pudong areas. At first, denizens that live outside of the Inner Ring will bear high transportation and commuting costs to and from work. The addition of subway lines will push people out to these new cities, which will ultimately change their commuting patterns. Expansion of Shanghai will mitigate the effects of congestion in certain areas of the district; nevertheless, the increasing population will push boundaries of the city to maximum carrying capacity.

As China's international metropolis, Shanghai must meet the challenges associated with further urbanization such as sprawl. Growth of population will place unprecedented impacts on infrastructure. Present-day measures are taken to control congestion, such as congestion charges and auctioning license plates, but the current physical structure of Shanghai's transportation framework is limited. With great anticipation, urban planners are investigating solutions that identify how to develop a more sophisticated, integrated transportation system as Shanghai expands. It is true – the economic prosperity of Shanghai exists to promote China's provisional growth; however, the Red Dragon cannot sustain itself without the beating of its heart. As Shanghai shifts from a monocentric to polycentric city, it must take these factors into consideration.

Case of Beijing: Air Pollution

Smog blankets the city – a haze dense enough that it blots out the sun. Pollution is undoubtedly the first impression visitors form of China. The head of the dragon – Beijing – has struggled with air pollution for many years. The majority of Chinese cities today exhibit poor air quality, however, Beijing is the most prominent case. As the Chinese capital, Beijing has an innate responsibility not only to its city, but also to the country. The very air inhaled by city dwellers is the same air that is killing them. The main factors, such as coal consumption by industrial parks and vehicles, make the city almost unlivable. The effects of sprawl in present-day Beijing are a result of the very urbanization that is supposed to catapult China into the future as the world's leading economy. In order to eradicate the smog, the government will need to implement and enforce stricter regulations.

China's first priority to alleviate air pollution will be spearheaded by a reduction in coal consumption by mills and factories. The end-goal is to encourage those facilities to move towards using more environmentally-friendly resources (Stanway, 2014). But, as society sees in global news today, the world's conversations on the development of alternative resources like nuclear power and the use of compressed natural gas are contingent upon appeasing international demand and come at the willingness of global cooperation. Industrial markets such as aluminum, lead, and steel would need to be minimized to foster the growth of capacity for alternative energy resources. Air pollution undeniably affects economic progression, but even more importantly, has implications on human welfare. Within Beijing, vehicle pollution, industrial land use within Beijing, and "Yellow Dust," make the city nearly uninhabitable during the winter and spring seasons (Herskovitz, 2014). Before any qualitative analysis can be discussed, it is important to identify the historical trail of Beijing's urban land use patterns.

Located in northern China, Beijing is governed as a municipality under the national government, with 14 urban and suburban districts and two rural countries. It is surrounded by Hebei Province and is relatively close to Tianjin to the southeast. It is second to Shanghai in population and is China's political and educational center (Bjstats.gov.cn, 2014). Historically, change in land use began in the late 1970s when the Chinese government became concerned with food security. Similar to Shenzhen regarding farmland depletion, the government tried to regulate policies in Beijing by implementing a multi-phase plan to regulate land conversion. These included urban master plans to protect farmland was the first objective and was followed by the second objective of increasing construction of urban areas. Following the Open Door Policy, urbanization took off. During these phases, land was allocated efficiently, but was not moderated accordingly – farmland was zoned, but construction plans would take precedence. The transitions were dependent on the government's balance between promoting urbanization with farmland protection (Zhang, 2012), but this balance was not achieved and instead resulted in the costly externalities associated with sprawl in Beijing today.

Sprawl in Beijing can be attributed to expansion of its infrastructure system as a result of spatial growth. Of particular interest is its system of ring roads that support its spatial structure. The pragmatic growth of cities almost always at first follows predictions of the monocentric mod-

el. The interstate network in Beijing follows the same pattern. Within the first inner ring is the Forbidden City, which is surrounded by the Imperial City. The second ring is encapsulated by commercial area and the third by residential area. The remaining rings push the boundaries of the city to new construction and industrial land use. Notably, the fifth ring is planned to link ten scattered districts and the sixth ring is designed to connect multiple satellite towns (Hornsby, 2008). The prolific growth of the city is causing it to unintentionally move towards being a polycentric metropolis (Figure 4). As with Shenzhen and Shanghai, Beijing has developed plans that are expected to encourage growth and reduce the effects of sprawl. The causes of Beijing's pollution problems are clear. The state's emphasis on growth makes pollution of secondary importance. Water in China is not potable; over one hundred cities are seriously short of water. Within the six rings of interstate, the water table under Beijing has become so low that the city is actually sinking. Trees have been cut down to open land for industry, which means that China is not only losing land to desertification but also to industrialization. As a result, there are an estimated 178,000 people that die from respiratory diseases each year due to pollution. In fact, the total cost of air pollution is 8 to 10 percent of gross domestic product. To put it differently, the costs associated with pollution may be as large or even exceed total economic growth. The pollution problem is compounded by its reliance on coal – the main source of harmful particulate matter – and this causes the majority of the population to live in a dangerously polluted milieu (Buoye, 2002).

Figure 4. Beijing's Ring Road Network.

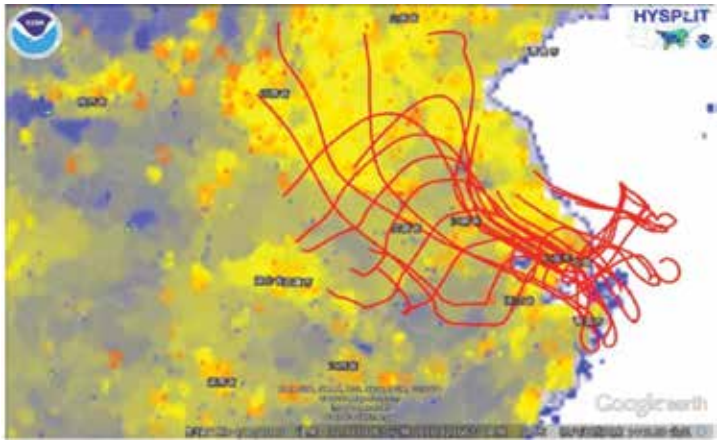
(Source: Kannaiyan, 2006)

The essence of Beijing's pollution problem involves both scale and growth. China is a global leader in carbon emissions. In terms of sulfur dioxide, Beijing's rate has already exceeded its environmental capacity, and is responsible for the acid rain that covers one-third of China's total land mass. According to Stephen Roach (2009), an economics professor at New York University, Beijing's problem is a part of China's macro system switching from pollution-intensive to more environmentally-friendly:

> The Chinese economy is heavily skewed toward exports and fixed investment. […] It is not sustainable from a macro point of view because it threatens to produce twin possibilities of a deflationary overhang of excess capacity and a protectionist backlash to open-ended exports. And it is not sustainable from an environmental point of view because the industrial-production- dominated growth model has a natural bias toward excessive carbon emissions.

With Beijing as China's political backbone, the city must move towards rebalancing these variables. In early 2013, Beijing witnessed unprecedented levels of PM – particulate matter – causing a public outcry to the government. On January 12th the Air Quality Index (AQI) reading was 755 – the charts nominally index a maximum reading of 500 (The Economist, 2014). The index is based on standards stated by the American Environmental Protection Agency (EPA). The AQI has a descriptive measurement from 'Good' to 'Hazardous'. An AQI score between 0 and 50 would classify as 'Good' while a score of 300+ would classify as 'Hazardous,' meaning that people may experience serious health effects (Aqicn.org, 2014). Industrial pollution, according to the Chinese Ministry of Health, has made cancer China's leading cause of death (Larsen, 2014), and factory mills and industrial areas in Beijing and Hebei Province contribute to this statistic. A 2013 geothermic land-satellite by the National Energy Administration reveals the wind patterns that carry pollution from coal-burning factories in northwest and northern China to cities such as Beijing and Shanghai (Figure 5).

Figure 5. Geothermal landsat depicting pollution by wind patterns.



(Source: HYSP landsat, 2013)

In addition to pollution from coal consumption and vehicle exhaust, Beijing and northern Asia witness a seasonal phenomenon known as "Yellow Dust" during winter and spring. Winds from Inner Mongolia and Kazakhstan kick up dry soil particulates from dust storms carrying them across northern Asia. They have even reached as far as Korea and Japan (Herskovitz, 2014). The scenario in Beijing is even more disconcerting because the dry soil particulates mix with pollutants from factory mills and industrial areas. The combination can cause serious health effects to those without proper breathing masks due to multiple toxins like sulfur and aluminum. Even though this natural phenomenon is difficult to protect against, the result of its combination with China's already-polluted air poses an even greater risk to city dwellers.

If Beijing's pollution is to improve, the country of China must take measures to reduce its use of coal and natural resources for energy. Taking control of the pollution issue is not only a city issue, but more so an issue to be wrestled with by the wider Chinese population. It is a rarity to see blue skies in Beijing or in other Chinese cities alone, but the government is showing encouraging signs that it is ready to tackle its pollution issue.

Solutions

Persistent air pollution has prompted the government and even entrepreneurs to take steps to identify solutions. For the national party and policymakers, this means rethinking current economic models that rely upon heavy industry for a large percent of gross domestic product. Recently, Beijing has either charged a maximum fine or shut down factories or power plants for their output of air pollution. Forty percent of the 7 million people worldwide who died from air pollution in 2012 were from China (Bennett and Chen, 2014). This haunting statistic should drive Chinese officials to tighten environmental legislation. As Beijing continues to sprawl, the economic activity in the area will increase, but it should do so to sustain a steady-state subsystem similar to the case of Shenzhen. Among other solutions are implementation of vehicle restrictions and placing standards on gasoline. Furthermore, a look at waste absorption capacity and a pollution tax might serve as potential solutions.

Of the myriad of entrepreneur solutions, several have gained nationwide attention, including a roof sprinkler systems (Kensley, 2014), wind tunnels (Meng, 2014), and electrostatic "vacuum cleaners" (Wan, 2014), all sharing the same objective — to remove smog particles from the air. From the air filters in people's homes to the facemasks worn on a daily commute, the number-one priority among city dwellers is personal safety. The government is committed to rectifying the issue; in fact, Beijing will allocate 760 million yuan (estimated 124.64 billion USD) to improve the city's air quality by 2017, says Mayor Wang Anshun (2014). Investment has gone into the creation of pressurized domes and will extend into the provision of cleaner factories. For example, the International School of Beijing has built a $5 million two-domed structure that encloses an outside recreational area where students can play (McKirdy, 2014). The pressurized dome is inspected multiple times during the day to ensure that the amount of particulate matter is absent. As CNN's Dayu Zhang (2014) commented, "Until the skies clear, life in the bubble seems surprisingly good".

Among other solutions is a pollution tax that the Beijing government would impose on mills or plants equal to the external cost it has on society. For O'Sullivan (2007), placing a buffer between a polluter and its potential victim is the easiest way to reduce exposure to pollution. However, the tax would need to be combined with a zoning measure. If not, the polluter would be free to migrate, increasing pollution in certain areas. A combination of an industrial zone and a tax would reduce pollution to a socially optimal level to minimalize exposure (O'Sullivan, 2007). The tax might increase production costs of the material, which would in turn increase the cost of the product. If the product cost increases, then the demand for labor should decrease. According to O'Sullivan (2007), the tax would decrease pollution for two reasons: 1) the producer would decrease pollution as a means to avoid the pollution tax itself, and 2) the increase in the price of the product decreases total product production. A tax would increase the relative attractiveness of the city, too, because the air quality would improve.

Tradeable permits are another effective tool used by the Beijing government to place on heavy polluters. The permit takes a cap and trade approach not to impose a tax, which would reduce demand, but instead enforces a quota – a set amount of pollution that it will allow. The coal cap being imposed affects the entire country of China, not just Beijing. According to Greenpeace Asia, by the end of 2017, 12 of 34 provinces have included coal consumption targets into their master plans including Beijing at 50 percent. The majority of polluting plants are located in northern China, so the highest targets tend to be in those areas rather than in the Yangtze River Delta or the Pearl River Delta. These coal measures imply a reduction in coal consumption by an estimated 350 million tonnes. Coal's consumption has already dropped significantly compared to previous years (Table 2). As coal consumption has decreased, renewable energy like solar and wind capacity have both increased since 2012 (Li and Myllyvirta, 2014). These steps indicate fundamental changes in China's developmental models to curb air pollution.

Table 2. China's National Coal Consumption Growth Rate

Consumption Growth Rate	
Year	Coal Consumption Percentage
2003	19.20%
2004	17.50%
2005	10.60%
2006	10.80%
2007	5.60%
2008	3.70%
2009	7.40%
2010	9.50%
2011	9.40%
2012	2.80%
2013	2.60%
2014	3.01%

(Source: Li and Myllyvirta, 2014)

During the Asia-Pacific Economic Cooperation summit (APEC) held in November 2014 in Beijing, pollution control measures were implemented to dispel some of the smog. Blue skies were seen throughout Beijing, but the smog returned once the strict regulations were lifted. Officials were able to observationally validate that the restrictions imposed had worked; in fact, the government has stated that a more fundamental approach will be taken to give Beijing permanent blue skies by the year 2030. Ten thousand plant operations in and around the city were stopped and an odd-even license plate scheme was implemented to reduce the number of vehicles on the road. However, these anti-pollution measures were deemed costly and not "sustainable," affecting 3 percent of the country's industrial output (Marin, 2014). Time spent in the next few months will allow the Beijing government to determine cost-effective ways to rid the city of smog.

Possibility is present – Beijing's smog problem is not irreversible. Clean air has multiple implications on daily life, the attractiveness of the city, and overall human welfare. New cases of respiratory illnesses will be reduced and those already diagnosed will have a chance at a healthier future. The future of Beijing and of China is contingent on the national party making daily life better as a result of clean, smog-free air.

Conclusion

The Red Dragon symbolizes the growth of China's East Coast through urbanization. Similar to a dragon, the head of China also relies on its stomach and tail to survive. Chinese officials must recognize the undeniable interdependence of Shenzhen, Shanghai, and Beijing as they relate to the country's future. Shenzhen as China's first Special Economic Zone, Shanghai as China's international metropolis, and Beijing as China's political center, represent the urban venerability inspired by Mao Zedong to bring about economic prosperity. Understanding the undeniable interconnectedness of tier 1 cities like Shenzhen, Shanghai, and Beijing is pivotal to the country's future. More so, the state must learn from how these cities have grown and apply that knowledge to the expansion of tier 2 and tier 3 cities in the future. As cities emerge and continue to grow, what has been the normative mindset of the state will be challenged. It will challenge what it knows, what it has known, and what it can do. The consequentialist factors associated with low-dense, spatial growth along China's East Coast have perpetuated externalities that change how the state plans and builds its cities.

Each case represents a challenge of urban growth. With sprawl we notice that the non-agricultural expansion of land makes the environment vulnerable. We are able to deduce that sprawl creates disharmony within the city bringing about congestion and challenging infrastructural systems. China's mindset for economic prosperity has been contingent on industrial growth within cities which has created negative externalities such as smog and other types of pollution. Planners, officials, and policymakers must be more forward-thinking to create more sustainable cities. Reconsidering industrialization as the single most important part of economic growth while working to create a steady-state subsystem to balance economic and ecological needs will create a more harmonious society. For the sake of the world, and itself, China must rebalance how it builds its cities: rather than rapid urbanization that spurred sprawl in the past, China's eye to the future should focus on sustainable urbanization that will carry it into the future.

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Female Empowerment and the Informal Economy

Faculty Sponsor
Dr. Robert Blanton

Abstract

The informal sector is a puzzling concept that encompasses a multitude of occupations ranging from street vending to home-based operations that are recognized differently by various states. What is not perplexing is the makeup of the informal sector. It is almost entirely dominated by women. In addition, their numbers are mainly confined to lower income ventures when compared to men. What is discovered is that the informal sector, like other institutions, is a gendered process, where men often secure and dominate higher income ventures despite being outnumbered by women in the sector. Women have less bargaining power than men and must contend with higher levels of income insecurity due their social welfare needs not being met. These needs include lack of education, lack of access to health-care, childcare, and shelter. There is also a linkage between being poor and working in the informal economy. By this knowledge it is easy to see that women are placed in an even more disadvantaged position. However, organizations such as the Self Employed Women's Association of India (SEWA) argue that women led organizations are more effective at mobilizing women in the informal economy.

Introduction

According to the World Development Report of 2013, employment is a central factor in economic and social growth (2013: 2). Creating an infrastructure necessary to alleviating poverty, jobs are a transformational vehicle, providing for social and economic progression and ultimately a sustainable existence by improving the functionality of cities, connecting the economy to global markets, protecting the environment, fostering trust and civic engagement, and/or reducing poverty. While these positive effects are often associated with areas of formal work, they are also found in the informal economy. Because transactions in the informal economy tend to be based on bartering for goods and services rather than depending on the exchange of official currencies, they are untaxed, unregulated, and mostly overlooked when governments compile statistical information.

Work in the informal economy is in fact invisible to most governments (ILO 2011). As most states do not recognize informal employment as employment at all, the various jobs associated with informal jobs do not receive protections from the state. In informal economy jobs, then, employment comes without labor or social protection (Chen 2007: 2), so informal workers in these jobs are subjected to high levels of job uncertainty, no recourse regarding workers' rights, and, in some cases, no immediate ways to secure payment for services.

Gender in the Informal Economy

The informal economy is particularly noteworthy when examined through the lens of gender. Despite advances made over the past decades, women are still underrepresented in the formal workforce, particularly in high-ranking positions. Only twenty-five percent of women hold senior management positions in the global economy (United Nations Department of Public Information 2013). In developing countries, women are generally concentrated in low wage agricultural markets (Payne and Nasser 2012). By the same token, women constitute 70% of the world's 1.3 billion people living in extreme poverty, defined as subsisting on less than a dollar a day (United Nations Department of Public Information 2013).

Barred from the private sector due to discrimination and/or lack of opportunity, women must find other means to earn a living outside of the formal economy.

Chen (2001) affirms that most women who are economically active in developing countries are participants in the informal economy. In some countries in sub-Saharan Africa, for example, virtually all of the female non-agricultural labor force is in the informal sector (2001: 2) Similarly, the informal sector accounts for over ninety-five percent of women workers outside agriculture in Benin, Chad, and Mali. In India and Indonesia, the informal sector accounts for nine out of every ten women working outside agriculture (2001:2). In ten Latin American and four East Asian countries, half or more of the female non-agricultural workforce is in the informal sector (2001: 2). The informal sector overall is a larger source of employment for women than men (Chen, 2001: 2), and according to Chant & Pedwell (2008), it often functions as the entry point for women. While some of these women move on to formal economy jobs, many end up remaining in the informal sector for a variety of reasons, from discrimination in the formal economy, exploitation in the informal economy, and raising family, among others(Chant & Pedwell 2008); there is little room for upward mobility.

History

The informal economy began to gain recognition by scholars in the early 1970s, as they began to explore the rise and significance of the informal economy, as well as its role in broader development processes. According to Hart (1973), the rise of the informal economy occurs as inadequate wages, price inflation, and an increasing surplus in the requirements of the urban labor market lead to a high degree of informality in income-generating activities. To potential workers, the appeal of informal economy jobs is the ease of entry and because they do not necessarily require high skills. The ever infamous adage of "making ends meet" embodies why this economy arose to begin with and why it persists.

Towards better understanding this sector, Hart (1973) began to document the wages and expenditures of civilians in developing countries such as Ghana, compiling data on the average wage of urban laborers in Accra and listing the necessities that eventually consumed a family's budget and the deficits that remained. For example, food prices in Accra in 1966 enveloped 80 percent of the minimum daily wage (Hart 1973).

Twelve years prior, wages increased 40 percent yet commodity prices doubled over that same period of time (Hart 1973). After accounting for rent, transportation, bathing, and the like, a typical family would accrue debt as a means of maintaining their living conditions. This predicament held true even for those working more than one job as workers were also subjected to low hours compounded with their low wages (Hart 1973). The circumstances encouraged people to engage in "petty capitalism" as a supplement to wage-employment. Urban workers would mostly engage in the sale of consumer goods ranging from wrist watches to refrigerators, most of these goods stolen (Hart 1973). In this case the informal sector presented a short-term "salvation" of sorts to the poor people of Ghana.

Hart's account stands in stark contrast to the "Lewis Turning Point", a concept developed by economist W. Arthur Lewis. He posited that with the proper integration of resources and economic policies, traditional low-income economies could be transformed into dynamic modern economies (Chen 2012). During the transition, petty trade, small-scale production, and casual jobs would be absorbed into the formal economy; thus disappearing, transferring human capital into newer sectors, generating modern jobs that would compensate for the surplus of traditional laborers (2012). This would, in turn, lead to a point in which wages would increase above the subsistence level.

This model held true for developed countries such as Japan after WWII where the society was rebuilt and unemployment declined after a time. However, this dynamic is not apparent in many developing countries. Rather than being merely a transitional phase, it was found the informal work persisted, and that an increasing number of the labor force was relegated to a "marginal existence" (Singer 1970), that is, they remained casually employed, subjected to intermittent employment, participating in disguised employment, or were just openly unemployed.

Singer argued that growing unemployment was closely associated with modern science and technology (Singer 1970); two fields that are mostly associated with richer countries, due to the quantity and quality of innovations in those fields. He posited that tendencies within the field of science and technology introduced a degree of internal dualism – drastic disparities between standards of existence that persisted and even worsened over time -- in under-developed countries.

Singer also posited that the interrelations between richer and poorer countries in the global economy contain elements that make rapid growth possible for richer countries and difficult for poorer ones (Singer 1970). He theorized that as richer countries develop and share more refined technologies, which are both capital-intensive and costly, and as mortality rates decline due to health advances, population explosions and rising unemployment begin to ail developing countries that are unable to develop these technological capacities (1970). The development of large industrial centers that require more reliance on machinery and fewer – albeit highly-skilled -- laborers offered virtually no opportunity in the undeveloped markets that possess an enormous amount of unskilled laborers. [2]Singer's work was path-breaking in this respect, and had a major impact on the International Labor Organization (ILO) and the international community as a whole in that it implicated developed countries in the economic growth of poorer countries.

Prior to 1973, the ILO, under the presupposition that the informal economy would eventually be absorbed by the modern market, was mostly concerned with management development programs and vocational training for graduates (Bangasser 2000). However, trends of urban migration coupled with increased unemployment became apparent in the late 1960s. As a modern job gap became more prevalent, so too did economic activity in the informal sector. It was in 1967 that the World Employment Program was introduced as a proposal and later enacted in 1969. Designed to bring employment generation to the forefront in national planning and development efforts, the WEP presented a thesis that countered the notion of modern markets eventually absorbing more casual and informal ones.

"Missions" were then generated to help assist and assess the development problems of developing countries, with the mission to Kenya being the most famous (2000).

With ninety percent of the population concentrated in rural areas and twenty percent of urban income being remitted to the rural area, Singer and Jolly (1973) found that the relationship between the urban and rural portions was weakening in Kenya. Initially, the turnover for labor employment between the urban and rural populations was balanced, with urban workers returning to their villages after a stint in urban employment. Yet this trend began to dissipate due to a raise in wages for the urban community (Singer and Jolly 1973). This policy was caused and supported

by capital-intensive technologies in the modern urban sector (1973). As movement into the cities exceeded movement back to rural areas, a surplus of labor developed as increases in formal work did not keep pace with the rapidly growing labor pool. A key result of this situation was the growth of the informal sector (1973).

Related work found that this dynamic was heavily gendered and apparent in other countries. For example, in his analysis of Ghana, Hart found that in the city of Nima, eighty percent of women were sales workers with the remaining percentage participating in manual occupations, mostly working as self-employed tailors (1973). Outside of the trading venue, women were mostly concentrated in prostitution (Hart 1973).

In order to alleviate unemployment and train a skilled workforce, the state of Ghana used the Workers Brigade, a public sector, para-military organization established in the late 1950s which provided opportunities for work in primary and secondary production for both men and women. The problem with this organization lay within its patriarchal structure; women eligible to enlist in the Brigade were to be "engaged in cooking, sewing, marketing of produce, office work, farming, poultry rearing, food preservation and household duties in the camps" (Hodge 1964: 115). Living in separate training camps, resources were disproportionately distributed between males and females, and women received inadequate facilities and no leadership. It was fairly clear that the Workers Brigade gave top priority to occupying the time and energies of young men.

While the Worker's Brigade was an attempt to mobilize informal workers, it did little to integrate women into the formal economy.

Solutions to problems in employment are not always found in governments. India in the 1990s was plagued by alcoholism in the male population, which threatened to drain the incomes of individual households. Confined to mostly agricultural work, the women of India mobilized under their own leadership.

In 1990, women dairy farmers in India constituted eighty-five percent of the estimated seven million employees in this sector (Shefner-Rogers et al. 1998). Of these, only sixteen percent were members of a dairy cooperative, a channel through which milk is marketed. Consequently, the majority of income from milk sales was controlled by men, despite the fact that it was earned by the work of women. This predicament was worsened by the fact that men held a majority of membership positions in the village-level cooperatives, and they also constituted the majority of its

paid employees. Disempowered by this patriarchal system of labor, women were at the mercy of the earning power of their male counterparts.

Fatigued by their husbands spending their dairy earnings on liquor, women in the village of Suburdi formed a women's club, the *Mahila Mandal*. They began orchestrating a grassroots campaign to shut down local breweries in an attempt to eliminate the reckless consumerism of their husbands. When breweries refused to desist, the women destroyed them and established their village as an alcohol-free zone (Shefner-Rogers et al. 1998). The actions ultimately introduced these women to the participatory power of mobilization and encouraged them to take control of their households. Empowered by their success, women were able to become members of cooperatives in greater numbers, and used their money to invest in their families. This group was indicative of a broader pattern of female empowerment in India.

Instruments of Empowerment

The examples of Ghana and India present a theme in the sphere of gender relations in the informal economy. It is a theme that reflects some of the negative values of patriarchal societies, the assumption that female labor is worth less than male labor and that women are better-suited to work under men than alongside them. This leaves women disempowered with little recourse in helping them carve out a decent living compared to their male counterparts. They face higher levels of income insecurity, little to no labor protection or social welfare, and are not recognized as integral to growth (Chen et. al 2005; ILO 2011). While these circumstances befall most participants in the informal sector regardless of gender, it will be shown that women are at a higher risk than men in most scenarios. It should also be noted that men are indeed integral parts of the informal economy, but when they are mostly concentrated in higher income activities when compared to women (Chant & Pedwell 2008), it becomes hard to argue that the informal economy is a gender-neutral process.

As these discrepancies remain prominent in the informal sector, grassroots organizations have come to the forefront to help ease the problems women face in the informal sector. To show some of the ways in which organizations can effectively mobilize to overcome some of these obstacles, I will examine the Self Employed Women's Association of India (SEWA).

The Case of SEWA

In India, it is estimated that ninety million of the 314 million people in the workforce are women (Datta 2003: 353). Almost ninety per cent of them employed are in agriculture and related activities, which include work in informal household industries, petty trades and services, and construction (2003: 353).

SEWA was registered in India as a trade union in 1972 by Ela Bhatt, who was a trade union lawyer in the Textile Labour Association (TLA) at the time. SEWA consists of self-employed women workers who voice their issues, organize as a collective, and pursue initiatives that will organize women for full employment. SEWA differs from traditional trade unionism in that, once recruited, the women form trade cooperatives in an effort to become owners of their labor (Webster 2011: 110). SEWA is both "an organization and a movement" according to their official website; it incorporates more than 3000 self-help groups and collectives, owned, run, and controlled by the workers themselves (Jhabvala and Sinha 2006: 178).

Bhatt recognized a need for a mobilization of informal workers after she realized that the work being done by the wives of the textile workers was unpaid domestic work (Webster 2011: 106). They were also performing vital economic activities such as street vending, embroidering from home, recycling and various labor services. The works were not only important sources of household income, but also contributed significantly to India's GDP (2011: 106). Possessing adequate skills that helped generate wealth, Bhatt came to discover that the women did not need counselling on how to run their households, instead, they needed help in defending their interests as paid workers as they were not protected by any of the labor laws in India at the time (2011: 106). In 1969, after living in Israel and taking a course on labor and cooperatives, Bhatt managed to persuade the president of the TLA to create a separate union for women within the TLA (2011: 106), and thus SEWA was launched.

Initially SEWA's claim to being a trade union was dismissed by various officials due to preset notions of what a worker was, and being in the formal economy constituted the meat of those notions (Webster 2011: 107). As mentioned earlier, these notions still exist in India as well

as other countries, which is why workers in the informal economy still do not possess protections comparable to those in the formal economy, and women even less so.

To help alleviate the risks associated with informal employment for women, SEWA has aggressively pursued initiatives of social security in order to increase and maintain workers' productivity, thereby increasing their economic security. The elements associated with social security, to SEWA, include basic elements of healthcare, childcare, shelter, education, and insurance (Jhabvala and Sinha 2006: 179). Meeting the basic needs is foundational to further mobilization; once basic needs are met, women can then become self-sufficient and maintain livelihoods on par with their male counterparts.

SEWA's programs have shown that social protection plays a vital economic support role to women in the informal economy. Its relevance is validated by the longevity of the programs; some started within the same decade SEWA was officially established, others in the 1990s. The common theme among these programs is that they are run by cooperatives that are headed by women. SEWA also has a global presence. They are affiliated with various organizations such as Homenet, Streetnet, and also have a division in Turkey. They have adequately shown that women are effective at mobilizing each other, and are better-suited at identifying problems most women in the informal economy face.

Assessment and Broader Implications

The economic situations of women in the labor market are often tenuous; they are often concentrated in small-scale operations with virtually no job security or social benefits from the state. Since states do not formally acknowledge the informal economy as integral to growth, initiatives to address the participants move at a muzzled velocity, if at all. This is bolstered by the fact that some states do not include the informal economy in official statistics, and for those that do, disputes of what constitutes as informality arise, thereby leading to skewed estimations. These skewed estimations, preceded by a prejudiced supposition of what constitutes "employment" have led to states being negligent of the realities faced by informal workers. It is only through organizations such as SEWA that governments are made to address the issues faced by informal workers. Through SEWA it was shown that informal workers, more specifically informal workers who are women, can nonetheless mobilize to overcome

these obstacles and provide services and rights for themselves in the absence of support.

However, until formal employment is readily accessible to a majority of a state's populace efforts to recognize and integrate the informal economy into the formal economy should be attempted. Integration into the formal economy includes social security coverage, an extension of workers' rights, and a willingness of state governments to address the grievances of informal workers. Using the case of SEWA in India, I will suggest some of the basic components of policies towards incorporating the informal economy and better recognizing and empowering female labor.

Solutions

Integrating the informal economy into the formal economy is a difficult issue, and has been the subject of much contention among scholars and policy-makers. Disagreements arise over its legitimacy as well as effective ways to operationalize labor. Four schools of thought are prevalent in the analysis of the informal economy and how to best approach the phenomenon. These schools provide legitimate insights, but they overlook critical linkages that are associated with the informal economy.

I. The dualist school, which is the most prevalent, asserts that the informal sector consists of marginal activities that provide income for the poor and a safety net in times of crisis (Chen 2006). Because of this adherence to a survivalist paradigm, the dualist school sees the informal economy as a phenomenon that can be fixed with the creation of modern jobs that provide credit and business development services to informal operators (Policies & Programmes n.d.). In addition to credit services they also believe that basic infrastructure and social services be provided to families in order to alleviate vulnerabilities such as inadequate housing and access to basic resources which include electricity and proper waste disposal (Policies & Programmes n.d).

Despite its popularity, the dualist school overlooks the fact that the informal and formal sectors are intimately connected. There are several instances where they intersect, such as the relationship between waste pickers and garbage and recycling centers. Waste pickers are not formally

employed nor are wage thresholds enforced yet they contribute greatly to societies through their work in areas where municipal garbage collection is not present.

> II. The structuralist school posits that the informal sector should be viewed as a set of micro-firms which are essentially extensions of larger firms (Chen 2006). Proponents of this system assert that workers would serve to reduce input and labor costs, thereby increasing the competitiveness of large capitalist firms. They differ from dualists in that they emphasize the formal and informal modes of production as being inextricably linked and interdependent. Structuralists also believe that the capitalist nature contributes to the growth of the informal economy rather than a lack of formal job growth (2006: 6).
> Their solutions to the informal economy revolve around the government addressing the unequal relationship between large firms and micro firms and regulating both employment and commercial relationships (Policies & Programmes n.d.).

Structuralists, however, overlook the growing evidence that participation in the informal economy does not necessarily produce enough revenue to sustain a living. Also, by not addressing social needs such as housing and healthcare, a regulatory policy intervention between informal workers and large firms does not guarantee an escape from poverty. In addition, if structuralist policies were implemented they run the risk of further enlarging the informal economy without advancing it into the formal economy. As noted by the ILO (2011), if trade leads to increased labor competition for formal firms, they may be forced to become informal or to even rely on informal production methods in order to remain competitive.

> III. The legalist school views the informal sector as being composed of micro entrepreneurs who choose to operate informally in order to avoid the taxation, time, and effort of formal registration (Chen 2006: 6). Attributing the reluctant nature of these entrepreneurs to the costly and cumbersome procedures of governments, legalists advocate for simplified and less costly bureaucratic procedures that will effectively integrate informal entrepreneurs (Policies & Programmes n.d.). In addition to simplified procedures,

legalists also advocate the idea that extending property rights to the assets of informal workers will create an environment where informal workers can seize their productive potential (Policies and Programmes n.d.).

Legalists fail to account for the complexity in the makeup of the informal sector. They cast a broad net over informal workers, essentially categorizing them all as entrepreneurs when a significant number of them work for micro firms that are represented in collectives. In addition, these collectives do engage with their respective governments. Some of these collectives abide by sets of rules and regulations and are registered by the government. The problem lies in the fact that equal representation between the sexes in these collectives is not prevalent, and not all workers receive the same wages. The dairy cooperative in India reinforces this assumption.

IV. The school of voluntarism adopts a more pessimistic view of informal workers by also focusing on their avoidance of regulation, but suggests that these acts are deliberately performed to enjoy the benefits of not being regulated (Policies & Programmes n.d). This approach makes the mistake of separating a minority category that would influence preventative legislation.

As the informal economy is not a homogenous group in terms of sex and occupation, each school makes legitimate arguments and assumptions, yet because of the informal economy's heterogeneity integral policy structures that encompass all schools should be pursued. These policies should facilitate the integration of the formal economy, and address the exclusive problems faced by women.

Distinguishing where women in the informal economy differ from men lies in their diverging paths during youth. For example, in India poor young girls are often more likely to be used in child labor and less likely to attend school; consequently their health, nutritional needs, and education are a low priority (Jhabvala, R., & Sinha, S. 2006: 170). This pattern of exploitation continues during adolescence, as they combine the roles of being productive and reproductive while simultaneously performing unpaid caring work (2006: 170). The end result is a low-skilled, uneducated female who may have developed health issues of her own in addition to being a mother. In such cases, women are essentially confined to the

informal economy while men are in a relatively better position to address poverty or even bypass it completely.

In the informal sector, street vendors are among the most visible as they represent a significant share of total employment in the informal economy. They occupy between seventy-three and ninety-nine percent of employment in trade in most developing countries (Chen 2001: 4). In India, this occupation is growing and burdened by bureaucratic scrutiny. In all, an estimated eleven percent of all urban workers, approximately 14.4 million, earn their livings by selling goods or services from the streets (Chen et al. 2012: 10). While street vending is a prominent employer it also provides an important marketplace in which goods and services can be bought at affordable prices and positioned in convenient locations. Yet prior to 2014, street vending was considered an illicit activity and vendors were continuously harassed by local government and the police. In addition, as cities and towns around India modernize and facilitate growth, street vendors are looked upon as a burden and hindrance to urban planning. They are often evicted to make way for large-scale urban infrastructure projects.

Seeing a need to support the vulnerability of street vendors, the National Association of Street Vendors of India (NASVI) was established in 1998. Among their initiative of giving a stronger voice to street vendors, priority was placed on surveying the more obvious issues faced by street vendors. Composing a report of seven cities in India in 1999, the troubles faced by street vendors was brought to the forefront (Sharit 2001). In addition, the report also presented unique issues faced by street vendors in relation to sex. It was found that women in particular face exclusive problems including a lack of adequate childcare, discrimination in the granting of loans from credit societies, greater poverty than their male counterparts, and not being allowed to occupy space on the pavement (2001: 23).

In addition, a common theme of local police corruption aggravated the ongoing injuries, with some women being extorted into paying protection fees in order to secure space and/or permission to sell. Once this report was brought to a workshop headed by the Ministry of Urban Development, the National Task Force on Street Vendors worked jointly with the NASVI to produce a national policy with and for street vendors. In 2004, [5]a policy was adopted that recommended registration and identification cards for street vendors, and amended legislation and practice to reduce their vulnerabilities (Chen et al. 2012: 10). The implementation of this

policy fell on deaf ears as few state governments framed their own state policies based on the national policy.

Due to the lack of implementation the NASVI called for a national law and even received support from the Supreme Court in 2010 when judgment was made for the "appropriate government authority to enact a national law by June 2011 to protect the fundamental rights of vendors and hawkers to carry on their business" (Chen et al. 2012: 10). These campaigns, however, met with opposition by government officials, more specifically, the Minister of Housing and Poverty Alleviation and the Minister of Law and Justice. Claiming that the appropriate government authority resided in state or local governments, the officials asserted that a national law was deemed unnecessary. Yet the sheer tenacity of the NASVI and other organizations that helped change the views of these officials and their support was enlisted for a national law in 2011 (2012: 11). A draft law was formulated by the Ministry of Housing and Urban Poverty Alleviation in consultation with the NASVI and other organizations of street vendors and was presented to the Parliament of India for its decision at the winter session of 2012-13. It was passed in the lower house in 2013 and the upper house in 2014. It allowed for registration of street vendors as well as establishing demarcated areas for vending that were protected by law.

The measure in India to protect street vendors does not adequately address home-based workers, who are eighty-five per cent female (Chen 2001[6]: 4). It is at this point that other social and economic woes must be addressed, such as housing and opportunities for home-based workers to expand their operations in order to live a more decent life. Questions, however, arise as to whether programs geared towards addressing these issues are viable and, more importantly, sustainable. SEWA provides not only an answer but the process as well.

Through SEWA, cash loans for the purchase of supplies and the purchase equipment or upgrading of equipment for home-based workers were initiated in 1977. There were 173 applicants in 1978, but the number rose to 29,500 in less than two decades (Obino 2013: 3). The repayment rate was greater than ninety-five percent, on par with and even exceeding more mainstream banks in the area. Because of the success, SEWA began expanding loans from Rs 2000 up to Rs 100,000 in 2013 with interest rates ranging from twelve to seventeen percent. The loans are usually paid back in decreasing rates of eighteen percent in 35 monthly installments. When

gathering information on what exactly their clients were purchasing, the bank found that over forty-four percent of the money borrowed was being used for the purpose of repairing or upgrading the family house. As Obino (2013: 4) notes "(I) n the vast majority of cases, housing improvements were explicitly linked to the members' desire to expand their productivity" (2013: 4). This is explained by instances where improvements to electrical connections allowed women to utilize sewing machines to produce items to sell.

Yet improving the house can only be achieved if housing finance is available for a woman and her family. As the lack of access to land serves as a key source of disenfranchisement for women (Property Rights and Tenure Security n.d.) the MHT answers this issue by providing housing assistance to all of its members. The house is a key vehicle in escaping poverty as it allows for women to access loans and adequately protects and stores their assets (Property Rights and Tenure Security n.d). The MHT expands the offer of housing loans beyond SEWA Bank's own limitations by offering larger loans tailored to the incomes of women in the informal economy and by shifting the focus of housing interventions from single individuals to entire communities (Obino 2013: 8). Most important is their notion of transitional tenure. It is a concept of a guaranteed ten to fifteen years of non-eviction for loan applicants. In accordance, once a loan application is submitted, MHT officers obtain assurance from urban planning regulations regarding evictions in the relevant settlements. This security frees the mind of applicants and allows them to fully invest in the house and not weigh the costs associated with an untimely eviction. In addition, a woman's husband is also included as a co-recipient of the loan and loans are only processed to active members that are backed by a guarantor. As the MHT provides awareness and training activities to the areas they service, the guarantor is usually a neighbor or family member. Coupled with investments to the house, this promotes a more robust business, placing home-based women workers in a better position to help their families escape poverty.

The actions of the NASVI and SEWA effectively integrate most of the policy initiatives carried by the four schools. The expansion of rights and formal registration for street vendors echoes the policy initiatives of legalists and, to a great extent, the school of voluntarism. The initiatives of the SEWA Bank and MHT help to establish social coverage advocated

by dualists. In addition, as home-based workers become more independent and repay their loans, they will be able to adequately address the issues of poverty, a notion overlooked by structuralists.

Conclusion

Ultimately, the informal economy is a persistent part of the global economy. The formalization of every informal enterprise is practically unfeasible and economic downswings, which contribute to the growth of the informal sector, occur regardless of one state's initiatives. In addition, many people look to obtaining revenue outside of regulation and taxation. Furthermore, there is no one comprehensive piece of legislation that will be inclusive of the heterogeneity of the informal economy. The specific challenges faced by women such as housing and access to credit may not be issues faced by men. In addition, the gendered process of the informal economy almost guarantees the exploitation of women in various informal sectors. The situation of women dairy farmers in India reinforces this point. Conversely, patriarchal norms present a formidable obstacle to gender equality, as the Workers Brigade in Ghana has shown. Therefore, a balanced mix of policies addressing the needs of informal workers both men and women needs to be undertaken. However, until states abandon their patriarchal notions, women-led organizations such as SEWA will often do a more efficient job with addressing and mobilizing the overrepresented population of women in the informal sector.

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Family Income's Effect on Child Development: A Look at Two Parent-Mediated Pathways

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Abstract

This paper reviews a body of literature to assess the relationship between parent/family income and child developmental outcomes. It addresses two parent-mediated pathways by which income affects child development. The Family Stress Model (FSM) looks at how financial strain affects parents' stress, and how this stress or psychological disturbance affects parenting. The Parental Investment Model (PIM) looks at parental investments of time, money, and resources. PIM is further explored via parents' socioeconomic status and how class position influences what values parents instill in their children. Overall, more negative outcomes are found in low-income children. Recommendations include methods to influence income directly, such as higher wages, and the broader suggestions of redefining poverty and what it means to be poor, and family intervention programs. Going forward, researchers, policy-makers, and professionals should keep in mind the complex interaction of income and other variables within the context of the nation's current financial disparity.

Introduction

Researchers are continually interested in the connection between parents' income and a child's developmental outcomes. They want to know if a family's income significantly impacts a child and in what ways. Fervor is only added to this area of study in light of the growing age of inequality in the United States and the desire to understand the effects of financial disparity on children. A look at current trends in today's economic climate supports the need to understand income's effects on children in the present context:

> Fom 1950 to 1975, the real incomes of the poorest 40 percent of families almost doubled. In contrast, from 1975 to 2000, incomes grew very slowly at the bottom and in the middle, but soared at the top…the average income of the top 5 percent of families more than doubled (Gilbert, 2015, p. 263).

Relatively recent changes in American culture and the economy have significantly influenced the attainment of income. The shift from a manufacturing, industrial era to an information era leaves many working class people unable to find jobs that will adequately support their families. The Great Recession of 2007-2009 left the country with an unemployment rate of ten percent, affecting minority men the most (U.S. Bureau of Labor Statistics, 2012). Additionally, the changes in family patterns include an increase in single-parent families since 2007 (Vespa, Lewis, & Kreider, 2013). Overall, Vespa et al. (2013) note that "the economic welfare of all family groups with children under the age of 18 declined since 2007" (p. 13).

Gilbert (2015) mentions that in 2011 "30 percent of custodial mothers and their children were surviving on incomes below the official poverty line" (p. 87). The amount of income a family earns can either support or hinder physical, social, emotional, cognitive, and behavioral aspects of development. Tina Rosenberg (2013) comments that "by the time a poor child is one year old, she has most likely already fallen behind middle class children in her ability to talk, understand, and learn" (as cited in McGlynn, 2014, p. 56). Research is laden with statistics such as, "the proportion of students from upper income families who earn a B.A. has increased by 18% over a 20-year period while completion rates of

poor students have grown by only 4% during the same period" indicating income's long-term effects (McGlynn, 2014, p. 55). Income, however, proves to be difficult to isolate. It is even more challenging for a researcher to reach direct, causal conclusions. A family's financial means is part of a complex relationship with several factors mediating its effects. These mediating factors, or pathways, help to explain how income influences child development and in what ways. In short, by focusing on two major parent-mediated pathways, one can see how income affects child development, with a larger proportion of negative outcomes displaying themselves in low-income children.

The Family Stress Model (FSM)

The Family Stress Model (FSM) describes how financial burdens create stress in parents, which in turn affects positive parenting. Positive parenting is parenting "that balances structure and predictability with warmth and affection [and] promotes optimal outcomes for children, including for children living in poverty" (Mistry & Wadsworth, 2011). Lee, Anderson, Horowitz, & August (2009) consider the connection among low income, parental depression, and quality of parenting as well as social support. The sample included two hundred ninety families with children said to be at risk for problem behavior. The authors gathered the sample from an intervention program from a larger study, and it is interesting to mention that almost half of the parents only have a high school diploma. They found that low income was associated with high reports of depression in parents. Parental depression leads to poor parenting, including less support, decreased affection and verbal interaction, and even harsh or indifferent parenting (Lee et al., 2009). Lee et al. (2009) note that this cycle is consistent with FSM, which states that economic struggles can upset everyday life, creating mental anxieties. Anger, irritation, and withdrawal, prompted by this psychological distress, can be taken out on children via parenting behaviors. Effective parenting that includes themes such as "sensitivity, cognitive stimulation, and warmth," as outlined by Lugo-Gil & Tamis-LeMonda (2008, p. 1066), is replaced by negative parenting behaviors, characterized by low involvement and high parent-child frustration (Lee et al., 2009). Lee et al. (2009) detail that social support helped to mediate parents' depressive symptoms and frustrations, leading to better quality parenting. It is still important to note that the study found

that more low-income parents report depression than their wealthier parent counterparts.

Another study that builds on of the Lee et al. (2009) model is that of Lee, Lee, & August (2011) which includes a sample of families from various income backgrounds with children at risk for conduct issues. It reaffirms the relationship between financial stress and parental depressive symptoms and its effect on parenting, but incorporates the aspect of children's externalizing problem behavior. Externalizing behaviors in this study included aggressive behavior, poor academic performance, and low developmental ability. These traits affect parental stress, increase depressive symptoms, and disrupt parenting in the context of low-income families (Lee et al., 2011). While positive externalizing behaviors help to decrease the negative effects of financial stress on parents, Lee et al. (2011) express that problem behaviors decrease social support and quality parenting. Decreased social support hurts low-income parents' psychological well-being, further inhibits parenting, and increases externalizing problem behavior in children in a cyclical fashion (Lee et al., 2011).

Like Lee et al. (2009) and Lee et al. (2011), Mistry, Lowe, Benner, & Chien (2008) found that income can indirectly affect child development through parenting practices. Their study looked at low-income mothers, economic pressures, and family and child functioning. The study utilizes a multi-methods approach so generalizability is not possible from the ethnographic information, but it is useful to consider. Feeling positive about the family's economic state was seen as positive not only because of the ability to pay for basic things, but "affording some…extras and purchasing bigger ticket items were associated with feelings of pride and accomplishment" for mothers (Mistry et al., 2008, p. 197). Mistry et al. (2008) concluded that maternal well-being, in part, depends on providing these extras, and economic stress occurs when mothers are not able to do so. Economic stress can lead to maternal depression and decreased self-efficacy; therefore, women who felt this way had more difficulty interacting with their children, expressed less warmth, and engaged in more controlling parenting (Mistry et al., 2008). In turn, these negative parenting skills were associated with higher levels of problem behavior in children (Mistry et al., 2008).

Gershoff, Aber, Raver, & Lennon (2007) also explored the direct and indirect effects that income and material hardship have on children's cognitive ability and social-emotional appropriateness. Material hardships

include being unable to pay debts, inadequate access to food, and the like. They used the Early Childhood Longitudinal Study, which has a large kindergarten sample, to conduct their research. They found that lower income and material hardship negatively affect parental mental health and cause stress. As seen in other studies, this stress decreases supportive parenting behaviors, leading to a reduced probability that the child will display socially-appropriate behavior (Lee et al., 2009; Lee et al., 2011; Gershoff et al., 2007; Mistry et al., 2008). Results also showed income alone does not predict parental stress, but it is the extent of material hardship present that increases parental stress and negative outcomes.

Parental stress, due in part to low income, can negatively affect parenting skills and involvement, leaving a child to suffer developmental delays due to a lack of appropriate stimulation. This is the basis of FSM, which Mistry and Wadsworth (2011) explained in the following manner:

> This strain [economic strain] is a conduit to parents' mental health problems, inter-personal conflict, and disrupted parenting…High levels of stress and family dysfunction can interfere with the ability to deliver warm, engaging, responsive parenting, leading instead to parenting characterized by harshness, inconsistency, and physical punishment. (p. 13)

Lee et al. (2009), and Gershoff et al. (2007) discussed financial stress and its role in parental depressive symptoms, leading to parenting that hurts children's social and emotional development. In an interview, a Licensed Marriage and Family Therapist commented on low-income families:

> Parents are often preoccupied with meeting basic needs and fail to attend to emotional and cognitive development…They often lack the resources and knowledge to deal with all developmental needs at the early stages of life which causes the domino effect (Personal communication, March 15, 2014).

The FSM process still applies to higher-income families, but typically in the opposite direction. These families do not have the same financial and environmental stress that plagues those in poverty and with low incomes. Therefore, middle-income parents can approach parenting in a warmer, engaging manner. FSM helps to explain income's indirect role in child development, especially in the context of low-income and disrupted parenting practices that threaten normal child development. Despite the contribution of this model, however, it fails to address the more direct

parent-mediated pathways by which income impacts the development of children.

Parental Investment Model (PIM and/or IM)

PIM refers to the resources, time, and money that parents invest in their children. Investments can include tangible items such as books, to opportunities such as extracurricular activities or a private education. More disposable income increases a child's opportunities for cognitively-stimulating materials and enriching activities. Gershoff et al. (2007) pointed to possible effects of income on children, including the social and emotional competence that goes along with living in a safer area with better schools to social acceptance and confidence by having trendy and favorable material items. The opposite is true in that not being able to afford items can isolate children, causing emotional and behavioral problems (Gershoff et al., 2007). Most notable are the cognitive gains that parental investments allow for through stimulating interaction and goods. Gershoff et al. (2007) demonstrates how parental stress (or lack of it), as mentioned in FSM above, can also further influence child outcomes by affecting the ways in which parents invest in their children.

Most people think of investment in terms of resources to provide a plethora of tools for children, including books, toys, tutors, and exceptional schools. The opportunities for extracurricular activities and access to private schools increase opportunities for cognitive, social, and emotional development. In terms of future outcomes, Gilbert (2015) found that "the class distribution of students bound for an elite college is…the large majority (71%) concentrated in the top classes" (p. 113). Not only does income influence to some extent learning opportunities and rate of development, but it also predicts future opportunities of the child, such as college and income earnings.

Mistry and Wadsworth (2011) explain PIM as "[h]igher levels of SES enable parents to "invest" in their children by providing them with the material goods, services, parental actions, and social connections that promote children's education and overall well-being" (p. 11). Lack of financial resources creates material hardship and limits funds available for stimulating materials and activities, which in turn affects development. Additional support for development is hindered due to finances, and lower-income children fall behind in academic achievement as compared to other income brackets. Low-income parents simply cannot afford to in-

vest time to stimulate development or money for materials and high-quality education that increase positive developmental outcomes.

In comparison, middle-income and upper-income children have advantages in their development. These families have more resources that provide adequate nutrition, activities, and access to healthcare to support health and growth. More educated parents exercise parenting skills and practices to support all areas of development. Following the FIM process, higher-income parents have the resources to provide a myriad of materials for children such as books, educational toys, extracurricular activities, tutors, and high-quality education. McGlynn (2014) cites that "high income families are increasingly focusing their resources in terms of money and time on the factors that will enhance their child's early cognitive development" (p. 57). Middle-income and upper-income children perform better academically due to resources parents can provide, and often begin school better prepared than poor children. PIM explains how income translates into material goods, opportunities, and time that can benefit a child, but misses the indirect psychological effects that can hurt both parents and children.

Parenting skills can also include high or low level of investment, which demonstrates how FSM can further influence PIM. Lugo-Gil & Tamis-LeMonda (2008) conducted a study to analyze the relationship among family assets (including income), parenting, and cognitive outcomes in children during the first three years for low-income families. They used data from the Early Head Start Research and Evaluation Study and directly observed parenting in the home environment. Lugo-Gil & Tamis-LeMonda (2008) explain that parenting quality influences children at every age, affecting a child's language acquisition, ability to read, and education preparedness. Good parenting incorporates themes of "sensitivity, cognitive stimulation, and warmth" (Lugo-Gil & Tamis-LeMonda, 2008, p. 1066). From a financial standpoint, research has shown that parents who invest more time and money have children with increased cognitive ability, academic success, and positive adult incomes (Lugo-Gil & Tamis-LeMonda, 2008). Therefore, while income level is related to a child's cognitive development, this study demonstrates once again that income has an indirect effect on child development by way of parenting attitudes and behaviors.

Furthermore, Hindman & Morrison (2012) look at the different parenting techniques found in middle-income families and their relation to preschool literacy and social competence. The children were formal-

ly assessed while the parents were given surveys about their parenting methods and their child's social skills. Parenting for this sample concentrated on three different parenting domains, including the "home learning environment, autonomy support/expectations, and management/discipline" (Hindman & Morrison, 2012, p. 191). Home environment is linked to literacy and collaboration skills, while parental support of autonomous behavior was associated with child cooperation (Hindman & Morrison, 2012). The study showed that parental management and discipline influenced self-management and compliance in children. Middle-income and upper-income families engage in this multidimensional parenting. Parents with higher incomes tend to have "higher levels of education predicting more frequent home focus on letters and sounds, book reading, and math" (Hindman & Morrison, 2012, p. 210), dictating a higher level of parental investment in their children. This study demonstrates how parental investment helps in healthy learning and social development, but the authors also admit that parents' self-reports can skew the data somewhat.

Parental Socioeconomic Status (SES) & Associated Values

Socioeconomic status (SES), which takes into account income, education, and occupation, is a key component in further understanding PIM. Parents with higher income tend to be more educated, hold a more prestigious job, and practice parenting that supports multiple areas of development. Bloomquist's (2009) study displayed that middle-class children, in comparison to working-class children, exhibited more advanced language development, due in large part, to the home environment. The sample consisted of sixty two to six-year-old children who were prompted to name images of both normal items and combination items that incorporated two normal items together. Middle-income children used more labeling, more words, more descriptions, and were more comfortable during the experiment (Bloomquist, 2009). This study is a good example of how parents' income, as part of socioeconomic status, indirectly affects cognitive and language development by the ideals that parents instill in their children. Bloomquist (2009) expresses that, while working-class parents focused on teaching factual, basic language skills, "middle-class parents focused on including more descriptive information about objects when discussing them with children…development of expression…[and] encouraged their children to experiment linguistically through description and elaboration" (p. 342). Middle-income parents in this study encour-

aged critical thinking and creative interaction with language and reading, supporting the child's autonomy and comfort level in self-expression. Working-class parents encouraged their children to provide the correct answer, limiting the opportunity for creative exploration (Bloomquist, 2009). The different income levels produce different parental standards, which affect parenting styles and values passed on to children.

Gilbert (2015) continues the discussion on how parents instill values in their children that are set forth by the parents' class position. Middle-class and upper-class parents tend to instill characteristics such as self-direction and self-control which focus on development of the self and allow the child to explore and learn about his or her world (Gilbert, 2015). In contrast, Gilbert (2015) states that working and lower classes focus on obedience and conformity, and these characteristics relate to the parents' occupation. For example, a parent who works in a retail store must be obedient and conforming at his or her job, and these characteristics are passed down to his or her children. Curiosity and independence, on the other hand, prepare children to think critically and question the world around them.

Lareau (2011) conducted an ethnographic study dealing with social class, parenting, and parental values. She looks at the concepts of concerted cultivation, found in middle-class families, and natural growth, found in working and poor classes. Lareau (2011) explains the former as parents' intentional fostering of a child's abilities through schedules, critical thinking, and frequent interaction with institutions, such as teachers. Middle-class children are engaged in organized activities, reasoning, and individual development, but this can cause exhaustion in the family system (Lareau, 2011). This drawback aside, it is clear that middle-class children are given multiple opportunities to explore their environments and experiment with a variety of skills – which may have overall positive effects. In comparison, Lareau (2011) details that working-class and poor families focus on providing a safe atmosphere to meet basic needs and have frequent kinship interactions. Children in this environment have more leisure time, strong family ties, and use language to respond to directives (Lareau, 2011). As a result of these two different styles, Lareau (2011) found that "there was quite a bit more talking in middle-class homes than in working-class and poor homes, leading to the development of greater verbal agility, larger vocabulary, more comfort with authority figures, and more familiarity with abstract concepts" (p. 5). Lareau later used the Panel

Study of Income Dynamics to test her qualitative results quantitatively, and the results were supportive of her original ethnographic study.

The values that parents instill in higher-income families lend themselves to healthy and even advanced development. Parents instill more autonomous characteristics in middle-income and upper-income children to support self-growth and learning. Gilbert (2015) mentions the characteristics of curiosity, self-direction, and regard for others that are encouraged in these families. These characteristics aid in developing self-confidence and critical thinking skills, which support healthy cognitive, social, and emotional development. Hindman and Morrison (2012) commented that because "middle-class American families expect children to attend to teachers and other authority figures, to share with peers, and to respect the space and property of those around them…[they] develop stronger self-regulation and cooperation/compliance" (p. 194). Higher incomes support opportunities for children to develop socially and emotionally, as do the different expectations that higher-income parents set.

Moreover, if parents are talking to their children more, allowing them to express themselves, and teaching them how to communicate well with others, they are preparing their children to be socially-acceptable adults. Organized activities also have additional value than their manifest function. Gilbert (2015) illustrates that greater involvement in scheduled activities with a distinct social group fosters a sense of identity, self-worth, and accomplishment for upper-class children. These imparted attributes have positive effects on children.

It is important to note that parental expectations do increase as parents' SES increases. A study by Luthar and Latendresse (2005) looked at affluent youth. The sample consisted of affluent youth ranging from sixth graders to twelfth graders, divided into three cohorts. It also included a parallel inner-city, low-income sample to compare with the affluent youth. It found that affluent children suffer higher rates of substance abuse, anxiety, and depression due to achievement expectations and family seclusion (Luthar & Latendresse, 2005). Affluent parents tend to have higher expectations for their children, leading to anxious or depressive symptoms. Children may be isolated physically from parents or isolated emotionally. Even more disturbing is "[a]mong affluent, but not inner-city youth, substance use was linked with depression and anxiety, suggesting efforts to self-medicate" (Luthar and Latendresse, 2005, p. 49). The interviewee cited earlier mentioned that in higher-income families "youth…are often

in need of more attention to address emotions and cognitions as they go through this life-cycle change. Youth will sometimes turn to peers and can become involved in high risk behavior…to gain the attention of a parent" (Licensed Marriage and Family Therapist, personal communication, March 15, 2014). If high-income parents constantly work, the children miss out on important parental interaction and stimulation to enhance development. High income, therefore, does not guarantee adequate parental investment.

Conclusion and Recommendations

Income has a profound impact on child development through parent-mediated pathways, with lower-income children suffering greater negative developmental outcomes. This research looked at two pathways, FSM and PIM, and further explored the parental values related to SES. The Family Stress Model details how financial stress can create additional stress and/or depression in parents, which then can inhibit healthy parenting. The Parental Investment Model articulates a parent's ability to invest in his or her children in terms of time, material, and/or resources. In both of these models, a parent's socioeconomic status is instrumental in influencing what characteristics he or she passes on to his or her child.

While both pathways contribute significantly to the topic of income's role in child development, each framework only paints a partial picture. It is the combination of these two frameworks that allow for a more comprehensive understanding. PIM addresses income's effect via investments, whether they are material or time. The more income a family has, the greater likelihood it will act as an advantage for a child's development, and PIM explains this basic notion. FSM starts the discussion of how income affects parental psyches, which in turn influence social, emotional, cognitive, and behavioral development of children via parenting practices. These two frameworks fall short, however, in a couple different aspects. FSM focuses heavily on low-income families rather than a broader exploration of how income, in general, shapes parental and child psychological functioning. For example, the stress that comes along in maintaining the lifestyle in a high-income family could possibly affect a high-income parent in a similar manner that financial strain affects a low-income parent. More research in the upper stratums is needed to format a similar model that more appropriately serves as the FSM for the upper-income brackets. Additionally, research has made light of the con-

nection between SES and parental values. Further research should focus on income's ability to mold worldviews, values, and even the type of relationships family members build with each other and their communities.

Future research and recommendations should engage a multi-faceted approach in addressing the relationship between family income and child development. Now more than ever, families, professionals, and policy-makers need to be aware of the differences that income can make in the life of a child. Research should strive to educate the reader and encourage appropriate decision and/or policy-making. This desire is the main goal of this research, and knowledge gained should be considered within the context of the growing economic inequality in the United States of America

It is important to note that there are other factors unrelated to income that produce the negative outcomes seen in low-income children from this research. For example, a middle-income mother may have depressive symptoms that disrupt her parenting; however, unless her depression stems from stress over financial insecurity, then the negative child outcomes due to her parenting are not an indirect effect of income. This research is rather limited in its scope, and does not address other diverse channels through which income affects child developmental outcomes. Also, it is imperative to mention that a disproportionate focus of this paper included research on low-income families due to limited research on other income brackets and their impact on child developmental outcomes.

Two recommendations for further research, and hopefully eventual programs/policies, deal with the concept of poverty and family intervention methods. Clearly, poverty-stricken and low-income families suffer from material and psychological stresses that can interrupt child development. Gershoff, et al. (2007) state the following:

> Twenty-one percent of American children live in families with income…between 100% and 200% of the poverty threshold… [and] 65% of non-poor but low-income families experience one or more material hardships such as not having enough food or having utilities turned off because of inability to pay bills. (p. 71)

Employment practices, such as increasing minimum wage or benefits packages, would of course ease the financial stress of these families. Public assistance helps, but its restructuring in the 1990's left many families without any guarantee of income support (Gilbert, 2015). Producing stable, living-wage jobs for parents would ideally help to decrease economic

strain, better parental psychological states and parenting, and provide opportunities for child development.

Also, redefining the concept of poverty, from the outdated standard of the mid-20th century to include American lifestyle changes, would raise the poverty line in order for the problem to be addressed more accurately. From the statistic above, one sees that low-income families bear the same burden as families in poverty. While the definition of poverty has been changed to account for changes in prices, it has not looked at changes in the standard of living. Gilbert (2015) states that the current policies are "saying something about the meaning of poverty…what defines people as poor is their material deprivation in an absolute sense, rather than the relative gap between their standard of living and the standard typical of people in the same society" (p. 229). Recall from Mistry et al. (2008) that parents' distress increases when they cannot afford those "extras" or "big ticket items" that would be considered part of the typical standard in U.S. society. By not incorporating standard of living in concepts of poverty and low-income, the outdated definition further exacerbates an indirect pathway that harms child development, the parental psyche.

Additional monetary gains to poor and lower-income families are not enough to dispel negative influences on child development. Family intervention models, and parenting-specific interventions, such as the one cited by Mistry and Wadsworth (2011), "have also been proven to be effective in helping families and children cope with economic stress…to improve disrupted parenting by addressing the multiple, interconnected risks of the FSM" (p. 14). Teaching positive parenting and interaction is not only beneficial for the child's development and the family entity, but proves that low-income is not an absolute predictor of negative outcomes. For example, Gershoff et al. (2007) mentions that parents under financial stress may actually engage in positive parenting to make up for their lack of resources. These are suggestions, however, and need increased and continued research before they can be properly proposed and implemented. They are big picture ideas, and this research does not have conclusive evidence that their implementation would have long-term success.

In conclusion, the growing body of research points to income as being a key variable in the development of children. Income allows parents to provide resources, appropriate stimulation, and developmental opportunities, but only when there is enough.

Only by acknowledging income disparity and its effects on child developmental outcomes as a problem can this topic be placed on the agenda to solve.

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Diversity on Earth, Diversity in Policy: a Comparison of the Styles of Environmental Governance

Faculty Sponsor
Dr. Nicole Detraz

Abstract

This paper examines the two main styles of environmental policies governments implement globally: protective and exploitive. It evaluates the effectiveness of both approaches as well as projects their popularity in upcoming years through analyzing individual policies, the national implementation methods, and the international community's reception. The focus will be case studies of Bolivia, the first country in the world to grant the Earth its own legal rights, and Brazil, which continues to exploit the scarce natural resources of the Earth in a bid to improve its economy. Both states are attempting to improve their citizens' lives, yet they reflect a stark policy contrast, allowing effective evaluation of the environmental policy styles in an applied setting.

Introduction

Four oceans with different salinities and creatures teeming under their waves; seven continents that host habitats ranging from icy tundra to lush river valleys; jungles and deserts, plains and mountains; sparsely populated steppes as well as cities with billions of people crowded into the streets; and over nine hundred thousand different types of insects alone… this planet called Earth is filled with diversity. Very few people will disagree that, of the more than one million species on this planet, humans are the most successful in terms of domination, and that they decide the fate of the Earth and her resources for good or ill. Humanity itself comes in a hundred thousand different shades, and within every single one of the seven-plus billion individuals living in the world today, a free and independent mind exists with its own unique ideas, code of conduct, and belief system. This paper studies governments, their actions, the effects on their own citizens, the effects on the people of the world around them, and the effects on future generations, effects which can affect the diversity of species and people's development in a myriad of ways.

The concurrent environmental opinions held by governments can be compressed into two general trends. The two main tendencies of environmental policies are either protective or exploitive in nature and this paper will examine two representative countries: Brazil (exploitive) and Bolivia (protective).

Both protective and exploitive ideologies are matters international contention. There are many interested actors, including intergovernmental organizations such as the United Nations (IGOs); non-governmental organizations (NGOs), which are typically composed of private citizens and can be national or international in scope; and multinational corporations (MNCs), which are profit-seeking transnational enterprises. These entities seek to influence the environmental stances of various governments in the world.

While all of the aforementioned external influences shape the individual environmental policies of countries, a myriad of internal factors affect a country's policymaking, including, but not limited to, a country's history of independence and sovereignty, its economy, and its leadership initiatives in policymaking. Niccolò Machiavelli once wrote that "The one who adapts his policy to the times prospers, and likewise that the

one whose policy clashes with the demands of the times does not." In using Machiavelli's belief as a guide and given that each nation's set of circumstances is unique, the following questions should be answered in this study: 1) How are protective and exploitive approaches different?, 2) How do protective and exploitive environmental policies manifest in the governance of states globally?, 3) Which policy style more expresses the sentiments of the international community?, and 4) Which style is likely to become the future global trend?

This paper does not consider the actual environmental ramifications of these policies and which policy ideology is better, as the term is highly contestable. Instead, the paper addresses the effectiveness of the policies individually and attempts to trace the trends' developments within international politics.

The Existing Schools of Thought on Environmental Policy and Research

Exploitive environmental policies have historically been an international tradition, reaching their zenith during the English Industrial Revolution. Exploitive policies refer to those that are mainly concerned with extraction of resources from Earth, deemphasizing the conservation of resources, preservation of wilderness, and environmental quality improvements. The basic tenets of this policy style stress the economic possibilities within the environment, focusing on the possibilities of human expansion, expanding those economic possibilities, and improving human quality of life.

According to Ugelow and Walter, many of the more economically developed states are pressuring less developed states to temper practices considered environmentally harmful, such as burning cheap fossil fuels in factories while ignoring carbon emissions standards or logging in rainforests such as the Amazon Basin (Ugelow and Walter, 1979). Exploitive environmental policies produce a much lower short-run cost, allowing countries to stabilize their economies more rapidly and efficiently than protective policies. This situation often prompts developing states to question the true motives behind protective policy adoption requests from the more developed countries, given that these countries urging conservation usually used exploitive practices during their own economic development (Ellison, 2014)

Protective policies, conversely, emphasize the sustainability of natural resources and protecting biodiversity (Hatch, 2005). Protective environmental policymaking is both very new and very old. Many cultures

around the world, such as the Sioux of the American West who required all buffalo appendages to be used productively in an attempt to preempt over-hunting, and some Amazonian tribes that practiced crop rotation to avoid subsurface nutrient deficiencies, have practiced protective policies for generations (Bruns, 2012).

However, as an international movement in protective policy making, it is much more recent, rising in popularity in the 1960s, with major inspiration coming from Rachel Carson's revolutionary work, Silent Spring. The basic tenets of protective-style policymaking reside in the opinion that the Earth's bounty is found in more than those aspects that can be commoditized. This can take either an eco-centric view, that the Earth itself has rights and should be protected, or (the more common) anthropocentric view, that people need to preserve the Earth for future generations to enjoy (Kirkman, 2002). Another anthropocentric view concerning protective policy proponents is a new branch of environmental research known as environmental security. Environmental security as a research area concerns human security in response to environmental changes (Detraz, 2011). Climate change and increased human consumption are leading to water shortages in many places, which could conceivably lead to increased violence as various groups of people struggle to survive. Environmental security researchers are concerned with the possible human conflict that might arise from these resource shortages (Detraz, 2011). To lessen the likelihood of potential conflicts, proponents of this approach recommend that states and the international system enact policies that embody protective environmental policymaking, so that critical amounts in the clean water and fresh air of human habituated regions are exceeded (Cleveland et al, 2001). A recurring theme in this situation is the disconnection between the policy makers and the people, who are unable to make informed decisions on environmental policies due to their limited knowledge of all other contributing factors.

Explanation of Methods

The two countries chosen are the Plurinational State of Bolivia, herein referred to as Bolivia, and the Federal Republic of Brazil, referred to as Brazil. These countries were selected due to their contrasting environmental policy styles and their regional comparability. Bolivia and Brazil are both Latin American countries, and while having many unique aspects to their cultures, both are members of many of the same IGO

and NGOs, such as the Latin American Integration Association (ALADI, 2014). They are both classified as developing countries, or peripheral countries according to world systems theory, meaning that they are not in possession of many of the economic resources taken for granted by the core states such as the United States (Wallerstein, 1976). Both struggle against national poverty and pressures from international debtors and their environmental policies must be considered in accordance with developmental goals (Kaimowitz, 1996). Both states have a similar colonial history where many of their policy decisions were made by other countries that did not seek either state's best interests. They differ greatly in size, which might be problematic, however, that fact is far outweighed by the other similarities.

Environmentally, the international community has chastised both countries for unsavory environmental practices, and both have responded differently. Brazil, in line with the exploitive environmental school of thought, continues to engage in extensive logging and expansion of soybean cultivation and other agricultural products into the Amazon rainforest (Perez, 2007). Bolivia, conversely, is making a noticeable effort to develop more protective environmental practices, especially concerning sustainable development (Purdy, 2007). Their economic standings also greatly differ, reflecting the benefits and costs of the two policy styles while also demonstrating the two policy mindsets.

First Case Study: Brazil, Exploitive Policy in Action

A Historical Overview

While the purpose of this paper is to assess the different types of environmental policymaking, the political history of the two countries being analyzed remains relevant. Many scholars agree that the effects of colonization can persist in affecting policy decisions even after the country has achieved independence (Marker, 2003). These colonies were accustomed to trading with their former occupiers, and even as they fought to form unique national identities (Marker, 2003). Some of these difficulties were predicted Immanuel Wallerstein's world systems theory and can constitute a dependency cycle. Often, former colonies go through their own industrial revolutions as they struggle with enhancing their production potential (Escobar, 1995).

Brazil, with the largest surface area of any South American country, has not always had autonomous political control, as it was colonized

by a more developed state: Portugal.

Originally, the Portuguese discovered few natural resources that could be traded to further economic goals. Instead, they used Brazil as a new land for refugees fleeing from Portugal's own economic crisis. The only resource of any real export value was the wood of the brazil tree which creates a rich red dye. Exploitation of this resource started Brazil's tradition of allowing the forestry industry to operate unconditionally (Brazil, 2011). Gold was discovered in the 1690s, and Brazil experienced a gold rush, similar to the California and Alaska gold rushes later experienced by the United States. As the world approached the 18th century, however, it became clear that the gold deposits were limited and that, for the Portuguese at least, the abundant natural plant life of Brazil, as well as the ease developing agriculture due to the climate and soil, remained the main assets of production. When Brazil finally achieved its independence in 1821, it boasted very few industrial assets, despite the Industrial Revolution which was occurring in Europe and America (Brazil, 2011).

Coffee and sugar became the two major industries of Brazil, dominating the economy and political system. In fact, in the 1800's, coffee magnates had enough power to help co-ordinate a military uprising, which ousted the traditional imperialist model, where a foreign government ruled. The new model was centered around commercial interests, specifically the coffee planters, serving as the de facto rulers of the country through a puppet government (Brazil, 2011). Due to the instability of economic factors and lack of governmental oversight, when the world entered the Great Depression, in roughly the 1930s, Brazil was particularly hard hit, setting the stage for exploitative environmental policy decisions to be made in an effort to catch up once more (Brazil, 2011).

The Environmental Problems Faced by Brazil

Brazil is a crucial state in regards to the planet's biodiversity and forest retention. Brazil has the largest amount of both tropical and primary forests and the second largest area of forest cover in the world, some 477 million hectares (Carvalho, 2006). Approximately 95 percent of Brazil's forest is located within the Amazon Basin, which also spills into Bolivia, Ecuador, French Guyana, Guyana, Peru, Colombia, Suriname, and Venezuela. This means that any problem/attitude toward the forest has the potential to spread beyond Brazil's borders and cause conflict between Brazil and these other South American countries1 (McDermott et al, 2010).

In 2006, the Brazilian Amazon was broken up into five sections, each controlled by a different power group. See Figure 1 below.

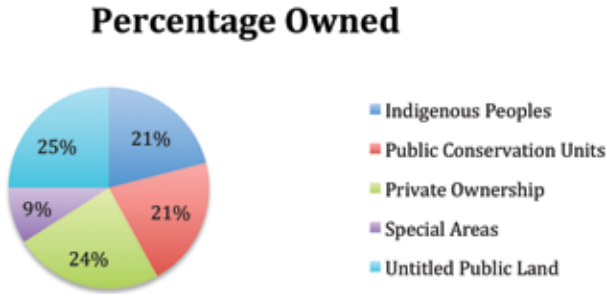

Figure 1.

As a result of massive deforestation, (for example, the Atlantic forest has gone from 120 million hectares to 10 million hectares in the last two decades (Gromko, 2013)), there have been large, negative effects on the world's biodiversity. The Amazon Rainforest is home to thousands of species of animals and plants which are found nowhere else in the world and accounts for 10 percent of the world's biodiversity (Critical Ecosystem Partnership Fund, 2001). Several of these species, some of which are extremely well-known such as the jaguar, giant anteaters, and spider monkeys, are counted as virtually extinct (Canale et al, 2012). In an exhaustive scientific study concluded in 2012, researchers examining almost 200 individual forest patches found only 767 mammal species out of an expected 3,528, indicating a staggered and unprecedented rate of extinction (Canale et al, 2012).

This loss in biodiversity is troubling for two main reasons. The first is that it contributes to global warming and climate change2 (Rich, 1999). The second is that scientists quite frequently use animal and plant byproducts and systems to create products which greatly help humanity. These can include medication, such as making anti-toxin from distilled snake venom, and construction products such as modified steel cable fashioned after spider-silk.

Deforestation and its effects are not the only environmental problems facing Brazil. To the west, near the Bolivian border, the massive Pantanal wetlands are being drained in the name of hydroelectric power, which is less costly, in monetary terms, to produce than other forms of energy, such as solar. Hydroelectric power can also be less harmful to

the environment than burning fossil fuels; however, the cost of destroying an entire eco-system in order to produce it is a cost that is not currently being considered by the Brazilian government (United Nations University, 2008). Another challenge lies in the fact that drought a decade ago in the drier, northeastern portion of the country has turned almost 3 million hectares of forest into complete desert, further contributing to the deforestation of other regions besides the Amazon Basin. In addition, a population spike, despite the move outwards into the agrarian sector, in the major cities of Sao Paulo and Rio de Janiero has contributed to polluted water sources, which have had the effect of spreading disease throughout the population (Petta et al, 2013).

Policy: International and Domestic

Despite Brazil's pro-exploitive policy stance, to be further established and explained in the following section, the government has been a party to several international environmental protective international agreements. Though this might seem promising at first glance, it is important to note that many other countries have also signed these agreements and continue to exemplify exploitive policy-making. For example, China has signed several of these international agreements, and yet so little has been done to curb air pollution that the government has recently erected giant screens in Bejing designed to display the sunrise as it is now impossible to see the actual thing within the city limits due to the constant smog (Nye, 2014).

This is not to say that these international agreements are useless, because participation can prove to be a useful indicator as to a country's internal policy. It can also indicate the perceived political pressures both internal and external on a country, the possible trends in the development of policy-making, and the direction of international relations between specific countries. They also serve as indicators of international opinion and can be used to hold states accountable, depending on the wording of the original agreement and how far the international community wants to pursue matters (Chasek et al, 2010).

It is also important to look at agreements between just a few states, as these tend to be both more effectively monitored and more focused than those signed by large numbers of countries worldwide. Brazil has opened dialogue with the European Union (EU), one of the more protective policy-based regions in the world. The EU has promised to send aid to Brazil

in return for "improved" environmental policy, meaning a slightly more protective stance (European Commission, 2013).

This might give the impression that Brazil has a protective policy stance but, before that assessment can be made, it is more important to look at a country's internal policy than at its international stance. To bridge between the external and the internal, we will look first at trade relations.

Trade agreements affect environmental policy in two ways. First, if one country refuses to work with another, it is usually because of either a specific disagreement between governments or because the first country does not agree with some aspect of the second's domestic policy. Often there is a human rights or security stance at issue, such as the United States' trade sanctions on Iran because of their developing nuclear program. However, as environmental concerns gain clarity through scientific development, the potential rises for environmental policy differences to become a trade issue (Jackson 1992). Second, if a country has an industry that is particularly exploitive environmentally, such as the agriculture industry in Brazil, and then it establishes a trade agreement relying on that same industry, it indicates that a systematic industry overhaul and reform are not necessarily a priority.

Brazil, despite having relatively few environmental agreements with the EU, is the EU's largest Latin American trading partner, taking a full 37% of regional EU trade and 43% of EU investment (this includes privately-owned companies as well as governmental). This is especially relevant to this paper in regards to the fact that Brazil is EU's single largest source for agricultural goods (European Commission, 2013).

Brazil is also a member of Mercosur, a Latin American based trade group, and the World Trade Organization (European Commission, 2013). These organizations help broker a great many of Brazil's trade agreements and the negotiations around said agreements (European Commission, 2013). Almost all of Brazil's trade agreements rely on their agricultural and logging industries and do not, in return, offer to help increase the ability of the country to sustainably harvest/maintain their environments. (European Commission, 2013).

In 2012, the Brazilian Congress presented and passed the "Forest Code", a new set of laws which, in the words of Joao Capobianco the former under-minister of Brazil's Ministry of the Environment, means "amnesty for people who cut down forests, [reduces] permanently preserved areas…and encourages new deforestation". Essentially, the new code

eliminated many of the existing laws, especially on private lands, that restricted the amount of lumber that could be cut per year. It also cut deeply into the land rights of the indigenous populations, all the while lessening the penalty for those caught breaking the few surviving laws from possible jail to a hefty fine (Capobianco, 2012).

While Brazil does have a Ministry of the Environment, it does not wield very much power, either political or legal. If the President wishes, he or she can expand the Ministry's ability to protect the environment, but many crucial factors that affect the environment, such as agricultural practices, are technically under other departments. This greatly lessens the ability of even the most protective of Ministers power to change policy in the light of a less than friendly administration (Capobianco, 2012).

Capobainco described Brazil's transition toward a more protective stance in the 1990s, mentioning several different protective policies pushed by the presidential administration including, but not limited to, attempting to expand the amount of sustainable farming practices, which took almost fourteen years to push through completely, and increasing the punishment for illegal logging, which took twelve years (Capobianco, 2012). This was a departure from Brazil's historical policy, and it has reverted to its former policy of exploitive style decision making under more recent administrations, particularly Dilma Rouseff. The former Minister of the Environment actually resigned under the current administration of President Dilma Rouseff due to the losing battle she felt she faced in trying to push any sort of protective environmental stance on both the Congress, which has historically resisted protective environmental policy, and President Rouseff herself (Capobianco, 2012).

President Rouseff is considered disinterested in environmentalism, approving practices that further the process of deforestation and destruction of ecosystems. These include pursuing hydroelectric projects that destroy the wetlands and loosening prior restrictions on logging and sustainable farming in the major agricultural districts (Rapoza, 2012).

In summation, Brazil's environmental policy has been almost exclusively exploitive throughout its history, both during the colonial days and as an independent state. There have been brief and relatively weak efforts made toward conservative use of resources, particularly during the 1990's when there was a pro-conservation administration in power and as a part of international accords which have been ratified but largely unimplemented.

Reception and Exceptions

The movements and decisions of governments are not isolated or trapped in a bubble. Governmental policy does not just effect one group of people, or even one state's worth of people. In this increasingly connected, highly globalized world, the policy of one country can create a ripple effect that touches the people of other countries regardless of intent. Environmental policy decisions are no different. In fact, they can be considered even less isolated than any other policy as there is no way to keep them from affecting other countries. Air and water pollution will not stay simply in the country of origin but will travel to neighboring states. So, how are people reacting to Brazil's exploitive stance?

The world at large has given some very critical responses to Brazil's decisions. In recent years, the British Paper The Guardian as well as The New York Times have both written scathing articles. The New York Times went so far as to question if Brazil's policies would lead to environmental problems for the entire world (Barrionuevo, 2012). The Guardian was a bit more reserved in its judgments, but still pointed out the necessity of Brazil shifting to a protective stance (Branford, 2014). This sentiment was echoed by Forbes magazine (Rapoza, 2012). Several scientists have written in journals as diverse as the online journal Environmental Protection to Ecological Applications to Journal of Environmental Law, largely condemning the current, and historic, policy path from both a political viewpoint and a purely scientific stance. There are several international NGOs at work inside of Brazil, such as the World Wildlife Fund and the Institute for Environmental Research of the Amazon, attempting to create a more protective-policy friendly environment within the body of Brazilian lawmakers. Their goals are largely twofold, aiming both to stop Congress from passing new, exploitive laws and to lobby the president to expand the power of the Ministry of the Environment (Rapoza, 2012). These NGOs have not, however, been as successful at lobbying as the powerful agricultural interests within the country (Capobianco, 2012).

It is not just outsiders that are expressing displeasure at Brazil's policy, both current and historical. Brazilians themselves have been increasingly prone to vote for lawmakers who promise at least some sort of protective stance, even if they later deviate from it in action (Echegaray, 2013). In recent polls conducted by Market Analysis and the Brazilian

Ministry of the Environment, over 90 percent of Brazilians believe that air pollution, biodiversity damage, global warming, and water-source degradation rate as very serious problems for both national policy and global concern (Brazilian Ministry of the Environment, 2012). This is actually 30 percent higher than the international average (Echegaray, 2013). Over 70 percent of citizens show an interest in corporate responsibility and sustainability, while over 50 percent say that they would pay more money in return for a sustainably made product (Brazilian Ministry of the Environment, 2012). Those polled said that they would prefer it if their government started placing the environment over profit, and that they would support wide scale reform of the recycling process (Echegaray, 2013).

With such strong numbers, one might expect there to be other indicators of the power of majority opinion but such indicators simply are not there. There has been no mass public outrage at the new laws nor have there been any large scale protests over existing policy. One might also look for consumer action, such as boycotts or switching brands to reward the more sustainable companies in existence. However, less than 20 percent of all Brazilian consumers participate in such consumer action. Seventy percent of Brazilian households do not even take advantage of the existing waste management/recycling programs that aim for some level of environmental protection. This could be due to either apathy or simple lack of education, but it is most likely a mixture of both (Guardian, 2013).

This dichotomy presents an interesting conundrum when studying Brazilian reaction to its exploitive environmental policy. The general trend in thought appears to be toward a more protective stance, but the general trend in action is toward maintenance of the status quo. Many Brazilians tend to take full advantage of the improved economy while harboring the opinion that it should not be so immediately destructive.

To some degree, Brazil does guarantee the safety of certain areas of forest, an exception to the exploitive policy. The Tumucumaque National Park is one of the largest preserves in the world. Additionally, Brazil's indigenous tribes have historically had some measure of control over the practices on their lands (Capobianco, 2012). However, these policies are in flux right now as the government argues over the scope of the new regulations, or deregulations, and how much of the forest will continue to be protected remains to be seen.

Before we attempt to draw conclusions, however, from Brazil's policy, it is important that we get the full picture. To do this, we must

move into our next case study, an example of protective policy and examine it in the same lights as we did Brazil's exploitive policy.

Second Case Study: Bolivia, Protective Policy in Action

A Historical Overview

Both Bolivia and Brazil have incredibly rich histories before, during, and after periods of European colonization. In so far as geographic area is concerned, Bolivia is much smaller than Brazil, measuring about 418,683 square miles, making it about the size of the combined states of Texas and California (Encyclopedia of Nations, 2013). Like Brazil however, Bolivia has had to work hard in an attempt to catch up in the global economy with more highly developed countries, partially because, while other countries were setting out to become players in the global economy, Bolivia, like many former colonies, was going through a period of great tension as it struggled to work out how it would determine its future as a newly independent state (Piette, 2009).

Bolivia was once inhabited by indigenous people who constructed advanced, agrarian-based societies with durable cities, many of which are still in existence. (Bolivia Bella, 2012).

Then, in 1532, the Spanish conquistador Francisco Pizarro claimed the land that is now Bolivia for Spain. The primary interest of the Spanish was in discovery of precious metals, especially gold. Following the complete subjugation of the natives, Spain dominated the area for close to 300 years. During this time, many natives were forced to work as slaves. A class system developed wherein Europeans and their descendants were favored by laws and custom. This history of division, which differentiates between indigenous peoples and the lighter skinned descendants of Europeans, still affects Bolivia today. (Bolivia Bella, 2013). Bolivia finally achieved independence in 1825, in large part due to the work of a revolutionary named Simon Bolivar, from whom the country also elected to take its name (Piette, 2009).

In the days of Spanish rule, Bolivia's major export to the Spanish empire was silver, and the country remained highly dependent on mineral exports for many years after independence, becoming the major exporter of tin to the Allied forces during World War II (Encyclopedia of Nations, 2014). However, the mining industry is completely dependent on the global market for certain minerals. Bolivia's mining has dropped off as the global demand for its exports has decreased, which has, in turn, caused a

period of fairly widespread unemployment3. Bolivia has struggled economically, having been classified as a "highly indebted, poor country" in 2001 by both the World Bank and the International Monetary Fund (IMF) and receiving full assistance from the World Bank as it meets the World Bank's requirements for aid (World Bank, 2001). Since 2001, the country has made a strong attempt to diversify its economy, with oil and natural gas becoming key exports. Agriculture has also emerged as a large sector, especially in the eastern regions of the country which are more agriculturally productive. This region is particularly suited to the growth of soybeans, Bolivia's main agricultural export (Encyclopedia of Nations, 2014). While the country struggled for a time with illegal coca production (a basis for the narcotic cocaine), which harmed the overall economy in the country, that problem is being fought on many fronts due to the current regime's strong stance on the subject (Carroll, 2011). Bolivia is also expanding its tourism industry, and has achieved prominence in what is becoming a swiftly growing sub-section of that industry: ecotourism. The country has several sought-after destinations for the ecotourist, such as Chalalán Ecolodge4 (Conservation International, 2014). This diversification of the economy has led to a slow but encouraging rise in overall GDP and annual per capita income (Encyclopedia of Nations, 2014).

The Environmental Problems Faced by Bolivia

Bolivia has an incredibly diverse landscape. It is ranked as one of the eight countries of the world with the highest amount of biodiversity, encompassing about 3.5 percent of the world's rainforests. Living in the country are almost 3,000 species of vertebrates and more than 20,000 species of plants, 106 of which are found nowhere else in the world (U.S. State Department, 2014).

Many of Bolivia's environmental concerns originate with the mining industry, especially when one takes into consideration the fact that Bolivia spent centuries with mining as the main source of national income. Bolivia is also home to an estimated half of the world's lithium reserves, has the second-largest proven gas reserves in South America, second only to

Venezuela's, and is also home to the Mutún mine, an iron ore mine that promises to become the largest iron mine on earth (Farthing, 2011).

Bolivia's environmental problems are largely related to the mining industry, especially since, before they began to be nationalized, they were

all privately owned. There was very little governmental oversight of the mines, and conservation of the environment was not given a high priority by mine owners. Between 1990 and 2000, Bolivia lost an average of 270,400 hectares of forest per year, which is an average annual deforestation rate of 0.43% (Mongabay, 2006). While, due to the remote regions of Bolivia's interior, the loss of biodiversity is most likely not as staggering as Brazil's, it has proven difficult for researchers to form a complete picture of the toll enacted on the biodiversity of the region.

Other environmental difficulties that Bolivia has faced in recent history include a violent crisis related to water and water security. Cochabamba, Bolivia's third largest city, is located on what was once a lush valley in the Andes mountains. Though it remains an agricultural center for the country, a mixture of environmental damage, climate change, and population sprawl has made the area much drier than can be sustainably maintained (The Economist, 2000).

Bolivia also struggles with the long-term effects of unsustainable agricultural practices, primarily the slash and burn method of agriculture, as well as methods employed by the illegal coca industry (Cook, 2013). Some of the negative environmental effects caused by these farming practices include erosion and pollution of the water used for drinking and irrigation. The farms used primarily for export crops are more closely monitored by the Department of the Environment so these problems mainly affect the poor, rural farmers who rely on the land not only for their livelihoods but also for their daily food (Foundation for Sustainable Development, n.d.).

Policy: Internal and External

Up until recent years, Bolivia was not particularly a player on the global environmental stage. It was after the 2006 election of Evo Morales as President that Bolivia first began to garner international attention as a possible paragon of protective environmental policy. President Morales was elected on a radical new platform that promoted indigenous rights, recognized environmental concerns, and promised a departure from the corporatism that had taken away access to water for the Bolivian people. It is under his administration that Bolivia's environmental policy has taken a departure from tradition and history and become the most radically protective in the world, as least in word (Glennie, 2011).

This radical position can be found in Bolivian law itself. Under the newly redesigned Bolivian constitution, enacted by the current Bolivian administration after a charge led by President Evo Morales, "Mother Earth" has rights all her own, only to be overrun if it is required for the good of the people of Bolivia (Aguirre and Cooper, 2010). To clarify this a bit further, the rights of the Earth do not actually outstrip the needs of human beings so if it is for the good of the people, exploitive practices can and will still be used. That being said, the rights of the Earth have to be weighed carefully and considered before the government makes a decision and a pressing need for humanity must be found.

As noted above, according to theorists, there are two main viewpoints from which to look at protective environmental policy. It can be either eco-centric or anthrocentric (Dalile, 2012). Anthrocentric preservation efforts concentrate on the benefits to humanity of conservation policies. These benefits are very diverse and can range from health benefits from reduced pollution to advancing human scientific knowledge to future/current human enjoyment of nature's physical beauty (Dalile, 2012). This is by far the most common viewpoint behind conservation efforts, especially at a policy level.

Eco-centric conservation efforts, however, are made based on the belief that the Earth itself has rights that are unrelated to the needs of mankind. While this is not an uncommon policy for NGOs, it is rare for this to be the predominant viewpoint behind actual governance (Dalile, 2012). This particular environmental stance is so rare, in fact, that Bolivia is the first country to hold it and it is explicitly expressed in the Bolivian constitution. By giving the Earth its own rights, its own personage, it espouses the idea that human considerations are not the only standards by which decisions and policies should be measured. Human well-being remains the most important consideration, which is why there is the aforementioned caveat. However, the arguments surrounding any exploitive decisions must be related to more dire circumstances than simple convenience or increased profit before any exploitive decisions are made.

During his time in office, President Morales has made numerous speeches before the United Nations concerning protective environmental policymaking and has gone on record as criticizing some of the more widely practiced exploitive policies (Morales, 2010). His main point has been in chastisement of the involvement of corporations in a country's development, especially when their activities cause environmental damage

which impacts the citizens of said countries negatively while providing the citizens with little in the way of direct profit (Morales, 2010). Morales has also criticized over-reliance on fossil fuels, especially in the more developed world, which has the resources, he claims, to explore other possibilities more fully.

Bolivia's premiere achievement in the international arena however, was in the Right to Water Resolution, Resolution GA/10967 passed by the United Nations in 2010. Bolivia was at the helm of this particular resolution, which formally recognized that access to clean, potable water is a fundamental human right, a right which was not originally recognized in the Universal Declaration of Human Rights5 (United Nations General Assembly, 2010). This raises the possibility of international corporations opening themselves up to international censure or chastisement for indulging in the unsafe practices that so often accompany corporate decisions, such as dumping chemicals, by-products, or other wastes into local water supplies (United Nations General Assembly, 2010).

To fully examine international policy, one must also look at trade agreements, as these frequently show a willingness to allow exceptions to stated policy. Almost all of Bolivia's trade agreements are through two trade organizations; Mercoursour and the World Trade Organization, although they also trade with the Andean community and the individual countries of Chile and Mexico (Organization of American States, 2014). Bolivians do still rely heavily on their mining industry, with their main exports being natural gas, crude petroleum, zinc ore, and tin. However, in recent years, they have made an effort to improve and grow, sustainably, their agricultural sector and have begun exporting soybeans and soybean products (CIA World Factbook, 2013).

When examining Bolivia's trade agreements, however, it is also important to bear in mind that Bolivia is a very impoverished country. In fact, the World Bank International Development Association (IDA) and the International Monetary Fund (IMF) have recognized Bolivia as a Heavily Indebted Poor Country (HIPC) (World Bank, 2001). Because of this, Bolivia was qualified for a certain amount of aid and debt forgiveness. However, it had to meet certain conditions before these programs would be extended. The main condition was that the poverty level had to be reduced by a considerable amount in a comparatively short length of time. In order to accomplish this goal, industries had to be expanded rather more quickly than the natural, planned, environmentally conscious growth

provided for in the previously discussed codicil in the Constitution (World Bank, 2001).

Internally, it is true that Bolivia is having a hard time enforcing its policies and holding its position, though this is arguably less about hypocrisy than it is about the ideals of the country being inconsistent with its level of development and its available funds. Regardless of causation, the fact remains that Bolivia's internal policies do not always live up to its protective ideals. For example, the government has begun a series of highways, designed to facilitate trade that will cut through the Isiboro-Sécure Park. In addition, a hydroelectric project on the Amazon River is being built that will take a large toll on the environment during its construction (Friedman-Rudovsky, 2010). However, this series of dams is expected to help move Bolivia away from fossil fuels and reduce pollution eventually, thus furthering long term goals, even though the short-term effects might be negative.

Moreover, these projects are necessary for the good of the Bolivian people, according to Bolivian environmental experts. "Our Constitution," says Jenny Gruenberger, executive director of Bolivia's Environmental Defense League, "is meant to be viewed through the lens of living well [wholesomely] and not better [expensively]". The experts also stress the nationalism of these projects. They are being built by Bolivians and designed by Bolivians and are therefore going to be less harmful than if a contracted company came in, the inference being that Bolivians are going to be as careful to protect their home as possible (Friedman-Rudovsky, 2010).

Reception and Exceptions

As previously stated, Bolivia has lofty goals when it comes to protective policy decisions. That being said, how successful has it been in implementing these policies, and what has been the reception from the international community and the Bolivian people?

Much of the world is extremely pleased with Bolivia's policy stance. The British paper The Guardian has published several articles commending Bolivia; one of these articles claims "We Should Look to Bolivia for Inspiration" in its headline (Glennie, 2011). There are several non-profit NGOs who are hailing the country as a beacon of hope for those in favor of protective policy (Morningstar, 2011). While some experts, such as Roberto Laserna, are critical of what can be perceived as some hypocrisy

on the part of the Bolivian government, particularly due to the expansion of certain harmful industries, Bolivia continues to be hailed as an inspiration (Laserna, 2013).

Despite Bolivia's protective stance, it is clear that this impoverished country has to decide whether or not to cut corners in its environmental policy in order to grow its economy, and it is having a difficult time implementing many of its protective policies.

Part of the difficulty relates to the country's poverty and, therefore, its lack of means to implement any reforms that would require a substantial financial outlay. As mentioned above, Bolivia has rejected the more neoliberal policies of many of its neighbors, including Brazil, which has made it even more difficult for Bolivia to advance in the global economy. Another difficulty lies in Bolivia's need to for economic growth and the recognition of the fact that some of the loftier policy aims are very difficult to accomplish simultaneously. Thus, actual policy regulations are often less protective than could be expected if the country had a more robust economy.

In 2007, the Goteburg University's School of Economics and Commercial Law did a study on Bolivia's developmental goals and found that pollution from mining was not addressed in the policy changes. Moreover, President Evo Morales's forestry policies are much more inclusive of indigenous communities than former policies, in an attempt to share any new wealth with the poorest demographic within Bolivia (Jaldin and Slunge, 2007). This inclusion is concurrent, however, with increased strength in the logging industry, and new logging projects are creating paths through the primarily untouched lands belonging to the indigenous populations. This has not been met with a warm reception, putting Morales at odds with one of the larger groups on Bolivia. As Latin America's first modern indigenous president himself, Morales has to be careful not to overly upset the indigenous group, especially having cited them as a major reason that the policy sweep was so necessary (Morales, 2010). However, recently a ban has been imposed on exporting/damaging fifty tree species that are threatened historically by the logging industry, so attempts are still being made to balance the protective policies with the need to lift indigenous peoples from the extreme poverty from which they have suffered for many years (Jaldin and Slunge, 2007).

Another factor to consider when discussing the effectiveness of Bolivia's environmental policy is the matter of the actual construction of

the Bolivian government. In Bolivia, the ministries have less power than in some other countries. It can be very difficult to enforce their policies and decisions, making them more like guidelines or suggestions when it comes to actual practice. No matter the intention of a very active Department of the Ministry, putting policy into practice can be a very arduous process in Bolivia (Slunge and von Walter, 2013).

Analysis and Conclusion

Brazil and Bolivia, despite the size differences between the two, have a very similar history of colonialism and, due to their geographical proximity, have very similar environments and history of environmental problems. See Table 1 below.

Table 1. Summary of the Case tudy

	Brazil	Bolivia
History	Former colony of Portugal, achieved independence only to have to fight the coffee barons for the country's rule.	Former colony of Spain, achieved independence only to have to fight the tin and mining barons for national sovereignty.
Environmental Concerns	Primarily related to agriculture and lumber industries, in 2012, researchers examining almost 200 individual forest patches found only 767 mammal species out of an expected 3,528, loss of ecosystems to make way for hydroelectric power.	Primarily related to mining industry, average annual deforestation rate of 0.43%, water crisis in Cochabamba region.
Economic Standing	Strong economy globally, strongest in Latin America.	One of the poorest countries in the world by the World Bank.
International Policy	Signed several environmental UN treaties however, most of Brazil's trade agreements rest on its agriculture and timber industries, have never spearheaded any environmental issues and are not outspoken about them on the global stage.	Signed several environmental UN treaties and, though they still rely on exploitive industries, are making an effort to improve sustainability, have led the charge on two different issues, once against overwhelming dissention.
Domestic Policy	Recently passed legislation expanding exploitive policy in lumber industry, planning a new hydroelectric project that will destroy the Pantanel Wetlands	Gave Mother Earth her own rights under the constitution, crippling debt and deadlines placed on aid by the World Bank, expansion of sustainable decisions but often unable to enact
International Reception	International community is incredibly dismissive and scornful toward Brazil's domestic policy.	Many in the international community hail Bolivia and Morales as heroes of environmentalism.
Domestic Reception	Passive, population contends that it is concerned with environmentalism but does not make an effort to actually affect policy.	Passionate, indigenous peoples actually angry at concessions made to supposedly enhance their quality of life, want Morales to back down on the destructive projects.

Exploitive policy faces international criticism and potentially, censure, especially as environmental problems around the world worsen. This is because environmental problems do not stay within borders. For example, a problem within Brazil involving the dumping of waste into the Amazon River will spread to the neighboring states through which the river travels, and indiscriminate burning of fossil fuel contributes to global warming which affects the entire planet. The fluid nature of environmental problems has the potential to lead to conflict and has sparked a swiftly growing field of research.

On the positive side, exploitive policy is easier and less taxing on the government to maintain. As evidenced by both case studies, states that practice at least some measure of exploitive policy, especially if that measure is high, have an easier time competing in the global economy and flourishing. Brazil's embracing of exploitive policy is one of the reasons that Brazil has been able to achieve and maintain the highest economic standard of living in South America, with most people ranking as middle class and with Brazil able to dominate the trade in the region. Obviously, in the case of Bolivia, their environmental policy is not the only thing that has caused the majority of its citizens to live in bitter poverty, but the government has been forced to compromise on its protective policy in order to hasten the remedy of their economic situation. If people are getting sick and starving due to poverty, due to something that is, essentially, fixable, the Bolivian government feels that it has more of a duty to them than it has to Mother Earth.

Protective policy's greatest drawback is that it can be prohibitive economically, especially for countries still developing a foothold in the global economy. For example, one of the primary stances of protective policy-holding countries is the necessity of moving toward green energy and away from a dependence on fossil fuels. In the long run, protective policy-approved energy projects can save money or break even with exploitive energy practices, but the short-term start-up costs can be prohibitive. Additionally, sustainable agriculture and timber practices can cost the consumer or taxpayer more, especially in the beginning. For example, wood from sustainably harvested forests has to be replaced, which means the industry must pay the upfront costs of new trees. In more developed countries, this is certainly possible, but it becomes less so as per capita income decreases. It also requires that the citizens be on board with the policy, especially with an eco-centric view. Politicians need votes to stay

in office and, as important as they think Mother Earth might be, she does not have an actual physical vote at the ballot box.

Many countries may, and have, decided that these costs were worth it. Germany, for instance, has one of the more aggressive protective policies in Europe, while also having one of the most stable and prosperous economies in the world, so these two are not mutually exclusive, especially for a country that has the means on the front end. There are major benefits to protective policies that such countries feel outweigh the cost. The first, as most clearly demonstrated by Bolivia, in an improved environment for the environment's own sake. The more commonly prioritized benefits are the human health benefits that come from lessening pollution as well as the cultural and natural heritage found in the natural world. Additionally, the adoption of protective policy can clearly lead to an increased standing in the international community as IGOs have begun a push toward protective environmental governance and are encouraging individual states to make the same shift. This increased standing is something that many countries care about as it can make policy changes easier to pass or make it easier to gain favors that can later be cashed in for favorable economic conditions or agreements (Sadecki 2013).

With both of these policies available, what then seems to be the biggest impetus behind states choosing one or the other? The answer to that is both very simple and very complex. From my research, I have found that the biggest drive toward policy-making style has been the people within the country. (I am basing my conclusions on countries whose citizens are free, or relatively free, to participate in the decision-making process. Countries where this is not the case have entirely different criteria for all of these things, and it not in the scope of this paper to address them.) In Brazil, for instance, the lumber industry has particularly powerful lobbyists that historically control much of the legislature. Unlike the barons of Bolivian history, however, the lobbyists of Brazil are, for the most part, Brazilian. The people of Brazil, despite ranking the environment as an area of concern, do not take advantage of or pursue or actively push their lawmakers toward a more protective policy (Echegaray, 2013). Contrarily, in Bolivia, the indigenous peoples (who make up a large part of the Bolivian population) are actively, even violently at times, pursuing protective policy. They have even protested measures that the current government is making in an effort to improve the standard of living (Fuentes 2014). Therefore, in order to make a case for one over the other, we must

move to the consequences for future citizens resulting from the use of each type of policy. It is here that protective policy emerges as clearly more beneficial. The quality of life enjoyed by future generations through policies that encourage conserving resources, keeping dangerous pollutants out of the water and air supply, and stopping the advance of global warming will clearly be better than that afforded by exhausting fuel supplies, stripping arable land of its nutrients, and allowing the ocean to swallow up huge sections of coastal land. It is these future generations that nations must consider when setting their environmental policies, just as it is of these future generations that individuals must think as they make every day decisions on whether to live on the earth in a sustainable manner.

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QuaesitUM considers submissions from any current University of Memphis undergraduate student; eligibility also extends to those who have graduated within the last two semesters. Research reported must reflect University of Memphis student projects. All submissions must be faculty sponsored. Submitted texts may be single or co-authored, but all authors must have been University of Memphis undergraduate students during the time the research was conducted. Faculty members and graduate students are not eligible.

Content

Papers must discuss rigorous and analytical research performed by the author(s). Submissions should contain within the body of the text a section in which research methodology is described in detail.

All submitted text is to be the sole creation of the author(s) with the exception of correctly cited paraphrases and properly indicated quotations.
Any research involving human subjects must have approval from the appropriate Institutional Review Board. Submitting authors are responsible for adhering to IRB guidelines. Check with your faculty advisor for further information.

QuaesitUM understands that various disciplines exhibit a variety of differences regarding textual genres. For this reason, there is not a stated specific minimum or maximum article length. However, QuaesitUM prefers articles with a length of no more than 8000 words.

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All submissions must conform to the following guidelines. Submissions that do not will be rejected.

1. Remove all occurrences of author(s) names from the manuscript.
2. Include a cover sheet that contains name(s), date, title and name of faculty sponsor. Follow this cover sheet with a page containing an abstract of no more than 150 words.
3. All submissions must be in .docx or .doc format. Use the style (APA, MLA or Chicago) most appropriate for your area of research.
4. Regardless of the style used, all papers should conform to the following criteria:
   - Single-space the body of the text.
   - Use 12 point Times New Roman.
   - Include page numbers on all pages except for the title page.
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5. Figures and Tables
   - Provide a separate file for each table and figure.
   - Files must be a minimum of 300 pixels per inch (ppi).
   - Files must be 1200 pixels wide.
   - Figures must be JPEG, TIFF, PNG, EPS or PDF files.
   - Tables may be submitted in the formats listed above for figures.
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   - Do not embed figures and tables in the body of the text.
   - Clearly indicate the placement of all figures and tables.
   - Label all tables and figures and provide a corresponding caption at the appropriate location in your text.

6. Submissions may not be under review for publication elsewhere.

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A panel comprised of current University of Memphis undergraduate honor students screens all submissions. Papers meeting and exceeding this panel's criteria are forwarded to an editorial review board that consists of volunteer faculty members. Final selection decisions are left to the editorial staff—technical editor and two faculty advisors. This process is a blind review; the authors as well as the faculty who review the papers remain anonymous. This is the reason for requiring all names to be omitted from the body of submitted articles.

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