<table>
<thead>
<tr>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>African Union: A New Integrative Agenda and Its Implications for Good Governance</td>
<td>1</td>
</tr>
<tr>
<td>Scott Kristopher Morrella</td>
<td></td>
</tr>
<tr>
<td>The Impact of Contemporary China on the Development of African Countries</td>
<td>25</td>
</tr>
<tr>
<td>Alcina Walters</td>
<td></td>
</tr>
<tr>
<td>Nonlinear Optical and Electronic Properties of SiC/PMMA/Ge/Fe Waveguide for Device Applications</td>
<td>55</td>
</tr>
<tr>
<td>Bryan Conyers, Basem Darwish, Khadijah Ransom</td>
<td></td>
</tr>
<tr>
<td>Hurricane Katrina’s Path: A Comparative Study of Airborne Microbes in Selected Communities Affected by Hurricane Katrina</td>
<td>67</td>
</tr>
<tr>
<td>Brandon J. Carter, Lawrence Mullen</td>
<td></td>
</tr>
<tr>
<td>An Environmental Survey of the Water Microbes in New Orleans After Hurricane Katrina</td>
<td>85</td>
</tr>
<tr>
<td>Miquell Miller, Shermette Corbett, Gabrielle High, Kristen Guilford</td>
<td></td>
</tr>
</tbody>
</table>
PRESIDENT’S GREETING

Welcome to the inaugural issue of the Dillard University Journal of Undergraduate Research, where you will find original articles featuring research completed by Dillard undergraduate students under the guidance of faculty advisors.

Students, as you peruse the pages of your peers’ research findings contained herein, you will gain a wealth of knowledge, experience a renewed sense of admiration for your professors and fellow classmates, and importantly, you will be encouraged to, one day, submit your own research for publication.

Born with a heightened sense of curiosity and insatiable desire to learn, I have always found research to be one of the most stimulating and exciting components of my educational experiences.

I wholeheartedly support faculty and undergraduate research because when students are engaged, bold new ideas are born. When faculty and students collaborate, learning becomes a joint venture benefitting all.

Many countless hours of hard work and tireless dedication went into creating this journal, which serves as a portal into the brilliant young minds of our students. I am extremely proud of each researcher who contributed to this inaugural issue of the Dillard University Journal of Undergraduate Research.

May you continue to strive for excellence in all that you do.

Sincerely,

MARVALENE HUGHES, Ph.D.
President
PROVOST GREETING

The Dillard University Journal of Undergraduate Research (DUJOUR) is the result of intense efforts to capture the essence of Dillard’s research curriculum. This journal contains actual research conceived and delivered by Dillard University students. Here our graduates have shown their ability to engage in substantive research design and execution.

My research training in the social sciences has taught me the importance of defining the research question. An instructor of mine once impressed upon me that the differences between the disciplines in the social sciences rest in the way they “turn” the research question to reflect the disciplinary perspective. In this journal, students from a variety of disciplines have explored and “turned” researchable questions both similar and different.

DUJOUR is evidence that undergraduate research at Dillard offers students the opportunity to develop skills to meet contemporary and future challenges. We hope this interdisciplinary publication will serve as a forum for debate and discovery. Congratulations to everyone responsible for making this enterprise possible. I hope you will enjoy, as I have, the product of their labor.

Sincerely,

David V. Taylor, Ph.D.
Provost
NOTE FROM THE EDITOR

The student authors featured in the *Dillard University Journal of Undergraduate Research (DUJOUR)* epitomize the inquisitive spirit. Their articles demonstrate the curiosity, talent, dedication and vision that are so essential to academic rigor and excellence. This volume testifies to the importance of inquiry-based learning and scholarship.

Dillard University is known for its distinctive academic style and spirit. These attributes inspire the Dillard student body to conduct research, attend graduate school, and contribute to their communities. The Office of Undergraduate Research enables students to pursue these goals by encouraging the production of new knowledge, promoting creative work, providing motivation, and facilitating the scholarly kinship evidenced in this journal.

The studies featured in this, first volume of *DUJOUR* are examples of faculty-student collaborations during the five years since Hurricane Katrina. In one case the study was completed by students and faculty from two institutions. The Dillard faculty and administration serve as a constant source of guidance and support for undergraduate research, fostering excellence in education, and critical thinking skill development indigenous to the research process. Their support in this endeavor was indispensable.

Congratulations to those whose work is included in this issue of *DUJOUR*. I trust this journal will serve as a catalyst for discussion and discovery.

LYNN STRONG
Managing Editor, DUJOUR
Director of Undergraduate Research
Dillard University, 2010
Acknowledgements

The Managing Editor wishes to acknowledge the following people for production of this publication: President Marvalene Hughes, who planted the seed for the Journal immediately upon return to New Orleans after Hurricane Katrina; Executive Vice President Walter Strong, whose staff ensured the funding that resulted in student and faculty collaborative research and creative work; the Office of the Provost and Academic Affairs, as well as the DUJOUR Editorial Review Board—Dr. Lovell Agwaramgbo, Dr. Edwina Frank, and Dr. Jerry Ward; and the Dillard University Research Group, comprised of faculty who encouraged and supervised students, and ensured the vision…first articulated by President Hughes…of the Journal becoming a premier publication of undergraduate research. We applaud the initial efforts of the faculty and staff who supported our vision:

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African Union: A New Integrative Agenda and Its Implications for Good Governance

Scott Kristopher Morrella, 2007, Political Science

Faculty Mentor: Nchor Okorn, Ph.D., Political Science, Dillard University

Abstract

Efforts at regional integration have had far-reaching impacts on political, economic, and social policy in both the developed and developing worlds. Exceptional integrative efforts have been made within the African continent, especially through collective measures to improve governance. This paper first creates a conceptual and theoretic context by examining the literature of the classic integration theorists. The second part extensively explores integration on the African continent from the events leading up to the creation of the Organization of African Unity and its replacement by the African Union. Finally, the implication of these efforts in terms of good governance is considered.

Introduction

Although the African continent is renowned for its traditional sense of community and togetherness, decades of extraction and underdevelopment have led to social disintegration and governance crises. The history of colonialism and underdevelopment in international relations was the consequence of realist ideologies of competing imperial nations. The United Nations’ ascendancy in the second half of the 20th century caused a proliferation of integrative efforts that shifted national policies so that universal and regional objectives aimed at political, economic, and social development could be achieved. This surge in international cooperation has had dynamic impacts on the different regions of Africa, especially in regards to improving governance. In fact, a veritable African Renaissance has emerged through the institutionalization of the African Union (AU), the New Partnership for Africa’s Development (NEPAD), and the African Peer Review Mechanism (APRM).

Integration in Africa is the process by which African states devolve varying degrees of their sovereignty in order to form sub-regional and continental unions concerned with the collective development of their citizens. The study of regional integration in the African context is essential because this region has been neglected in the academic discourse on integration until
very recently. Understanding the process and outcomes of integration is of paramount importance to contemporary African development because it holds the solution to many of the problems caused by the disintegrative impact of colonialism on the continent’s governments and societies.

Conceptual and Theoretical Construction – Regional Integration

Definitions and Scholarship

Despite the extensive, convoluted nature of the literature on regional integration, a quantitative foundation has emerged from a small intellectual elite that constructed and deconstructed the definitions and variables of integration for almost 30 years.¹ This discussion began with David Mitrany’s response to the replacement of the League of Nations by the United Nations in 1945, the process of modernization, and increasing insecurity caused by the ideological divide of the Cold War. Mitrany fathered the functionalist approach to integration theory when he correlated the direct relationship between increased international organization/cooperation and international peace and order.² He suggested that political integration resulting from functional cooperation in technical areas would become binding because the benefits of maintaining and increasing integration would far outweigh the cost of disintegration.³

A decade later, Ernst Haas defined integration as “the process whereby political actors in several distinct national settings are persuaded to shift their loyalties, expectations and political activities toward a new centre, whose institutions possess or demand jurisdiction over the preexisting national states.”⁴ Haas’s study of international integration was influenced by the tripolarization of power amongst the Western capitalists, the Soviet bloc of communists and the marginalized and non-aligned countries. He claims the universal approach to international integration began as an effort toward collective security but devolved into regional attempts to balance power relations.⁵

The Princeton Center for Research on World Political Institutions commissioned a study by Karl W. Deutsch that focused on the Atlantic region and the functional capacity of NATO.⁶ This work defined integration as the “attainment, within a territory, of a ‘sense of community’ and of institutions and practices strong enough and widespread enough to assure, for a ‘long’ time, dependable expectations of ‘peaceful change’ among its population.”⁷ Deutsch’s analysis
concluded that successful integration is based on the self-interest of elites. He listed a number of necessary preconditions to successful integration, which became independent variables in the attempt to measure the concept. The neo-functionalist approach came out of Haas’s rebuttal to the Princeton study. He agreed that the role state elites play in the integration process is essential, but criticized Deutsch for neglecting to include mass democracy and mass participation as other independent variables.

Functionalism is the theory that institutional structures function systematically to fulfill the needs of all individuals in society. Neo-functionalism is the theory developed by Haas that aimed to study the integration of individuals within the institutional structures of society where negotiation in one functional sector would “spill over” into other sectors and deepen integration. The functionalists focused more on the institutional, legal, and technical aspects of integration, whereas the neo-functionalists viewed integration in terms of communication and interaction between the political actors of society through various means and levels of cooperation.

The focus of this scholarship shifted in the 1960s, as integration began to decline in Europe and intensify in the developing regions of South America, Asia, and Africa. The quantitative and comparative analysis in the work of Joseph Nye showed the incompatibility of applying the causal and predictive methodologies of European integration theory to other regions. Nye’s methodology deconstructed the concept of integration into the sum of its various components in order to study weighted types of integration, as opposed to Haas’s unweighted levels of integration.11

In a later article, Haas took the cue from Nye and invested a considerable amount of time in making a coherent distinction between regional integration as a process and as an outcome, and suggested a revised definition on the premise that “the study of regional integration is concerned with explaining how and why states cease to be wholly sovereign, how and why they voluntarily mingle, merge, and mix with their neighbors so as to lose the factual attributes of sovereignty.” He then proposed 13 potentially measurable variables used to create three pre-theories with integration as the dependent variable. The quantitative analyses of integration arising from the neo-functionalist approach always viewed integration as the dependent variable while proposing many different independent variables. The independent variables can be divided into political, economic, and social categories, where each category is composed of more specific factors that demonstrate a casual influence on integration. The type of government, degree and
scope of trade liberalization, and religious diversity are just three of the many possible independent variables impacting integration.

By the late 1970s, the focus of regional integration theory shifted dramatically from a quantitative paradigm to more pervasively qualitative models, which left all of the previous work of constructing valid independent and dependent variables largely untested. Keohane and Nye criticized the works of Deutsch and Haas, among others, for not considering the nation-state and national interest as the principle actor and motive in integration theory. They proposed studying the ambiguous concept of integration through a larger theoretical framework of interdependence. The new constructs of integration and interdependence were applied to the typology initiated by Nye in his earlier work.¹³ Within this framework, policy integration then focused on “the extent to which policies are coordinated with one another” and policy interdependence referred to “the extent to which decisions taken by actors in one part of a system affect (intentionally or unintentionally) other actors’ policy decisions elsewhere in the system.”¹⁴

Haas’s article complemented the methodological shift initiated by Keohane and Nye by studying the concept of integration through the framework of interdependence. As relations between nations evolved and new observations were made, it became clear that certain postulates needed to be revised.¹⁵ Haas began by addressing the failure of the dominant assumptions found in the historical literature. One such assumption was that regional bodies should make policy through disjointed incrementalism. Haas replaced the concept of disjointed incrementalism, once crucial to the process of regional integration (because it was thought to result in spill over and thus deeper integration) with what he identified as fragmented issue linkage. Fragmented issue linkage does not nullify incrementalism; rather it emerges when actors’ interests are frustrated and dissatisfied with the limited gains of weak policy linkages.¹⁶

Regional integration continues to be significant in explaining the cooperation among still sovereign nation-states, despite the sharp shift in the conceptual and theoretical construction over the decades. However, there remains a deficiency in the scholarship in regards to the implications of integration amongst the African nations despite their impressive movement toward an integrated continent. This deficiency results from the fact that the quantitative scholarship focuses almost exclusively on European integration (where the variables are more testable), rather than on integration in the developing world, which is harder to measure for a
number of reasons. However, the ascendancy of the African Union has resulted in an extensive qualitative scholarship, which has been significantly influential in policy formulation.

**African Integration – The OAU and the AU**

**The Path Toward African Unity**

In April 1958, merely 13 years after the chartering of the United Nations, the eight self-governing nations on the African continent convened at the Conference of Independent African States for a week in Accra, Ghana. The representatives of these states passed a number of resolutions in accordance with their collective vision of preserving “the fundamental unity of outlook on foreign policy so that a distinctive African personality will play its part in cooperation with other peace-loving nations.” Together they resolved to make every effort to promote the independence and self-determination of all African peoples through improved and increased trade, communications, research, race relations, open exchange of people and ideas, and the preservation of indigenous culture. The initiation of dialogue on the economic necessity of creating a common African market and the political necessity of institutionalizing African unity through regular meetings and the formation of a United Nations bloc were perhaps the most important decisions made during the Accra Conference. A permanent organization was formed months later at the All-African People’s Conference (AAPC) and was headquartered in Accra. Nkrumah and President Sékou Touré of Guinea announced the legal formation of a political union open to all independent African states with intentions to determine common defense, economic, and social policies. Seventeen more countries across the continent won independence by the end of 1960 and began to join the Pan-African dialogue.

The Union of African States (UAS) institutionalized the political and economic union of Ghana, Guinea, and Mali, which virtually polarized the pan-African movement between conservative and radical factions (where the conservative factions advocated a loose confederation of cooperative African states and the radical factions advocated for a politically, economically, and socially integrated continent). This split was further exacerbated at the AAPC meeting in Tunis, Tunisia, when certain delegates rejected the primacy of political union in favor of economic and social cooperation. By the second Conference of Independent African States in Addis Ababa, Ethiopia, in 1960, the lines were clearly drawn. On the one hand were the nations that advocated a loose confederation under the assumption that political unification was
impossible without first accomplishing economic and social unification. On the other hand were those states that sought concrete political integration based on the premise that economic and social integration would follow.22

Conservative leaders from predominantly Francophone states formed the Brazzaville group in December 1960.23 A month later, the more revolutionary Casablanca group (which included the UAS) was formed at the behest of King Muhammad V of Morocco in response to the selectivity of the Brazzaville group.24 Both groups institutionalized various committees and passed numerous resolutions. The Monrovia group was created in May 1961 in an obvious response to the Casablanca group. The Monrovia group absorbed the Brazzaville group and additionally recruited attendants from 14 other African countries who together put forward decisions that “were not fundamentally different from the provisions of the Casablanca African Charter.”25 The ideological rivalry was intense between the radical Casablanca group, which was “advocating for the formation of a United States of Africa,” and the Monrovia group, which “stressed the importance of the independence, integrity, and sovereignty of each African state, and advocated a loose association of those states.”26

The Organisation of African Unity (OAU) – Aims and Principles

On May 22, 1963, 32 African countries (including both the Casablanca and Monrovia groups) met in Addis Ababa and finally “agreed upon a compromise formula for achieving African unity.”27 The familiar debates between the old groupings continued until a consensus was reached calling for “a loose association with a dash of functional cooperation,” and when the charter was adopted and ratified by all 32 states, the Organisation of African Unity (OAU) was created on May 25, 1963.28

The OAU Charter envisioned the harmonization of policies with specific aims “to promote decolonization and independent self-government in African states; to guarantee respect for territorial boundaries of the states; and to promote social, political, and economic development on the African continent.”29 These aims were explicitly stated in Article III, through the declaration of the following principles:

1. The sovereign equality of all Member States; 2. Non-interference in the internal affairs of States, 3. Respect for the sovereignty and territorial integrity of each State and for its inalienable right to independent existence, 4. Peaceful settlement of disputes by negotiation, mediation, conciliation or arbitration, 5. Unreserved condemnation, in all its forms, of political assassination as well as of
subversive activities on the part of neighboring States or any other States, (6) Absolute dedication to the total emancipation of the African territories which are still dependent, (7) Affirmation of a policy of non-alignment with regard to all blocs.30

These principles created the solid foundation from which all future OAU decisions would be made, even when unwavering insistence on state sovereignty, inviolability of arbitrary territorial boundaries, and non-interference greatly hindered the normative and structural effectiveness of the organization. The inception of the OAU was initially celebrated and viewed with much optimism. The founders at the inaugural meeting sought to create an institutional structure that was inclusive as well as strong and effective. The strength and effectiveness of the OAU met with mixed success and failure throughout its 39-year existence.

**OAU – Success and Failure**

The most successful resolutions passed at the inaugural summit of the Organisation of African Unity were the Resolution on Decolonisation, the Resolution on Disarmament and the Resolution on Africa and the United Nations. However, these successes are relative and have been debated to various degrees.31 The aims and principles of the OAU Charter led to the realization of these successes but it is “undeniable that these principles also restrained the actions of the OAU, especially in the sphere of conflict management and resolution.”32 Many structural and functional limitations also led to inertia in the later years.

Because the OAU emerged from “the idea of the African states as strong and united against colonial subjugation and racism,” the Assembly of Heads of State and Government strongly objected to the colonial rule, apartheid, and racial discrimination perpetrated on the continent.33 The influence of the OAU in the process of decolonization led to early optimism for the organization and is often understated.34 Although the OAU was unable to successfully enforce sanctions against oppressive regimes, it did provide a necessary legitimacy for continental liberation movements. The Liberation Committee (formed in 1963) was essential in promoting independence and self-determination through a number of efforts including direct mediation, as well as applying unified pressure through the machinery of the UN and the Commonwealth. Even the most reluctant colonial systems were dismantled through OAU involvement. Additional success was made in the disarmament and the move to make Africa a nuclear-free zone. The OAU also made significant progress with respect to the cultural and
social development of all African people. Furthermore, the OAU cultivated a stronger African legitimacy and presence in the international arena through its amiable relations with the United Nations.³⁵

The most obvious failure of the OAU was its inability to establish peace and security on the continent, especially with regard to internecine conflict. Although the Commission for Mediation, Conciliation, and Arbitration was officially formed in 1964, it remained largely ineffective in accomplishing its goals because of the prevalence of direct negotiation.³⁶

The reluctance of the OAU to involve itself in the internal affairs of member states led to a “tendency to turn a blind eye to tensions and injustices that threatened the very fabric of those states.”³⁷ The unwillingness and inability to protect the security of member states greatly debilitated the organization. Unabated conflicts led to increasing criticism from both within and without the continent because the preservation of colonial borders took primacy over egregious human rights violations. Inaction or hesitation on the part of the OAU was responsible for the political breakdown in many African nations. The absence of a standing OAU military force to be used for peacekeeping or other essential missions was an additional complication.

The inability of the OAU to change with the times led many to view the organization as antiquated. While the UN gradually allowed more flexibility in its intervention in the domestic conflicts of member states, the OAU “adhered to a strict and rigid interpretation of the doctrine of sovereignty and territorial integrity that prevented it from engaging in many devastating conflicts.”³⁸ To remain a relevant force in the promotion of continental peace and security, the OAU would have had to take drastic steps toward uninvited humanitarian intervention and protection.

Structural and functional inefficiencies also plagued the 39 years of the OAU’s tenuous existence. The total centralization of power among the Assembly of Heads of State and Government truncated institutional effectiveness by relegating the role of the Secretariat to the periphery. Further, the personal and national interests of many African heads of state impeded the transcendence of national priorities in favor of continental and regional necessities. This reluctance to sacrifice nationalist agendas also resulted in the difficulty of achieving consensus in the Assembly. A flawed decision making process emerged from the requirements of reaching a quorum and a voting system based on a two-thirds majority, and very likely led to the indisposition of the OAU to get involved in crises, even when the consequences for inaction
were devastating. Decisions were impossible to enforce once they were made because there was no mechanism in place to do so and sanctions were often unsuccessful in forcing compliance. Moreover, the lack of financial resources and the unregulated accumulation of arrears of member states severely limited the scope and capacity of the OAU.\textsuperscript{39} The African Union, in contrast to the activities, structure, function, and culture of the OAU, was established to resolve the issues that its progenitor could not effectively address.

The African Union (AU) – Origins, Objectives, and Principles

Between 1968 and 1977, the Assembly of Heads of State and Government acknowledged that economic integration was prerequisite to the fruition of OAU objectives.\textsuperscript{40} The 1980 Lagos Plan of Action sought to establish the African Economic Community by the year 2000, which was to be initiated through the 1991 signing of the Abuja Treaty. The Abuja Treaty intended to “create a framework for the development, mobilization, and utilization of African human and material resources in an effort to achieve continental self-sufficiency,” and was officially enacted in May of 1994.\textsuperscript{41} The Abuja Treaty explicitly intended to create an African common market and sub-regional free trade areas.\textsuperscript{42}

The Abuja Treaty is especially significant because “the Constitutive Act of the African Union was essentially foreseen in, and proceeds from, the Treaty.” Indeed, certain articles in the Constitutive Act repeat verbatim sections of the Abuja Treaty.\textsuperscript{43} In 1999, the Sirte Declaration of an extraordinary OAU Assembly session led to the creation of the African Union (AU) and the implementation of the African Economic Community (AEC). The Constitutive Act was adopted in Lome, Togo, in 2000, and the AU became a legal entity (thus superseding the OAU) when it was ratified by Nigeria on May 26, 2001. In 2002, the Constitutive Act was ratified by each of the 53 African states and the AU became operationally effective on July 10.\textsuperscript{44}

Article III of the Constitutive Act unequivocally states 14 objectives rooted in the vision of the Abuja Treaty. These are as follows:

1. Achieve greater unity and solidarity between the African counties and the peoples of Africa;
2. Defend the sovereignty, territorial integrity and independence of its Member States;
3. Accelerate the political and socio-economic integration of the continent;
4. Promote and defend African common positions on issues of interest to the continent and its peoples;
5. Encourage international cooperation, taking due account of the Charter of the United Nations and the Universal Declaration of Human Rights;
6. Promote peace, security, and stability on the continent;
7. Promote democratic principles
and institutions, popular participation and good governance; (8) Promote and protect human and peoples' rights in accordance with the African Charter on Human and Peoples’ Rights and other relevant human rights instruments; (9) Establish the necessary conditions which enable the continent to play its rightful role in the global economy and in international negotiations; (10) Promote sustainable development at the economic, social and cultural levels as well as the integration of African economies; (11) Promote cooperation in all fields of human activity to raise the living standards of African peoples; (12) Coordinate and harmonize policies between existing and future Regional Economic Communities for the gradual attainment of the objectives of the Union; (13) Advance the development of the continent by promoting research in all fields, in particular in science and technology; (14) Work with relevant international partners in the eradication of preventable diseases and the promotion of good health on the continent.45

These objectives expanded the founding mission of promoting sustainable economic development. Abounding implications for integrated and sustainable social and political development were evidenced in objectives (3), (7), (13), and (14). Sixteen principles further expounded on the functional essence of the AU. These principles attempted to resolve the failure of the AOU Charter, and are as follows:

(1) Sovereign equality and interdependence among Member States of the Union; (2) Respect of borders existing on achievement of independence; (3) Participation of the African peoples in the activities of the Union; (4) Establishment of a common defense policy for the African Continent; (5) Peaceful resolution of conflicts among Member States of the Union through such appropriate means as may be decided upon by the Assembly; (6) Prohibition of the use of force or threat to use force among Member States of the Union; (7) Non-interference by any Member State in the internal affairs of another; (8) The right of the Union to intervene in a Member State pursuant to a decision of the Assembly in respect of grave circumstances, namely war crimes, genocide and crimes against humanity; (9) Peaceful co-existence of Member States and their right to live in peace and security; (10) The right of Member States to request intervention from the Union in order to restore peace and security; (11) Promotion of self-reliance within the framework of the Union; (12) Promotion of gender equality; (13) Respect for democratic principles, human rights, the rule of law and good governance; (14) Promotion of social justice to ensure balanced economic development; (15) Respect for the sanctity of human life, condemnation and rejection of impunity and political assassination, acts of terrorism and subversive activities; (16) Condemnation and rejection of unconstitutional changes of governments.46

The remaining articles of the Constitutive Act improved the structural foundation of the OAU by reinvigorating the essential organs as well as creating new organs with more specified
functions. Key to this was the resolution of the issues caused by the centralization of power within the Assembly of the Heads of State and Government. The Constitutive Act devolved greater power to the Commission of the Union (the reformed Secretariat of the OAU). The OAU’s Council of Ministers was reorganized and renamed the Executive Council. The Peace and Security Council (PSC) was created through a protocol in accordance with the Constitutive Act’s principles and objectives to alleviate conflict on the continent. The Pan-African Parliament was inaugurated in 2004 and serves as the legislative body of the AU as well as the primary mechanism to include the participation of civil society in the functioning of the AU. The Constitutive Act also outlined the creation of the African Court of Justice, which has currently been ratified by 12 member states and will begin implementation after ratification by a total of 15 member states. Three financial institutions (the African Investment Bank, the African Monetary Fund, and the African Central Bank) have been created but are not expected to be fully operational until 2028. The Constitutive Act also placed emphasis on the Abuja vision of Regional Economic Communities and currently the AU recognizes eight RECs.

Comparing the OAU Charter and the Constitutive Act of the AU

A comparison of the OAU Charter and the Constitutive Act of the AU shows the eagerness of contemporary African leaders to build upon the successes of the OAU while addressing the Charter’s greatest weaknesses (see Table One). This is especially evident in the Constitutive Act’s amendment to the aims and principles of the Charter. Much more attention is given to matters of political development, specifically conflict resolution and governance, although economic and social development continue to be top priorities. The Constitutive Act is more interventionist and demands the concession of national sovereignty to a more effectively organized and integrated continent. The Constitutive Act confronts the need for “an overarching framework for achieving lasting peace and security in Africa” that was lacking in the OAU.

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<th>ISSUE AREA</th>
<th>OAU</th>
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<tbody>
<tr>
<td>Integration</td>
<td>II, 1(a); II, 1(b)</td>
<td>III, (a); III, (c); III, (j); III, (k); III, (l)</td>
</tr>
<tr>
<td>Decolonization</td>
<td>II, 1(d); III, 6</td>
<td>III, (e); III, (i); III, (n)</td>
</tr>
<tr>
<td>International</td>
<td>II, 1(e)</td>
<td>III, (e); III, (i); III, (n)</td>
</tr>
<tr>
<td>Cooperation</td>
<td>II, 1(c); II, 2(f); III, 1; III, 4</td>
<td>IV, (f); IV, (d); IV, (e); IV, (f); IV, (g); IV, (h); IV, (i)</td>
</tr>
<tr>
<td>Peace and Security</td>
<td>II, 1(c); II, 2(f); III, 1; III, 4</td>
<td>IV, (f); IV, (d); IV, (e); IV, (f); IV, (g); IV, (h); IV, (i)</td>
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### Articles III and IV of the Constitutive Act

Articles III and IV of the Constitutive Act contain five objectives and four principles that are explicitly stated in the Charter. Objectives 1, 2, 5, 11, and 13 (listed previously) express the continued commitment to the synthesis of continental unity and solidarity through the integration of sovereign territories. These objectives reflect the desire to further capitalize on the foundation created by the OAU, as illustrated by aims intended to improve the perception and respect of the continent in a globalized system, as well as to eliminate the obstacles preventing the achievement of the maximum potential of African peoples and resources. Principles 1, 2, 5, and 7 of the Constitutive Act mirror the OAU’s insistence on maintaining existing borders and respecting the domestic affairs of member states while finding diplomatic, yet interventionist means of conflict management and resolution.

The Constitutive Act promotes continental peace and security, democratic principles and institutions, good governance, global integration, and sustainable economic and social development in order to counter the issues of “insecurity and instability” that are “rooted in problems of domestic governance and socioeconomic development.” Principles 4, 6, 8, 10, and 16 are extraordinarily progressive compared to the language of the Charter. Principle 4 establishes a coordinated continental defense policy, while principle 6 prohibits the use or threat of force. Principles 8 and 10 provide the AU the authority to intervene in member states “in respect of grave circumstances, namely war crimes, genocide and crimes against humanity,” or in the case of a member state’s appeal to the AU for intervention. Lastly, principle 16 condemns the unconstitutional change of governments in member states. The Constitutive Act is exemplary because it created an entirely new organization in order to reform the weaknesses of the organization it superseded. The redefinition of the concept of sovereignty and the extralegal right of the AU to intervene based on specified circumstances create the possibility of sustainable peace and stimulated growth across the continent.
The founding document of the African Union does appear to be structurally stronger than that of the OAU, but critics still consider the AU to be an “empty shell” in terms of its ability to concretely operationalize its aims and objectives.\textsuperscript{54} It is still too early in the AU’s evolution to empirically determine the ability of the organization to improve the political, economic, and social development of an integrated African continent. However, this paper contends that in the few years since the ratification of the Constitutive Act, the AU has had significant implications on the current push for good governance across the continent. These implications are most adequately illustrated through the creation of the New Partnership for Africa’s Development (NEPAD) and the African Peer Review Mechanism (APRM).

**Measuring and Monitoring Good Governance**

**Definitions of Governance**

The recent explosion of empirical research “aimed at measuring governance, monitoring country progress, understanding the causes and consequences of good governance for development, and learning from successes and failures” has had a profound impact on the world in general and Africa in particular.\textsuperscript{55} These studies show that good governance precedes economic development and has “stimulated the demand for monitoring the quality of governance across countries and within individual countries over time.”\textsuperscript{56} Perhaps the most comprehensive and exhaustive work on governance is the series of Governance Matter papers commissioned by the World Bank. The United Nations Economic Commission for Africa (ECA) has determined other measures of governance that are applied only to African states. Most recently, the AU has been vigorously developing African standards for governance through NEPAD and the APRM.

Defining good governance has proven to be quite complex and laborious, which has resulted in a proliferation of working definitions, each containing interrelated variable components. The World Bank broadly defines governance as “the traditions and institutions by which authority in a country is exercised.”\textsuperscript{57} This definition includes: (1) the process by which governments are selected, monitored, and replaced, (2) the capacity of the government to effectively formulate and implement sound policies, and (3) the respect of citizens and the state for the institutions that govern economic and social interactions among them.\textsuperscript{58}

The working definition employed by the ECA states that “good governance aims at ensuring that the voices of the citizens, particularly the poorest and the most vulnerable, are
heard in decision-making over issues that affect their lives. Thus, good governance ensures that political, social and economic priorities are based on broad consensus in society. Good governance therefore calls for creative participatory modalities for civil society groups, in public policy formulation and implementation, including the national budget.”

The definition of good governance emanating from within Africa has closely paralleled the work being done by the ECA. Kofi Annan’s definition, in the 1998 Annual Report of the United Nations, indicates that “good governance means creating well-functioning and accountable institutions – political, judicial and administrative – which citizens regard as legitimate, in which they participate in decisions that affect their daily lives and by which they are empowered.”

Annan’s definition reflects the concept as defined by the UN, but more importantly, it symbolizes an African approach to the interpretation of good governance. NEPAD was formed through a mandate of the OAU given to the heads of state of Algeria, Egypt, Nigeria, Senegal, and South Africa. The incorporation of NEPAD into the auspices of the AU in 2001 reaffirms the commitment of African integrative efforts to address governance issues. NEPAD is an intricate combination of strategies and institutions that may be “interpreted as a comprehensive program addressing most of the impediments of Africa’s development.”

Most importantly, it intends to engage in new forms of “partnership”; externally with the developed world and internally with civil society groups.

The first of the seven priorities of NEPAD is to establish “conditions for sustainable development by ensuring: peace and security; democracy and good, political, economic and corporate governance; regional co-operation and integration; and capacity building.” NEPAD is intended to be a catalyst toward the AU’s vision of a united continent guided by the core values of democracy. The Heads of State and Government claim this priority will only be achieved through the enforcement of the rule of law, respect of equality and equality of opportunity, individual and collective freedoms, means of participation, and the separation of powers. The enforcement of this priority was considered so vital to development that the African Peer Review Mechanism (APRM) was created specifically to establish “a system by which African countries monitor each other’s progress towards desired outcomes.”

The APRM was adopted by the Assembly in March 2002 to help “foster the adoption of policies, standards, and practices that lead to political stability, high economic growth, sustainable development, and accelerated sub-regional and continental economic integration.
through sharing of experiences and reinforcement of successful and best practice, including identifying deficiencies and assessing the needs of capacity building.” The APRM defines governance as successful when “the respective national constitutions reflect the democratic ethos and provide for demonstrably accountable governance and that political representation is promoted, thus providing for all citizens to participate in the political process in a free and fair political environment.” Membership to the APRM is voluntary and to date only 25 nations have signed the Declaration on Democratic, Political, Economic, and Corporate Governance and have agreed to “submit to and facilitate periodic peer reviews.”

**Indicators of Governance**

The concept of good governance is so complex that it becomes necessary for definitions to contain many elements in order to be as comprehensive as possible. However, extensive definitions of the concept are meaningless without empirical indicators to comparatively measure and monitor the performance of nations toward democratization (see Table Two). The World Bank has compiled the most exhaustive indicators. The ECA has also produced substantial indicators for measuring governance of 27 countries in Africa. The NEPAD/APRM indicators are still being developed through a close cooperation with the ECA and other development partners.

<table>
<thead>
<tr>
<th>INDICATOR</th>
<th>WORLD BANK</th>
<th>UNECA</th>
<th>APRM</th>
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<tbody>
<tr>
<td>Accountability</td>
<td>X</td>
<td>X</td>
<td>X</td>
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<tr>
<td>Constitutional Democracy</td>
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<td>X</td>
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<tr>
<td>Control of Corruption</td>
<td>X</td>
<td>X</td>
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<tr>
<td>Economic Management</td>
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<tr>
<td>Effectiveness</td>
<td>X</td>
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<td>Human Rights</td>
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<td>Independence of Civil</td>
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<tr>
<td>Society and Media</td>
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<tr>
<td>Peace and Stability</td>
<td>X</td>
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<td>Regulatory Quality</td>
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<td>Representation</td>
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<td>Rule of Law</td>
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<td>Separation of Powers</td>
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The 2006 World Bank paper by Kaufmaan, Kraay, and Mastruzzi updates the aggregate governance indicators for 213 countries and presents point estimates. This report uses clusters measuring six dimensions of governance. The methodology used by the World Bank study relies largely on the aggregation of 31 individual data sources from 25 different organizations. The clusters (and their ancillary indicators) are: Voice and Accountability (measuring political, civil, and human rights); Political Instability and Violence (measuring the likelihood of violent threats to, or changes in, government); Government Effectiveness (measuring the competence of the bureaucracy and the quality of public service delivery); Regulatory Quality (measuring the incidence of market-unfriendly policies); Rule of Law (measuring the quality of contract enforcement, the police, and the courts, as well as the likelihood of crime and violence); and Control of Corruption (measuring the exercise of public power for private gain, including both petty and grand corruption and state capture).70

The methodology used by the ECA to create indicators for good governance employs a research instrument with three components, including the organization of a panel of experts, the conduction of extensive national surveys, and rigorous desk research. The actual indices used were calculated using 83 indicators from the expert panel study. From this, 23 sub-indices were constructed to create governance clusters. These clusters (and their indicators) are: political representation (including measures of the political system, power distribution, political party freedom and security, electoral process independence and credibility); institutional effectiveness and accountability (including legislative and judiciary effectiveness); executive’s effectiveness (including management of state structure, civil service transparency, accountability and accessibility, efficiency of government services, and decentralization of structures); human rights and rule of law (including respect for human rights, respect for the rule of law, and law enforcement organs); civil society organizations and media independence; economic management (which includes investment policies attractiveness, pro-investment tax policies, and tax system efficiency and corruption); and control of corruption.71

The development of governance indicators for the APRM has been a gradual process. The closest the APRM comes to determining precise measures of governance are the nine
objectives put forward in the *Objectives, Standards, Criteria and Indicators for the APRM*. These key objectives are:

1. prevent and reduce intra- and inter-country conflicts;
2. constitutional democracy, including periodic political competition and opportunity for choice, the rule of law, a Bill of Rights and the supremacy of the constitution are firmly established in the constitution;
3. promotion and protection of economic, social, cultural, civil and political rights as enshrined in all African and international human rights instruments;
4. uphold the separation of powers including the protection of the independence of the judiciary and of an effective Parliament;
5. ensure accountable, efficient and effective public office holders and civil servants;
6. fighting corruption in the political sphere;
7. promotion and protection of the rights of women;
8. promotion and protection of the rights of the child and young persons;
9. promotion and protection of the rights of vulnerable groups, including displaced persons and refugees.

Each one of these objectives is further deconstructed into standards, indicative criteria, and examples of indicators. The standards for each criterion are determined by a number of different primary source documents including the Constitutive Act of the AU, the Charter of the UN, the NEPAD Strategic Framework Document, and many other resolutions and declarations that are specifically relevant to each objective. The indicative criteria are composed through various questions that suggest rough parameters for measuring the performance of African governments when answered. Finally, the examples of indicators are suggestions that still need to be thoroughly debated and agreed upon. The implementation of the APRM procedures for measuring and monitoring governance has been slow and deliberate; however, there is no reason to assume that it has failed in achieving its aims. In fact, the work of NEPAD and the APRM has indeed been influential in promoting the political integration and development of the continent.

**Conclusion**

The expanding literature on regional integration has had serious repercussions for contemporary leaders of independent and developing African nation-states. Although there has been a shift from quantitative to qualitative studies of the concept, there is a current need to create new methodologies to measure the degree and scope of integration. This is especially so with regards to the emergence of the African Union as the pre-eminent supranational authority governing continental integration and its implications on political, economic, and social development. Although the implementation and operationalization of the plethora of AU aims
and institutions has been slow to materialize, it is evident from this study that it has been extremely successful in promoting a common agenda of good governance. The specialized functions of NEPAD and the APRM in terms of promoting and measuring governance can be positively correlated with accelerated continental integration. However, the concept of governance is as complex as the concept of integration. Although the World Bank and the UN have made significant strides in the quantification of variables measuring governance, development of the NEPAD indicators is paramount to African efforts to take ownership of the democratization process. Finally, multivariate studies need to be conducted once the many variables measuring integration and governance are determined so as to have a better statistical understanding of the relationship between the two concepts. The historical literature failed to adequately determine valid independent variables to test the casual factors leading to integration, with Haas himself declaring the neo-functionalist framework obsolete after the stagnation of European in the 1960s. The current literature on the subject is overwhelmingly qualitative and comparative but has been significant in influencing integration and governance policies in Africa. The role of the African Union in uniting the continent is telling. The shift from the OAU to the AU has led to the proliferation of new integrative institutions that are determined to improve governance, economic stability, and the way of life for all peoples of the continent.

Footnotes

3 Ibid.
5 Haas distinguishes between the universal integration of the UN and efforts towards regional integration such as NATO (1949), SEATO (1954), the OAS (1948), the ECSC (1952), and the EEC (1956).
7 Ibid., 5.
8 Haas, The Uniting of Europe, op.cit. 15.
11 Ibid., 858. Nye’s typology is composed of economic integration (formation of a transnational economy), social integration (formation of a transnational society), and political integration (formation of transnational interdependence).

13 Nye, “Comparative Regional Integration,” op.cit.


16 Ibid., 192.


19 Ibid.

20 Ibid., 170.

21 The countries to secure independence in 1960 are Benin, Burkina Faso, Cameroon, the Central African Republic, Chad, the Republic of Congo, the Democratic Republic of Congo, Côte d’Ivoire, Gabon, Madagascar, Mali, Mauritania, Niger, Nigeria, Senegal, Somalia and Togo. Esedebe, *Pan-Africanism*, op.cit. 173.


23 Ibid., 177.

24 Ibid., 178-179.

25 Ibid., 181.

26 Johnathan D. Rechner, “From the OAU to the AU: a Normative Shift with Implications for Peacekeeping and Conflict Management, or Just a Name Change?” *Vanderbilt Journal of International Law* (March 1, 2006): 3.


28 Ibid., 195.

29 Rechner, “From the OAU to the AU,” op.cit., 3-4.


32 Rechner, “From the OAU to the AU,” op.cit., 9.


37 Ibid.

38 Rechner, “From the OAU to the AU,” op.cit., 10.


40 Ibid. The Libreville decision was an endorsement of the 1976 Kinshasa Declaration of the Council of Ministers.

41 Ibid., 370.

42 Ibid.

43 Ibid.

44 Rechner, “From the OAU to the AU,” op.cit., 11.


46 Ibid., IV.


48 Ibid. These are: CEN-SAD, COMESA, the EAC, the ECCAS, ECOWAS, SADC, the IGAD, and the UMA.

49 Table One compares the Charter and the Constitutive Act by categorizing the different issues areas expressed by the goals and principles of each founding document. It is clear from this table that the Constitutive Act addresses significantly more issues areas than the Charter.


51 *Constitutive Act of the African Union* op.cit., III-IV.

53 Constitutive Act of the African Union op.cit., IV (h), (j).
56 Ibid., 2.
58 Ibid.
69 Table Two categorizes conventional indicators of good governance by themes in the definitions given by the World Bank, the ECA, and NEPAD/APRM.
71 Ibid., 43-44.
73 Ibid.

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Rechner, Jonathan D. “From the OAU to the AU: A Normative Shift with Implications for Peacekeeping and Conflict Management, or Just a Name Change?” *Vanderbilt Journal of Transnational Law* 39, no. 2 (March, 2006): 543-577.


The Impact of Contemporary China on the Development of African Countries

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Abstract

This study is a preliminary examination of the impacts of contemporary China’s development activities on the African continent. China’s “African White Policy Paper,” also known as the “Beijing Consensus,” defines and outlines China’s development interests in Africa as a positive contribution to the development of a continent that has been historically ignored. The purpose of this study is to examine and understand the outcomes of China’s activities to determine whether or not the primary outcomes promote Africa’s development as suggested by the White Policy Paper, or China’s domestically driven self-interest in oil and other natural resources. Findings and conclusions of this study support the view that China’s self-interests are the primary rationale for its activities, although there are both positive and negative influences on specific African countries. Finally, the paper explores whether China’s activities constitute a new colonialism, neo-colonialism, imperialism, or a new development phenomenon.

Introduction

China’s interest in the African continent has generated a significant amount of international concern. Government officials, representatives of international organizations and non-profit humanitarian organizations, intellectuals and activists have engaged in relentless debate on the influence such a relationship has on the developing African continent, and its implications for the rest of the world. On one hand, China’s trade, investment, development aid and technological projects throughout the African continent appear to be consistent with the aim of positively contributing to the social, physical and economic development of a continent that has been historically ignored. On the other hand, Chinese actions may strictly center on a need to obtain raw materials, ignoring immediate African necessities and failing to consider the disadvantages that result from this controversial relationship. Some analysts ask whether the current relationship between China and specific African countries reestablishes the existence of
colonialism in the midst of globalization. They may also be concerned about the possibility of neo-colonialism and imperialism, or “globalonialism,” a term used to describe simultaneously the positive effects of globalization and the negative effects of colonialism. China’s trade, investment, development, aid and technological contributions are multifaceted, and as a result may produce varying perceptions, concerns and outcomes.

**Problem Statement**

**China’s Search for Natural Resources**

China’s foreign policies are strategically organized around its rapidly expanding need for natural resources. This need for raw materials has been brought about by the growing demand of a country that currently accounts for a fifth of the world’s population.1 With over 1.3 billion people (July 2007), the People’s Republic of China must address its inability to meet the population’s growing demand for goods and services. According to the United States Council on Foreign Affairs, China’s current foreign developments are attributed to its “booming domestic economy, rapid urbanization, increased export processing, and the Chinese people’s voracious appetite for cars, [which] are increasing the country’s demand for oil and natural gas, industrial and construction materials, foreign capital and technology.”2 Between 1990 and 2000, China’s consumption of aluminum, copper, nickel, and iron ore increased from seven percent to 15 percent. In 2005 the country consumed approximately 20 percent of the world’s aluminum, copper, nickel and iron ore.3 The need for additional raw materials has led Beijing to continually encourage “representatives of state-controlled companies to secure exploration and supply agreements with states that produce oil, gas, and other resources.”4 The government, on the other hand, aggressively sought opportunities to build goodwill by “strengthening bilateral trade relationships, awarding aid, forgiving national debt, and helping build roads, bridges, stadiums, and harbors,”5 in the hopes of accessing a foreign country’s natural resources.

The international search for natural resources led China to previously colonized countries on the African continent. China ventured into territories that were marred by political, social and economic instability, deterring the interest of competing western powers (United States and Europe). According to an article in the Washington Post, “Chinese companies have developed a reputation for going where others won’t because of political, environmental or ethical concerns, or because profit margins are too slim.”6 Africa could provide China with vast amounts of “oil, mineral ores, timber, and cotton,” and at the same time become a vital consumer market for
Chinese manufactured goods. As the world’s second largest oil importer after the United States of America, China has significant interest in the oil producing African countries of Sudan, Chad, Nigeria, Angola, and Gabon. From 1995 to 2006, it is estimated that China’s share in Africa’s trade volume increased from 0.9 percent to 10 percent (Holslag 2007). The 2005 trade figure of $40 billion is expected to rise to $100 billion by 2010. The International Energy Agency predicts that by 2030, China’s net imports will jump to 13.1 million barrels of oil per day. 

China’s African Policy: “Go Out” Strategy and White Paper Policy

The “Go Out” strategy adopted by China encourages Chinese industries to expand on an international level. This was specifically stated in China’s Tenth Five-Year Plan (2001-2005). According to Friedrich Wu (2005), a “national team of 120 state-owned industrial groups could spearhead the internationalization of Chinese enterprises.” Industries such as “power generation, mining, automobiles, electronics, iron and steel, machinery, chemicals, construction, transport, aerospace, and pharmaceuticals were given “high levels of protection, generous state financial support, as well as special rights in management autonomy, profit retention, and investment” by the Chinese government.

China’s foreign officials have proclaimed the existence of a humanitarian approach to a relationship that provides “meaningful deliverables that would serve primarily the interests of Africa.” The Chinese government issued a plan politically referred to as China’s African White Paper Policy. White paper is generally used in politics and business, and acts as an authoritative report or guide to outline problems, proposed action, and policies. The China-Africa white paper approach emphasizes the establishment of a strategic partnership between China and Africa, which features “political equality and mutual trust, economic win-win cooperation and cultural exchange.” According to the policy, the Sino-African relationship would center on trade and investment, financial, agricultural and resources cooperation, infrastructure, debt reduction and relief, economic assistance, and multilateral and tourism cooperation. An informal concept directly linked to the White Paper Policy is the “Beijing Consensus.” This consensus models China’s plans for economic development in underdeveloped regions, including the African continent.

China’s African policy includes sincerity, friendship and equality, mutual benefit, reciprocity and common prosperity, mutual support and close coordination between China and...
the African continent. It also includes the possibility that two nations can learn from each other, seek common development, and explore the road to sustainable development. The ultimate aim is to promote a well-rounded relationship between China and Africa within the political, economical, educational, cultural, health and social arenas. China has undertaken specific massive infrastructure and technology projects, where they contributed their financial, intellectual and physical expertise to construct roads, railways, ports, dams, and buildings. China also sent doctors, scholarships and educational programs to support the African nationals in the process of development.

**Research Question**

This paper attempts to examine whether or not China’s development policies and practices on the African continent are consistent or inconsistent with the stated intent of the African White Paper Policy and Beijing Consensus to promote deliverables in trade, investment, development, aid and technology that primarily serve the interests of African countries.

**Hypothesis**

China’s trade, investment, development, aid and technology projects in Africa, as measured by outcomes in Zambia, Zimbabwe, Sudan, South Africa, The Republic of Congo, Nigeria and Mozambique, are dominated by China’s domestic need for raw materials, independent of the consequences they have upon African countries. In other words, China is acting solely out of self-interest, which is contrary to the stated policies that define the Sino-African relationship in the African White Paper Policy. Some of China’s development activities bear a striking resemblance to previous examples of colonial relationships between a European mother country and an African host country as indicated by the country’s increased dependence on China, and a decrease in the country’s self-reliance. Development activities, however, may sometimes result in positive outcomes and benefits for African countries.

**Literature Review**

Research on China’s development activities on the African continent included studies, articles, journalistic reports, and critiques and impressions of Western writers and African observers.
Academic Studies

The Sino-African relationship receives mixed reviews. On one hand, scholars applaud the policies and influence that China has on Africa; on the other hand, critics rage over the negative effects the relationship has on the African continent. According to a report by Stephanie Hanson (2008) of the Council on Foreign Affairs, because of Chinese investment, Africa registered 5.8 percent economic growth in 2007, its highest level of growth ever. Hanson elaborates on the views of experts who say the “roads, bridges, and dams built by Chinese firms are low cost, good quality, and completed in a fraction of the time…[China] has cancelled $10 billion in bilateral debt from African countries, sends doctors to treat Africans across the continent, and hosts thousands of African workers and students in Chinese universities and training centers.”

The Chinese government has also been criticized for the foreign policies that were adapted to suit its domestic needs. According to David Zweigh and Bi Jianhai, while the Chinese government encourages state-controlled companies to “seek out exploration and supply contracts with countries that produce oil, gas, and other resources…Beijing aggressively courts the governments of those countries with diplomacy, trade deals, debt forgiveness, and aid packages.” Human rights groups and Africans themselves are concerned with the operations of Chinese firms in Africa, which are not hiring Africans. According to Elizabeth C. Economy with the Council on Foreign Affairs, Sino-African deals stipulate that 70 percent of labor must be Chinese. Economy also makes it clear that China’s policies are similar to those established by Europe, Japan and the United States “offering poor countries comprehensive and exploitative trade deals combined with aid.”

At the Center for Strategic and International Studies, Ian Taylor, author of Common Sense About China’s Ties with Africa, presents three realities that should be considered. First, “China is not a unitary actor.” According to Taylor, there are a significant number of small-scale traders of Chinese origin that are operating in Africa. It is therefore impossible for the Chinese government to have control over all the Chinese activities within Africa. In reality, there are multiple factors in the equation, and it is incorrect to assume there is “one lever to pull and all will come right.” Second, China may not have received a fair analysis, for some of the faults cited may not actually be China’s fault. In other words, some of the information that criticizes China’s presence may be inaccurate. For instance, it has been claimed that Chinese companies are importing Chinese workers, both skilled and unskilled; however, there are a significant number of examples of local Africans being employed in management and administrative
positions. It is also alleged that Chinese manufactured goods are having a devastating impact on the small and medium businesses, producers and local traders in Africa. However, it is ignored that consumers in Africa are content with the available low-cost Chinese products. A study by Deborah Brautigam showed that these Chinese businesses actually serve as catalysts for local industrial development. According to Taylor, Chinese goods are being blamed for the collapse of the African manufacturing industry, when these Chinese products came after the collapse of the industry. Finally, Taylor believes it is the responsibility of African leaders to efficiently manage their relations with China to benefit their own economies and citizens. Thus, it is not China’s responsibility to seek the interests of the African continent. Africans are the ones who should work to ensure a “win-win” situation.

With the support of the American Foreign Policy Council (AFPC), David Shinn and Joshua Eisenman are engaged in thorough investigation and analysis of China’s policies, strategies and goals in Africa. According to Shinn, it is important to review the African perspective. On one hand, a majority of Africans welcome the efforts of China. Sierra Leone’s Ambassador to China said, “the Chinese are doing more than the G8 to make poverty history. If a G8 country proposes a project for Sierra Leone, there is an environmental assessment and evaluation of the human rights and governance situation. The Chinese just come and do it. I’m not saying that it’s right, just that Chinese investments are succeeding because they don’t set high benchmarks.” However, at the grassroots level, Shinn says there is “growing anti-Chinese sentiments when large numbers of Chinese are employed on Chinese projects and as Chinese traders move increasingly into the African market. There are, for example, an estimated 30,000 Chinese migrants in Zambia and as many as 300,000 in South Africa.”

**Journalistic Reports and African Observers**

Richard Behar (2008) describes China’s presence on the African continent as simply an invasion. Behar compares this invasion to a “parasite that invades and depletes their host.” According to Behar, the Chinese seem to be everywhere: clearing trees in Mozambique, drilling for oil in Sudan, digging in copper mines in Zambia, opening textile factories in Kenya, prospecting for uranium in Zimbabwe, buying cobalt in the Congo, laying expressways in Angola. They have launched a satellite from Nigeria and built phone networks in rural Ghana and a dozen other countries. Hospitals, water pipelines, dams, railways, airports, hotels, soccer stadiums, parliament buildings – nearly all of them are linked, in some way, to China’s gaining
access to raw materials. According to Behar (2008), this Sino-African relationship appears more than “a revamped, upgraded replay of colonialism.”

Behar’s journey throughout sub-Saharan Africa presented mixed reviews. On one hand, China is perceived as part of the problem in many African countries. George Nicholls, the coordinator of Pasco Risk, the largest Africa-exclusive corporate intelligence agency, says, “Chinese corporations and crime syndicates have been accused of bribery, smuggling, counterfeiting, corruption and dumping…they are opaque, they go everywhere, they operate outside the international system. And they are thinking 50 to 100 years out. Chinese policies may ultimately do nothing to develop Africa in anything other than the short term.”

On the other hand, Gabriel Nguema Lima, the son of Teodoro Obiang Nguema Mbasogo, ruler of Equatorial Guinea, says, “The Chinese listen better, and they understand that sometimes you need to make sacrifices for a future gain. They’ll do a hydroelectric plant at half the price, and, in return, they get future projects.”

Victor Kosongo, the Congo’s most powerful mining official, agrees with Nguema Lima; he explains, “We asked the World Bank for roads, but they wanted to attach too many conditions…Asians listen more to our concerns without being patronizing.”

As presented in the Economist (March 2008), China has simply replaced the Europeans as the African colonizers. Such a conclusion was specifically based on China’s extraction of raw materials from the African continent, which the authors define as clearly colonial. Robert Rotberg, a director of Harvard University’s Kennedy School program on conflict resolution, may particularly agree with this analysis. Rotberg says, “I would not say this is colonialism, as that term was specific to a particular place and time…But I would call it a postcolonial exploitation in which Chinese are stripping the continent of raw materials as fast as they can and are fairly ruthless about bringing their own laborers for projects and ignoring locals.”

An additional issue is the selling of value-added products back to the Africans, ultimately resulting in unfavorable trade balance amongst African countries. According to Wilfred Collins Wonani, head of the Chamber of Commerce in Zambia, “sending raw materials out, bringing cheap manufactured goods in. This isn’t progress. It is colonialism.”

Despite the China Nation Petroleum Corporation pouring $5 billion into the Sudan’s oil industry, most Sudanese are poor, “living in one-story mud-brick houses along dusty, unpaved streets that date from the middle of the 19th century.” The benefits of the oil boom have not been evenly spread throughout the country, with the influx of foreign workers competing with locals for job opportunities, and affordable housing within the city of Khartoum.
crude oil, has been “accompanied by higher inflation and property prices.” Southern Sudanese “live in meager huts, eating peanuts with perch fish out of the contaminated Nile. There is no electricity. A Swiss charity provides health care. An American aid group flies in food and mosquito nets. Most children do not go to school. There is no work to be found. Petrodar, for one, has its own workers – almost all of whom are foreigners (mostly Chinese, Malaysians, and Qataris) or Sudanese northerners.” In an interview published by the Sudan Tribune, a Petrodar accountant says, “I am here to make money. My company is here to do the same…I know this is a very poor and insecure place, but I am not responsible for fixing all the things that are wrong in Sudan…That’s life. That’s business.”

Another issue that has arisen includes the negative impact of cheap Chinese goods in local African markets. Imported Chinese goods drive Zambian tradesmen out of business. Ironically, the exportation of Chinese textiles to Africa contributed to the demise of the Mulungushi textile factory. The Zambian factory was previously established with the assistance of China. By the end of 2004, Chinese exports of textiles to South Africa had grown to 80 percent; this is in addition to the 75,000 South Africans that lost their jobs in the South African textile industry. The impact of the importation of these Chinese products (home electrical appliances, light industry products, and mechanical and electrical products) has been felt throughout several African local goods markets. In addition to Chinese products, legal and illegal Chinese immigrants have also flooded the markets. According to Michael Sata, a Zambian opposition politician, “Chinese laborers are brought in to work in extractive industries, construction, and manufacturing projects, fueling charges that Chinese investors are taking rather than creating jobs.” As described by Ms. Zimba, a Zambian native, the Chinese are “briefcase investors. They just fill their briefcases with our wealth and leave.”

**Research Methods**

Five initial interviews and seven initial case studies were developed and implemented for this study. However, it is recognized that more extensive research and additional methods will be required in the future. The researcher personally interviewed a carefully selected sample of reputable scholars and activists familiar with African development.

Of the 48 African countries that China is directly or indirectly engaged with in trade and development policy, seven are used here as case studies: Zambia, Zimbabwe, Sudan, South Africa, The Republic of Congo, Nigeria and Mozambique. Each provides a unique point of view.
with regards to the positive and negative impact that China is having on the African continent. China’s impact on these African countries can be analyzed using five distinct indicators: a) infrastructure and development; b) the impact on local markets; c) the impact on the job market; d) socio-cultural interactions; and e) human rights and governance. Infrastructure and development refer to China’s contributions in the form of roads, schools, hospitals, water supply and other necessary facilities. Impact on the local market refers to the negative and positive effects Chinese investments have on indigenous businesses. The impact on African jobs refers to the net increase or decrease in jobs for locals. Socio-cultural interactions involve the extent to which Chinese and Africans engage and interact with each other, and their living conditions and cultural exchanges. Human rights and governance refer to whether China’s activities are producing or reducing corruption, fostering indigenous governance and transparency, and advancing basic human rights.

To represent the data in table form, the researcher constructed a matrix that describes the Sino-African relationship based on these five points of analysis. These relationships would be characterized as positive (+), negative (-) or positive/negative (+/-). A positive relationship occurs when the economical and infrastructural contributions of China increases the value of the African country. A negative relationship contradicts a positive relationship, for despite the economical and infrastructural contribution of China, the value of the African country decreases or remains stagnant. A combination of both positive and negative is defined by a relationship that has both positive and negative outcomes, where the value of the African country from one perspective increases, while the value from another perspective decreases. The use of the term “value” is specific to the economic, social, cultural, and infrastructural elements of the country, and whether China’s presence has brought improvements in the areas that are of specific benefit to the African country.

**Research Findings**

**Interviews**

The individuals who contributed to the research process include scholars located in the United States of America. They are experts on Africa, African relationships with foreign countries and international institutions, and the influences that foreign investments have upon the continent. China’s role in Africa is constantly debated among scholars, activists and African observers. Similarities in interviewee opinion are based on the Sino-African relationship, but
there is also conflict and contradiction among those interviewed.

There is a general consensus among the interviewees that the Sino-African relationship is one of unequal exchange. While the relationship might differ according to the African country, there is an overall superior-subordinate relationship, where the trade is more in favor of China than Africa. According to Dr. James Turner of Cornell University, the present relationship is a pragmatic one, as opposed to an ideological one. China is willing to invest in Africa in exchange for access to abundant African natural resources. This is different from the previous ideological approach of China under the rule of Mao Zedong, when China supported anti-colonial and liberation movements in Africa because they argued that they believed in the principle of national liberation of oppressed people.

The African continent requires the financial and technological support of foreign countries and international organizations – multinational corporations (MNCs) and non-governmental organizations (NGOs). To a great extent, Africa’s current situation is a result of years of neglect during the period of colonialism, and this situation can only be overcome with the financial and technological support of economically stable economies and organizations. China has assumed a role that many Western nations have overlooked. Two years ago, the external debt burden of sub-Saharan Africa was $294 billion. According to Roxanne Lawson of TransAfrica, China did more in the last five years to cancel or delete African debt than Western nations have done in the last 15 years, which is one positive aspect of China’s presence across the African continent.

In addition to the positive impacts China has made within specific African countries, the negative impacts are also noted throughout the interviews. These negative impacts include the Chinese extraction of the African country’s natural resources, the unequal nature of the partnership, the destruction of the local markets, the destruction of the environment and communities, and human rights violations that are supported or ignored by the Chinese government. The question, therefore, is whether this relationship falls under the banner of colonialism. The majority of the interviewees believe that the relationship should not be considered colonialism. It is far from colonialism, especially noting the various benefits that the Chinese government and private organizations bring to the African countries. On the other hand, it may not be classical colonialism, but for some, it may be classified as neo-colonialism or even imperialism. According to Lawson, Africa has experienced colonialism and has obviously learned from it. African leaders are wary of Chinese investment overstepping its boundaries.
Also, there is a general consensus that colonialism involves the acquisition and control of land, and China is not attempting to control African physical space. Nor is China attempting to impose its culture upon the African population, which is another feature of colonialism. Dr. Jemadari Kamara of U. Mass-Boston and Dr. James Turner define this relationship as a form of neocolonialism. The Chinese promise they will invest in the African economy, but their primary motive is to stockpile African materials, minerals and extractive resources. On the other hand, such a relationship also defines imperialism, as China is using its economic power to maintain an uneven trade relationship with Africa.

Ultimately, Chinese presence throughout Africa is making the country more dependent, rather than more self-reliant. China has brought its own teams to work. Very few Africans, if any, are employed and trained, and there is no technology transfer. According to Dr. Kamara, when China comes into an African country to build a sewer system, roads, athletic complexes, mega stadiums, or state department buildings, they are all built by Chinese workers. Other scholars and African observers may disagree with this reasoning, especially if they believe China is not making Africa more dependent, but rather increasing Africa’s self reliance. According to Lawson, Chinese investments make Africans more self-reliant by giving them more negotiating room.

There is a general consensus that Africa countries need to be careful. They especially need to protect their domestic markets, since there is no indication that China will withdraw from Africa anytime soon. Most of the interviewees said that, given the growing needs of China’s domestic economy, China will continue focusing narrowly on its own self-interest, without prioritizing Africa’s development.

Case Studies
Zambia

Positive Outcomes

In the early 1980s, China launched a project in Zambia dedicated to the abundant yet financially unstable textile industry. China utilized its access to financial resources to assist in the development of the Mulungushi Textiles Factory. China also invested in other Zambian sectors, including the cooper mining industry, banking, agriculture and health. More significantly, China assisted in the construction of the Tanzania-Zambia Railway. The project is classified as one of the biggest that China has ever carried out in the international arena. As
described, it was “colossal and involving complicated techniques and the construction was carried out under the most difficult conditions.”43 According to the Embassy of the People’s Republic of China in Estonia, the construction of the railway supported “the African people in their struggles against imperialism, colonialism, and for national independence.”44 A total of 320 bridges measuring 16,520 meters; 22 tunnels measuring 8,898 meters; and 93 stations measuring 376,000 square meters were constructed.45

Copper is Zambia’s leading export commodity, and China’s interest in Zambia is clear. China is the world’s biggest user of copper, importing more than a fifth of the world’s total consumption, and the eighth biggest exporter of finished copper products.46 The mining sector accounts for almost 30 percent of China’s overseas investments. The Chinese-run Non-Ferrous African Mining plc (NFC) will dedicate $150 million to expand the Chambishyi copper mine of Zambia.47 The Chambishyi copper mine is the largest Chinese-owned mine in Zambia’s Copperbelt province. According to Chinese President Hu Jintao, the Copperbelt province will become one of the first of perhaps five tax-free “special economic zones” that China would build in Africa.48

Negative Outcomes

There are numerous problems with Zambia’s copper mining sector, from the rising rate of accidents to the treatment and wages of locals. The biggest disaster in Zambia’s industrial history occurred with an explosion at Chambishi (BGRIMM). The explosion left an unknown number of Zambians dead, forcing the government to create a makeshift cemetery at the front of the mine’s main gate. Similar to the secret nature of trade agreements, the Zambian government did not provide information with regards to the cause of the explosion; however, local experts blame the large numbers of unskilled casual workers for the explosion.49 The unsafe mines and disadvantageous presence of Chinese investment in Zambia were the central position of Michael Sata in Zambia’s 2006 presidential elections. Despite his political efforts, Sata received only 29 percent of the votes. Nevertheless, his views on Chinese investment were widely accepted in some areas, and after the elections, locals viciously attacked Chinese-owned businesses.50

According to Behar, workers at the Chambishi receive the lowest wages and endure the worst safety conditions across the Copperbelt. They are not protected by labor unions. Chambishi employs a “casual” labor force that pays workers $200 a month, the lowest wage received by workers in the Copperbelt.51 A Zambian manager behind the counter of a Zambian-
China Mulungushi Textile location says “the Chinese are not good to work with, pay is poor and if you have a problem at home and need money, they won’t help you. They won’t even give you an hour off to take your daughter to a health clinic if she’s sick.”\textsuperscript{52} Even at Chinese-owned stores, it is rare to see Chinese workers, Behar says; they simply come to clear the registers. This is a clear indicator of relations and cultural exchange between Chinese and Zambians. According to Amos Malupenga, the managing editor of The Post, Zambia’s top daily newspaper, “workers are being mistreated by their Chinese employers…there is a feeling our people are [being] exploited by these Chinese investors, and a feeling that the Chinese investors receive preferential treatment by the government at the expense of other foreign and local investors.”\textsuperscript{53}

Zimbabwe

Positive Outcomes

Zimbabwe has had a longstanding relationship with China. During the war with Ian Smith’s Rhodesian government, the Chinese provided material support for Zanu rebels who were opposed to the white minority rule. With Ian Smith’s resignation, and Robert Mugabe’s Zanu-PF election sweep in 1980, Mugabe first turned to China for support.\textsuperscript{54} Robert Mugabe (1987-present) adopted a “Look East” policy. The severe political and economic instability of the former British colony Zimbabwe (previously Rhodesia) necessitated foreign assistance.

The Mugabe government has openly accommodated the desires of China. With the financial and technological support of China, Zimbabwe had access to sources of capital and trade, expertise, and technical assistance.\textsuperscript{55} China signed a $1.3 billion deal with Zimbabwe to aid the country with its short energy supply. This is in addition to a joint chrome-mining venture between China Star Communications and Zimbabwe’s state mining company.\textsuperscript{56} According to Michael Wines of the International Herald Tribune, in return Zimbabwe granted China’s request to a stake in Zimbabwe’s platinum mines, the second-largest platinum reserve in the world.\textsuperscript{57} The mineral and precious metal deposits of Zimbabwe are estimated at over $500 billion.\textsuperscript{58} There are several natural resources that the Chinese nation requires for its fast-growing economy. In the first quarter of 2005, total Chinese trade with Zimbabwe amounted to approximately $100 million.\textsuperscript{59} Recognizing the role that China plays in Zimbabwe’s economy, Mugabe recommended that citizens of Zimbabwe “learn Mandarin and nurture a taste for Chinese cuisine.”\textsuperscript{60}
Negative Outcomes

Some Zimbabweans are weary of Mugabe’s “Look East” policy; some suspect China’s presence simply replaces the former British colonial power. Despite the uncertainty, China has contributed significantly to the economy and technological know-how of Zimbabwe. According to Michael Wines, some of the Chinese exchanges amount to goodwill; for instance, China donated the blue tiles adorning the $13 million Mugabe palace. The Chinese have also won million dollar contracts to provide hydroelectronic generators for the national power authority.

The Zimbabwean commuter system has also been affected by China’s contribution. First Automobile Works of China has dedicated 1,000 commuter buses to the Zimbabwean government to upgrade its municipal fleet; however, Zimbabweans complain about the failing Chinese buses, which constantly break down. These substandard Chinese products also fill stores and roadside stalls. This has caused deep resentment in Zimbabweans – even resentment for other Asian people, such as the Japanese.

Sudan

Positive Outcomes

Yitzhak Shichor (2005), in his article “Sudan: China’s Outpost in Africa,” declared China the main oil producer, exporter, and importer in Sudan. The China National Petroleum Corporation (CNPC) acquired a 40 percent majority share in the Greater Nile Petroleum Operating Company (GNPOC) for $441 million. This strategy was adopted by China to “guarantee [the] long term and steady supply of crude oil.” Great significance has been placed on the scramble for Africa’s crude oil. R.M Lloyd (2007) says Sudanese oil is of “high quality and therefore relatively cheap to refine.” Sudan’s ideal location also enhances its appeal; surrounded by water, the country is easily accessible by air or sea, which reduces production costs. According to Sudanese President Omar Hassan al-Bashir, “This relationship with China has been fraternal, brotherly and excellent. Our relation with China is built on mutual benefit. China has always supported the unity of Sudan. When our relations became problematic with the international financial institutions, we turned to China. Relations with China have enabled us to overcome economic difficulties.”

Sudanese Minister of Energy and Mining Awad Ahmed Al-Jaz said, “thanks to China’s National Petroleum Corporation (CNPC) strong assistance, Sudan has transformed itself from a crude oil importing country into an oil exporting country and has established a complete
industrial chain for the oil industry; led by the rapid development of the oil industry, Sudan’s overall economy is developing vigorously and entering a phase of economic boom."68

**Negative Outcomes**

Locals are not keen on China’s presence and impact on Sudan. According to Danna Harman of the Sudan Tribune, the “locals live in meager huts, eating peanuts with perch fish out of the contaminated Nile. There is no electricity. A Swiss charity provides healthcare. An American aid group flies in food and mosquito nets. Most children do not go to school. There is no work to be found. Petrodar, for one, has its own workers – amongst all of whom are foreigners.”69 Sudan activist Eric Reeves, a professor at Smith College in Northampton, Mass., asserts that China’s activities in Sudan are “gross human rights violations, scorched-earth clearances of the indigenous population.”70

China’s trade with Sudan also involves a controversial supply of weapons to the Sudanese government. Amnesty International cites that in 2005, China sold $24 million of military material to Sudan. The increased sale of arms to Sudan has contributed to the escalating violence in Darfur, indicating China’s failure to consider human rights efforts, and a violation of the United Nations arms embargo. The United Nations Security Council is responsible for the imposition of 13 arms embargoes over the last decade. These are imposed under Chapter VII of the UN Charter in response to the “threat of peace, breach of the peace, or act of aggression.”71 Sudan has reportedly turned to China (in addition to Belarus, Malaysia, Iran, North Korea and Russia) in its attempts to modernize its military effort, despite the sanctions imposed on Sudan by the United Nations National Security Council. These sanctions are responses to the violent Sudanese civil war (1983-present) between the southern, non-Arab populations and the northern, Arab-dominated government. The civil war is responsible for the displacement of more than four million southerners, while more than two million people have been killed since 1983.72 Despite the sanctions, Sudan’s weapons industry has continued to expand. It has been alleged that China, Russia and other nations have continued to secretly provide Sudan with military material.73

**South Africa**

**Positive Outcomes**

South Africa, China’s largest trading partner in Africa, has also reaped the benefits of China’s trade and investment policies. The Pretoria Declaration (2000) on partnerships between
the two countries and the establishment of the Bi-National Commission (BNC) promote diplomatic affairs, trade, education, science and technology, and defense. The Pretoria Declaration, produced in both English and Chinese, presents a “guiding vision for the future and the fundamental principles for the forging of even closer and stronger relations between the People’s Republic of China and the Republic of South Africa” (Embassy of China in South Africa 2000). Statistical evidence provided by the Chinese embassy in South Africa showed that accumulated Chinese investment in South Africa for 2005 reached $250 million, while South Africa’s investment in China reached $350 million.

China and South Africa both have extensive mining industries and expertise in resource extraction. China imports iron ore, copper, chrome, timber and paper pulp from South Africa, while South Africa imports value-added products from China. The Sino-Africa Cooperation Forum allows Chinese professionals to share their expertise with South Africans, ultimately contributing to the improvement of lives. For example, academics from China Fujian Agricultural and Forestry University have visited South African farmers to teach them how to apply mushroom planting technology to their agricultural processes.

Negative Outcomes

Many South Africans disagree with the proposed free trade pact between the two countries. Over the last 12 years, South African trade with China has increased from roughly 20 to 30 percent annually. South Africa has surpassed Germany as China’s largest import market. According to South African Deputy Minister of Trade and Industry Dr. Rob Davies, total trade between the two countries increased from $5.2 billion to $72.9 billion between 1998 and 2007. Imports totaled $49.1 billion, while exports from South Africa to China totaled only $23.7 billion. This trade imbalance is a growing concern for local policy analysts and political activists.

South Africa’s history is unlike other African countries, and not only with regard to the apartheid experience. The South African government and local organizations have also invested in other African countries, such as Zimbabwe and Lesotho. For instance, Engen Petroleum Limited, a leading refined petroleum products company in South Africa, signed a deal with the Shell Petroleum Company to purchase its interests in Lesotho and Zimbabwe. According to an article published by the Zimbabwe Times, Engen is present in 17 African countries.
The Republic of Congo

Positive Outcomes

The Republic of Congo, formerly known as Zaire, has mineral wealth that cannot be compared to any other African country. Congo’s soil has every mineral known to man: 10 percent of the planet’s known copper; 30 percent of its cobalt; 80 percent of its coltan; and untold quantities of bauxite, zinc, cadmium, uranium, gold and diamonds.

Despite the political and ethnic instability of the Congo, China saw great potential to formulate trade and development deals in exchange for highly demanded resources. As opposed to other African nations that favor China’s policy over the policies of Western nations and international organizations, Congo’s economy is totally dependent on foreign investment. The country welcomes all the foreign assistance it can get, and China is not attempting to replace the World Bank and other foreign countries as contributors to the economy. The Congolese authorities insist that “Western companies have nothing to fear from the sudden appearance of Chinese rivals.” As stated by Victor Kasongo, “If China wants to dominate the world, it’s not our business to stop them…Who are we to close the door to them when we don’t have water or electricity? If China doesn’t come [to Congo], we’re in big shit.”

According to China Economic Review, the National Assembly of the Democratic Republic of Congo (DRC) approved several construction and mining deals with China. To support the deals, China would devote an estimated $9 billion to the projects, of which $6 billion would be dedicated to infrastructure and development, and $3 billion to the mining industry. The deal also commits China to the construction of 9,000 kilometers of roads and railways, dams, schools, hospitals and housing. As part of the agreement, China Railway Group and Sinohydro Corporation would work hand in hand with Gecamines, which is DRC’s national mining firm. This is similar to the structure of other Sino-Congolese trade agreements. During the week of 20 September 2007, China and the Democratic Republic of Congo entered into a $5 billion deal centered on mineral resources exchanged for infrastructure projects and loans.

Negative Outcomes

A major problem with the $9 billion deal is the fact that the new infrastructure would be built by Chinese construction companies, using majority Chinese labor, ignoring the job and financial needs of locals. Behar reiterates that China is investing in the Congo because of its self-interest: “China’s decision to launch its first ‘special economic zone’ adjacent to Zambia makes
perfect sense. The zone will serve as the hub of an industrial-distribution system linking Congo by rail and highway to Chinese-built networks in Zambia and Angola, and ultimately to ports on either coast.\textsuperscript{81}

\textbf{Nigeria}

\textit{Positive Outcomes}

In 1971, the governments of China and Nigeria signed the Joint Communiqué on the Establishment of Diplomatic Relations between the People’s Republic of China and the Federal Republic of Nigeria. Since then, China has financially contributed to the economic, infrastructural, technical, scientific and technological development of the African country. They have engaged in joint economic and trade activities, and in 2003, trade volume between the countries reached $1.86 billion, representing a 59 percent growth for Nigeria. According to the Chinese Embassy on trade with Nigeria, the country’s exports to China registered a growth of 330 percent in 2004.\textsuperscript{82}

Chinese companies such as China Geological Engineering Company, China Harbor Engineering Company (Group) and China Civil Engineering Construction Corporation have undertaken major rehabilitation projects in Nigeria. These projects include the Nigerian railway and the Games Village of Abuja Sports complex. These agreements also filtered into the areas of investment promotion and protection. In exchange for the aid and development packages in Nigeria, the Chinese government gained access to petroleum, timber and cotton projects of Nigeria; however, Nigeria’s petroleum resource is most enticing to the Chinese government. China is Nigeria’s top oil exporter. In 2006, China secured four oil drilling licenses from Nigeria. In exchange for this investment, China would provide $4 billion in oil and infrastructure projects in Nigeria.\textsuperscript{83} These infrastructure projects included the construction of a railroad system and power stations. Nigeria provides a source of petroleum and energy for the China in addition to a market for Chinese goods.

In the area of cultural and educational agreements, China and Nigeria have signed various agreements that link institutions of higher learning between the two countries. In 1993, China began to award Nigerian students scholarships to study in China. There are roughly 20,000 Chinese people living in Nigeria, mainly in Lagos, Kano and Abuja. To ensure the smooth transition and unification of the cultures, the Nigerian Council for the Promotion of Peaceful Reunification of China was established in Lagos.\textsuperscript{84}
Negative Outcomes

Similar to the market situations in other African countries, low-cost Chinese imports have negatively affected the local markets. In Nigeria, low-cost imports have devastated the textile industry and other consumer products of Kano and Kaduna. Additionally, according to a Nigerian parliamentarian, many young people are unemployed and lack the skills to perform the jobs brought by Chinese industries.\textsuperscript{85}

Mozambique

Positive Outcomes

A former Portuguese colony, Mozambique is one of many African countries to accept Chinese assistance to boost development and technology. In addition to China, Mozambique also has economic and infrastructural links to South Africa, India, Brazil and Australia.

China has been directly involved in the construction market of Mozambique. China contributed between $5 and $12 million in the form of donations and loans to the development of Mozambique’s public infrastructure: Parliament buildings (1999), Ministry of Foreign Affairs (2004), Chissano Conference Centre (2003) and military quarter. In the private sector, $10 million was spent on the construction of the soya processing plant of China Grains & Oils Group (CGOC). Chinese firms have also constructed roads and bridges. The large bridge that connects Mozambique to Tanzania is the result of the technological and infrastructural development of a Chinese firm. Mozambican authorities say Chinese construction firms perform quality work at competitive prices – as much 25 to 30 percent cheaper than the competition.

Negative Outcomes

Despite the positive contributions of the Chinese government, 70 percent of Mozambique’s 20 million citizens live on less than two dollars a day, and only eight percent have electricity. According to the World Bank, the “country remains one of the most difficult in the world in which to do business.”\textsuperscript{86} On one hand, Mozambicans praise the efforts of China. Rafique Jasob, head of the Mozambican government’s center for promoting investments says, “China treats us like a peer…they have a culture of respect for other people…they don’t invade other countries. Americans? They don’t even know where Mozambique is.”\textsuperscript{87} On the other
hand, according to Jim LaFleur, senior economist for Mozambique’s largest business association, “The Chinese are building things in exchange for mining rights, timber rights, fishing rights, and these are absolutely bad deals…we’ve lost an asset, and in exchange we got a ministry building, which is just an opportunity cost for China.”

One major problem is China’s hand in Mozambique’s timber industry. Mozambique is China’s leading source of wood in East Africa. According to Dehar, “most of this timber leaves the country as raw, unprocessed logs, essentially subtracting its value from one of the world’s poorest economies and adding it to what is becoming one of the richest.” Eventually, the commercial value of the wood could be obliterated, as Mozambique is simply the provider of the raw material, with no plywood industry on which to benefit. As China’s wood-products are later sold at higher prices to locals in China and members of the Western world, the benefits are not evenly spread across the Sino-Mozambican relationship.

Analysis of Case Studies

Case Studies and Interviews

Historically, Africa was largely colonized by the British and French. With France imposing its rule in the north and west, the British took hold of the eastern and southern regions of the continent. The imposition of this colonial rule, however, does not exclude the colonial influence of Belgians, Germans, Italians, Portuguese, Spanish and Dutch. The distribution of the African continent among these European powers occurred at the Berlin Conference (Nov. 1884-Feb. 1885). Under the physical, economic and cultural control of these European nations, a mother and host country relationship originated. Ultimately, the African host countries were developed based on the interests of the mother country – that is, “as sources of raw materials and guaranteed markets for its manufactured goods.” With a clear European demand for gold (Africa’s natural resources), the colonial relationship was simply based on the expropriation of these resources without any form of compensation.

Four out of five interviewees – Roxanne Lawson, Dr. Nchor Okorn, Dr. Turner and Dr. J. Kamara – refrain from labeling China’s current activity in Africa as colonialism. Generally, they reason that the term colonialism is specific to an earlier time, and that colonial powers acquire land and impose power, which China has not done in Africa. As described by Lawson, “the Chinese do not actually want to have a cultural revolution; they do not want African to speak or act like Chinese.” Whether interviewees referred to China’s impact on the African continent as
imperialism or neo-colonialism, they agreed that China is engaging in trade, aid, economic and technological deals with African countries for the sole purpose of acquiring the continent’s national resources. There is a general consensus that these trade agreements dramatically favor China, despite the Chinese and African claim of a “mutually beneficial agreement.”

Chinese extraction of African raw materials is a clear indication of colonialism, says Dr. Randolph Peters of Dillard University. According to Peters, China has little concern for the effects of its actions on the African continent. For instance, the development of the oil and gas sector in Sudan entailed infrastructure development and the enhancement of certain facilities pertaining to the industry; however, it ignores the impact that such development has on the Sudanese people, such as loss of homes, agricultural grounds and jobs.

It is evident from these interviews and case studies that China ignores the specific and immediate needs of the African continent. Chinese investment in technology, infrastructure and other aid is dedicated to specific arenas that benefit short-term goals of natural resource extraction. China and its international organizations are unconcerned with the impact their trade and development agreements have on the African people. The safety of locals, as emphasized by the explosion in the Zambian mine, is not a priority. Obviously, the economies of these African countries are benefiting from increased trade and development, but this increased wealth is not trickling down throughout African communities. Many Africans work for meager wages that fail to support their households. Exploitation of labor sits contrary to the agreements outlined in the Africa White Paper Policy.

The White Paper Policy, presented as a platform that clearly defines the relationship between China and the African continent, has not been incorporated into the activities undertaken by the Chinese government. While China is a significant contributor to the development of African infrastructure, trade, development, aid and technology, the nation tends to ignore the negative effects its presence has on the African continent. The Chinese government claims the Sino-African relationship embodies China’s independent foreign policy of peace, cooperation, interdependence, solidarity, cultural exchange, equality and economically mutual agreement. The difficulty of attaining trade agreements between countries like China and Sudan, for example, signals an unjustified secrecy for a relationship allegedly built on mutual agreement.

The Chinese government, despite its underlying motives, undertook development programs in Africa when other economically stable Western nations refused to assist the
historically depressed continent. The Tanzania-Zambia railway (1970-1975), financed and executed by the People’s Republic of China, was one of China’s greatest contributions. The railway runs from Kapiri Mposhi, just north of the Zambian capital Lusaka, to the Tanzanian capital and major East African port of Dar es Salaam. It allowed Zambian travelers to avoid dependence on transport routes through apartheid South Africa. It also connected the interior of Tanzania with its coast. The Tanzania-Zambia railway project created a significant number of jobs for locals. In this case, China initiated technology transfer; Chinese engineers and electricians trained Zambians and Tanzanians to effectively maintain the railway system. On the other hand, Zambians are currently frustrated with the presence of China, and with legal and illegal immigrants who are taking away jobs and other opportunities.

China has also eliminated the $294 billion external debt burden of sub-Saharan Africa. According to Lawson, they have done more in the last five years to cancel or delete the African debt than Western nations have done over the last 15 years. In this case, China’s investment is nothing but a positive thing. China provides competitive opportunities for Africa to achieve greater communication, negotiation possibilities and investment. Hence, the Sino-African relationship has somewhat benefited the African continent, depending on the direction from which the point is argued. However, cost-benefit analysis is required to determine the extent of the benefits – debt reduction and elimination, infrastructural development, health care, education and technology – versus the costs, including the loss of self-reliance, natural resources and jobs.

China is strictly motivated by the need to obtain natural resources, and not by the terms and conditions presented in the White Paper Policy. If China’s aim was to fulfill the policy, it would pursue greater humanitarian efforts to bring a halt to the war between the Northern and Southern Sudan, as opposed to contributing to the violence through the sale of Chinese-made weapons. China wields the power to influence African social, political, economic and physical life, and yet its government does little to quell violence on the continent.

**Dependence and Self-Reliance Theories**

Across the globe, colonialist control of countries’ natural resources results in the destruction of self-sufficient economies and a decrease in self-reliance. The focus of this research is to determine the current dependent or self-reliant state of specific African countries. The varying outcomes brought about by trade and economic relationships between China and African countries are similar to those produced by African relationships with European colonialists. Such
a relationship has ultimately increased Africa’s dependency on an international body (China) and reduced its self-reliance. However, the data also suggests that some levels of reduced dependency can result from China’s development activities.

Roxanne Lawson says, “Chinese investment makes the African continent more self-reliant because it gives them more negotiating room. It allows them to have the opportunity to make better informed decisions, as to who they want to do business with.” This, however, is not the general consensus among other interviewees, who believe China’s investment decreases Africa’s self-reliance. Instead of encouraging technological transfer by training locals to do new jobs, China is importing its own labor. This does not benefit the skilled and unskilled local population who are now competing with Chinese laborers for jobs. According to Dr. Kamara, “there is no technology transfer, so in that sense they end up ultimately more dependent, because they do not benefit from those transfers in the process.” Lawson says the only thing that makes African nations more dependent is the policies of the neo-liberal market. Over the last 15 years, Lawson says, the policies of international institutions such as the World Bank (WB) and the International Monetary Fund (IMF) have been disastrous for these African nations, which is why the majority of these countries are impoverished. Although corrupt leadership within African countries is an issue, the continent is composed of 32 of the world’s poorest countries because they have taken on the investment policies of the World Bank and the International Monetary Fund. In other words, China should not be entirely blamed for the economic, infrastructural and political state of the African continent.

The Combination of Globalization and Colonialism

It has been determined that there is no precise way to define the current relationship between China and these African countries. However, the concepts of globalization and neocolonialism may help explain the relationship. Globalization is an open-ended concept with several definitions, applications and classifications. Roland Robertson (1992) argued that globalization refers “both to the compression of the world and the intensification of the world as a whole…both concrete global interdependence and consciousness of a global world.”92 Robertson provided a general definition that demonstrates the “increasing level of interdependence between national systems by way of trade, military alliance and domination.”93 Based on the definition provided, Waters (2001) noted that global compression “resembles the arguments of the theory of dependence and of world-systems.”94 With the structure and influence
of organizations such as the World Trade Organization, the International Monetary Fund and the World Bank, and the formation of international trade agreements, policies and cultural exchanges, globalization is enhancing the interdependent nature of the entire globe. On the other hand, neocolonialism is defined as the “enduring exploitation of formerly colonized nations,” and “continued reliance upon the former imperial power.”95 In this case, similarities persist between neocolonial economic relationships and those of the classical colonial period. According to Dr. Mtangulizi Sanyika, “globalonialism” is a term that describes a relationship with features of both the positive outcomes of globalization and the negative outcomes of colonialism. The dynamics of the dual effects and impacts of China’s development activities are thus captured in this single term.

**Conclusion**

The role of China across the African continent cannot be clearly defined without making specific reference to an African country. There is an invigorating academic debate as to what exactly defines China’s presence in Africa, whether it is colonialism, neocolonialism, imperialism, a new term such as “globalonialism,” or something else altogether. Academics and activists who define the relationship as colonial point to the extraction of natural resources from the continent, and the increased dependence on Chinese trade, investment, and development policies. Others argue that the Sino-African relationship is nowhere near a mother-host country relationship. China offers competitive policies and grounds for negotiation compared to those presented by Western nations and their international financial institutions such as the World Bank and International Monetary Fund. Debaters agree that China’s trade, investment and aid packages throughout Africa are structured to ensure that the Chinese benefit from Africa’s natural resources. That is to say, the agreements concentrate on the needs and interests of the Chinese domestic economy, and involvement in Africa is simply an opportunity cost.

The Beijing Consensus and African White Paper Policy claimed to be concerned with the creation of a strategic partnership based on political equality, trust, economic win-win cooperation and cultural exchange. However, implementation on the ground remains inconsistent with the policy’s rhetoric. Africans are losing their jobs and natural resources to the Chinese government, which in turn resells finished Chinese products to African countries and consumers at higher prices. The local goods and services markets of the African countries are being overpopulated with cheap, substandard Chinese products that compete with local goods and
services. China could have advanced African economic development by contributing to the production of African facilities that use local raw materials to produce finished products throughout the continent. China’s activities in Africa are centered on the Chinese domestic need for raw materials. For instance, China’s partnership with Sudan ensures that once they have invested in infrastructure to facilitate the Sudanese oil industry, China will retain a certain percentage ownership of the industry and its oil exports.

There is a general consensus that The Republic of China has contributed to the economic and infrastructural development of many African countries. China has the resources and technological know-how to do so. According to Harry G. Broadman, an economist at the World Bank, “Chinese firms can help African countries tap into global value chains, giving them a chance to increase the volume, diversity, and worth of their exports.” It is, however, the responsibility of African governments to monitor and enact reforms that protect the human and natural resources of the country. African governments should ensure the formation of basic markets, investment, infrastructure and trade regulations that guarantee equally beneficial relationships for their countries. Africa requires significant foreign support in the form of financial investment. As Dr. Okorn said, “no matter how developed a country is, all countries are dependent [to some extent] on other countries” as a feature of international relations.

Whether the so-called mutually beneficial relationship is making the African continent more dependent and less self-reliant requires further investigation. There are numerous elements that impact the current status of African countries, including a history of colonialism and neocolonialism, globalonialism, neoliberal markets, government instability and political corruption. This initial research requires further data collection and analysis both on the African continent and the People’s Republic of China to unravel the causative factors of Africa’s condition.

There is a plethora of information on the subject of China and its economic relationship with the African continent. This researcher concentrated on the issue from the perspective of the dependent or self-reliant outcomes of African countries, specifically Zambia, Zimbabwe, Sudan, South Africa, Congo, Mozambique and Nigeria, and whether the activities of The Republic of China align with the policies of the China-Africa White Paper Policy. There is an obvious need to continue and expand the research topic from a variety of perspectives and disciplines. The ongoing debate that persists among educators, policy makers, activists, governments, and organizations with regards to China and its relationship to the African continent in the modern
era is of global interest. Hopefully, this initial research has helped illuminate the complexities and challenges inherent in the future research that is required on this critical, globally important subject.

Endnotes


3 Ibid.

4 Ibid.

5 Ibid.


7 Ibid.


11 Ibid.


14 The Beijing Consensus is a term coined by Joshua Cooper Ramo. It represents the opposite of the Washington Consensus, which is the United States’ plan for reforming and developing the economies of third world countries.


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42 Interviewees – Mrs. Roxanne Lawson (Director of African Policy at TransAfrica Forum), Dr. R. Peters (Caribbean Scholar, French Instructor at Dillard University and African observer), Dr. Nchor Okorn (Nigerian Scholar and Political Science Instructor at Dillard University), Dr. James Turner (Director of the Africana Research at Cornell University), Dr. Jemadari Kamara (Director of the Center of African and Caribbean Community Development at the University of Massachusetts).
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Nonlinear Optical and Electronic Properties of SiC/PMMA/Ge/Fe Waveguide for Device Applications

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Abstract

A new optical device whose dynamic grating intensity can be electrically controlled at specific magnetic fields and wavelengths has been demonstrated. This new optical device has a semiconductor/polymer multilayer structure formed by pulsed laser deposition at room temperature. The reflection intensity can be electrically controlled with a response time of less than 2 ms. The EPR spectrum of the multilayer determined the concentration of the free spin and the effect of the light on the growth and decay of the Fe which was doped in the polymeric thin film using the high pulse laser deposition technique.

Introduction

When a strong laser beam traverses a nematic liquid crystal thin film, the average molecular orientation of the material can be reoriented by the optical fields, and the same can be observed in a polymeric thin film. Due to the spatial non-uniformity of the birefringence, the diffraction rings can be seen in the far-field pattern. This interesting nonlinear-optical propagation phenomenon has been described as the spatial analog of the well-known self-focusing or self-phase modulation. The molecular reorientation is referred to as the optical Fredericks transition. The same effect was observed in a waveguide made of thin film of PMMA and layers of Ge and Fe that were deposited by high pulse laser deposition technique. The observed diffraction rings can be controlled by applying magnetic and electric fields. In some cases, each diffraction ring consists of a cluster of rings and the separation of the rings can be enhanced by the applied field and control of the temperature of the waveguide diffraction rings.
which is observed in the far-field diffraction pattern. These preliminary results will be explained using second and third order enhanced Fredericks transition.

**Experimental**

**Pulsed Laser Ablation/Deposition Chamber**

The basic pulsed laser ablation deposition apparatus (PLAD) is shown in Figure 1. The PLAD system consists of two 6 inch cubes connected by a bellows assembly. The ablation cube is fixed while the deposition cube is mounted on a rail assembly that is controlled by a manually operated pneumatic pump. This setup allows the distance between the cubes to change quite quickly and has a 0.15 m travel range. Two oil diffusion pumps backed by rotary vane mechanical pumps maintain the vacuum. As shown in Figure 1, connections to the ablation cube include an oil diffusion pump (equipped with a liquid N trap), the ablation flange, a sample manipulation system, and one end of the bellows assembly. On either side of the cube are view ports with 4 inch quartz windows allowing for the introduction of the laser ablation beam. The windows are also convenient for the visual inspection and alignment of the ablation targets. Attached to the deposition cube is another oil diffusion pump, a quadrupole mass spectrometer (QMS) aligned axially with respect to the ablation targets, another sample manipulation system, and the other end of the bellows assembly. All six samples rotate simultaneously at the same speed. For ion extraction, a grid assembly has a 0.625 inch hole in front of the 0.5 inch sample stub. By adjusting the conditions such as ablation laser power and fluence, the neutral-to-ion ratio in the ablation plume can be controlled [10-14].

**The Waveguide Fabrication**

The polymer-coated slides were wrapped with Al-foil at both ends with approximately 1 cm width of midsection exposed. The exposed polymer-coated surface of a slide was set at an approximate distance of 5 cm from a target (either copper or iron). A laser beam of Nd:YAG 2nd harmonic 532 nm light (Quanta-Ray Lab-Series, Spectra-Physics) of about 150 mJ pulse energy was tightly focused onto the target surface with an f = 25 cm focal lens. The beam impinged the rotating target at a 45 degree angle with respect to the target surface normal. The resulting film thickness of about 400 nm was monitored by an INFICON Deposition Monitor sitting next to the
exposed slide section and facing the target. In the waveguides Ge/Cu, an optical fiber was impeded underneath the Ge layer to be used for special transition of multi-wavelength process.

**Optical Surface Morphology**

The surface roughness and the homogeneity of the deposited thin film surfaces of both Ge/Fe and Ge/Cu were analyzed using a scan electron microscope as shown in Figures 2 and 3. The figures show the thermal effect on the morphology of the Fe and Cu/Ni thin film after exposure to the temperature variation around 160 F, and the degradation of some spots on the surface. In general, the surface is relatively homogenous over the entire waveguide within the accepted margin of cladding’s characteristics. The roughness of the surface was measured at 20 nm and in some cases as high as 40 nm. This uniformed the optical coupling of the laser beams with the thin film and decreased the losses from the back scattering, which in turn decreased the heating underneath the Ge prism.

**The Waveguide Testing Setup**

The experimental setup for testing the waveguide is shown in Figure 4 and the waveguide setting is shown in Figure 5. Using a carbon dioxide (CO2) laser as a source of the transmitted light, and using a Ge prism coupler technique, the laser output can be directed into a spectrum analyzer for wavelength measurements. The back of the waveguide substrate was attached to a 24-pins thermocouple matrix to monitor the average temperature distribution across the waveguide. In the case of the CO2 laser, an IRCCD camera was used to profile the laser lines and a wavemeter was used to measure the laser lines offsets at different temperatures. In the case of the observation of the diffraction rings measurements, a HeNe laser with 625 nm and Ar ion lasers with 532 nm and 475 nm were focused on the waveguide, or transmitted through the waveguide, and the diffraction pattern was observed on the far field.

**Results and Discussion**

When the laser beam transmitted for PMMA-Ge/Fe and PMMA Ge/Cu at room temperature with no external fields, the projected pattern on the far field is shown in Figures 6 and 7, respectively.

When the waveguides PMMA-Ge/Fe and PMMA Ge/Cu were biased with the electric field in the range 10-20 V, the pattern was resolved and the diffraction rings of each cluster were
observed very clearly as shown in Figures 8 and 9, respectively. With the same settings, the magnetic field was turned on (about 50G), and the observed pattern was enhanced, but the cluster was embedded into hexagonal diffracted circular patterns as shown in Figure 10. The Hall effect may contribute to the appearance of the transversal E-field (Hall field) that induces birefringence.

When the laser beam transmitted through the embedded fiber in PMMA-Ge/Fe waveguide, it resulted in a normal Raman stokes as shown in Figure 11. After exposure to a temperature of 150F, and around the elasticity threshold of the waveguide, the waveguide began changing its characteristics, and the diffraction pattern resolution decreased. The reflection of the laser beam on the screen began showing a decrease in the number of rings. The patterns are shown in Figure 12(a, b, and c). Also, the laser beam showed anomalous change as it traveled through the waveguide as shown in Figures 13 and 14.

**Data Analysis**

The formation of the diffraction rings can be explained as in laser light with a Gaussian distributed intensity profile which reorients the molecular director in the \(x-z\) plane leading to a local refractive index change \(\Delta n(\rho,Z)\) which induces a corresponding phase shift in the light \(\Delta \phi(\rho)\), where \(\rho\) is the transverse position in the light beam. In this case, where the thin film is not fluid, and the structure of the surface is constrained by the above layer of Ge and Fe, this will produce a thermal gradient that will lead to another shift in the index of refraction and in turn to another shift in the laser beam resulting in a third set of rings.

The phenomenon of self-phase modulation is commonly observed in strongly absorptive organic solutions and thin films. Radiation-less relaxation of these species produces a temperature rise which modulates their refractive index as:

\[
n = n_0 + (dn/dT) \Delta T
\]

The special part of the modified plane wave after crossing the medium can then be written as:

\[
E(r,z) = 1/2 E_0(r,z) \exp[I(kz - \Phi)]
\]

Assuming that the Ge thin film is deposited uniformly over a PMMA over a SiC substrate, the thicknesses are equal to 1 µm and 8 mm respectively. Also, assuming elastic deformation, the stresses in the thin film and the substrate can be determined from the temperature change \(\Delta T\) with respect to the stress free state. The stress in Ge and SiC are \(\sigma_{Ge}\) and \(\sigma_{SiC}\), which would be in
opposite directions. The directions of these stresses would depend on the differential expansion coefficients. The linear expansion coefficient $\lambda_{\text{Ge}}$ is greater than $\lambda_{\text{SiC}}$. When the temperature increases, Ge layer tries to expand more than SiC, but it is prevented by SiC substrate. The stress in Ge is therefore compressive and in SiC is tensile, assuming the stresses are reasonably uniform across the thin film and the substrate. If there is no net force at the interface between the thin film and the substrate, then the force in Ge plus the force in SiC equals zero. That is,

$$\sigma_{\text{Ge}} \left( t_{\text{Ge}} \right) + \sigma_{\text{SiC}} \left( t_{\text{SiC}} \right) = 0,$$

so that

$$\sigma_{\text{SiC}} = - \sigma_{\text{Ge}} \left( t_{\text{Ge}} / t_{\text{SiC}} \right).$$

The stress free-state corresponds to both having length $L_0$ at $T_0$. If they were free, the thermal strain after temperature rise of $\Delta T$ in each would be:

$$\varepsilon_{\text{thGe}} = \lambda_{\text{Ge}} \Delta T \quad \text{and} \quad \varepsilon_{\text{theSiC}} = \lambda_{\text{SiC}} \Delta T.$$

At $T_0 + \Delta T$, the total strain in each is the same due to the constraint. Each expands by the same amount $L_0 \varepsilon_{\text{GeSiC}}$. Thus,

$$\varepsilon_{\text{GeSiC}} = \lambda_{\text{Ge}} \Delta T + \varepsilon_{\text{Ge}} = \lambda_{\text{SiC}} \Delta T + \varepsilon_{\text{SiC}}.$$

Then the individual stresses are:

$$\sigma_{\text{Ge}} = - \left\{ \left( t_{\text{SiC}} E_{\text{Ge}} E_{\text{SiC}} \right) / \left( t_{\text{Ge}} E_{\text{Ge}} + t_{\text{SiC}} E_{\text{SiC}} \right) \right\} \left( \lambda_{\text{Ge}} - \lambda_{\text{SiC}} \right) \Delta T,$$

and

$$\sigma_{\text{SiC}} = \left\{ \left( t_{\text{Ge}} E_{\text{Ge}} E_{\text{SiC}} \right) / \left( t_{\text{Ge}} E_{\text{Ge}} + t_{\text{SiC}} E_{\text{SiC}} \right) \right\} \left( \lambda_{\text{Ge}} - \lambda_{\text{SiC}} \right) \Delta T.$$

Since the thickness of the Ge thin film is much less than the thickness of the SiC substrate, then $\sigma_{\text{Ge}} = - E_{\text{Ge}} \left( \lambda_{\text{Ge}} - \lambda_{\text{SiC}} \right) \Delta T$, which is the thermal stress in the thin film when the elastic deformation is considered. If there is a net force at the interface between the thin film and the substrate, the waveguide will not be in equilibrium and the thin film will collapse and it will pop off of the substrate. The stability of the waveguide structure depends on the thermal stress limitation to the elastic deformation.

From that, the resulted change in the refractive index will be a combination between the temperature gradient and the thermal expansion effect and the stress between surfaces of the multi-thin film layers. This will add another factor that is responsible for the appearance of the third-order diffraction rings.
Conclusion

The optical waveguide for laser modulation was fabricated using the laser pulse deposition technique. Diffraction rings were observed with different wavelengths. The thermal effect and the stress effect due to the thermal expansion were responsible for multi-clustered diffraction rings. An external electric field was used to enhance the diffraction rings. The dynamic grating intensity can be electrically controlled at specific magnetic fields and wavelengths to enhance the number of the diffraction rings.
Figure 1. Pulsed laser ablation/deposition apparatus

Figure 2. Using SEM, the roughness of the surface can be measured.

Figure 3. a and b, show the surface morphology after 30 hours of exposure to the temperature around 160 F.

Figure 3. b
Figure 4. Schematic Diagram for Testing the Waveguide

Figure 5. The relative directions of the waveguide to E(0,0,z) and B(x,0,0)
Figure 6. SiC/PMMA/Ge/Fe, no external fields

Figure 7. SiC/PMMAGe/Cu, no external fields

Figure 8. SiC/PMMA/Ge/Fe, and E(0,0,z) is on

Figure 9. SiC/PMMA/Ge/Cu, and E(0,0,z) is on.

Figure 10. SiC/PMMA/Ge/Fe, E and B

Figure 11. The laser beam transmitted through the embedded fiber in PMMA-Ge/Fe wave guide, it resulted of a normal Raman stokes.
Figure 12. The reflection pattern of the transmitted laser beam around the point of electricity threshold (left) and after the elasticity threshold (right) of waveguide.

Figure 13. The laser beam profile inside (left) and outside (right) the waveguide reflected to the side of the screen around the elasticity threshold point of the waveguide.

Figure 14. Mathematical representation of periodic occurrence of the diffraction rings with consideration of the two thermal shifts (thermal absorption and stress).

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Alabama A&M University, Physics Department, Normal, AL
University of New Orleans, New Orleans, LA

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Hurricane Katrina’s Path: 
A Comparative Study of the Concentration of Airborne Microbes in Selected Communities Affected by Hurricane Katrina

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Abstract

The environment in New Orleans post-Hurricane Katrina is a concern. The city was under as much as 10 feet of water for weeks. Broken sections in the sewer lines contaminated the waters. Mold is growing in all the once-flooded buildings. Dead bodies were present. It is hypothesized that there are higher concentrations of airborne microbes inside versus outside areas in selected communities that can potentially pose a risk to residents of New Orleans. Cases of infectious diseases associated with Hurricane Katrina have been reported (1). Sampling and testing the air have shown the presence of high concentrations of bacteria and fungi. Determining which communities have unsafe levels of airborne microbes is important. Liquid impinger apparatuses were used to collect samples in several different communities with different levels of destruction in the greater New Orleans area. The impingers were filled with 20 ml of sterile water and attached to a vacuum pump that ran for 90 minutes. Impinger samples were split to compare culturing, microscopic, and molecular analyses. Data from the count of colony-forming units and the DAPI staining indicated that the concentrations are higher inside the buildings than outside. Also, data collected showed that areas with the most floodwater had the highest concentration of contaminants. Short- and long-term effects on the health of individuals working in and returning to the areas are of concern. There is a need to continue to monitor the concentration of microbes present and the relevant cases that may develop after remediation. Further, there is a need to determine what specific airborne pathogens are present as well as their significance. Broad range PCR amplification was conducted on the microbes cultured through collaboration with the University of Colorado at Boulder’s Department of Civil, Environmental, and Architectural Engineering.

Introduction

The environment in New Orleans post-Hurricane Katrina is a public health concern. Floodwaters ravaged 80 percent of the city streets for weeks, leaving as much as 10 feet of water inside buildings. Thousands of broken sections in the sewer lines as well as dead human and animal remains contaminated the waters. The water has dried up, but local communities are more likely to have higher levels than normal of pathogenic airborne
microbes, thus potentially posing a higher risk to residents (2). Fecal coliforms, fungi, and other pathogenic and opportunistic microbes including *Escherichia coli*, *Vibrio vulnificus*, *Vibrio parahaemolyticus*, viruses, and mold can be present in the air (3, 9).

When exposed to airborne particles, an individual is at risk to numerous types of infections such as chronic respiratory illnesses. Biological aerosols (bioaerosols) are “airborne particles that originate from living organisms” (1). Bioaerosols include viruses, bacteria, fungi, insect fragments, spores, and pollen. These aerosols come in different sizes. The increasing amount of time spent indoors has increased the risk of occurrence and transmission of airborne infectious diseases (1). There is a growing need to properly detect and mitigate airborne pathogens (1).

Mold remains the most prevalent microbe in the communities of New Orleans post-Katrina to date. Molds, mushrooms, and yeasts are classified as fungi with 100,000 species existing currently. There are fewer than 500 of these that cause infection, but these infections can be life-threatening. Large amounts of water damage after severe hurricanes increase the occurrence of mold (3). Forty-six percent of the western New Orleans area residents had some amount of mold damage with 17 percent of that damage classified as severe. Mold exposure can occur through inhalation, skin contact, and digestion. The general public can conduct visible mold testing, but after remediation, professional evaluation of a specific site is needed in order to determine mold presence. It is important to protect hands, eyes, and face when doing any type of remediation; more importantly, any items that make contact with mold should be cleaned or disposed of immediately (3).

The drying of water and stirring of sediments can cause many microbes to become airborne. Contaminated water caused by Hurricane Katrina was pumped back into Lake Pontchartrain, and as water evaporates, the air and the flooded communities are being super saturated with high levels of contamination (7). These soil and waterborne microbes pose potential health issues to residents (4).

Post-Katrina sampling campaigns were conducted in conjunction with the Environmental Protection Agency (EPA), the Center for Disease Control (CDC), the Louisiana Department for Environmental Quality (LDEQ), and the Federal Emergency Management Association (FEMA). The air monitoring techniques pre-Hurricane Katrina
are no longer effective, so new monitoring techniques are being implemented. A continuing problem posed to the EPA and LDEQ is the long-term health effects of the environment on African Americans, who are the majority population in New Orleans. The EPA Science Advisory Board reported that African Americans cannot filter harmful bacteria and other substances through their nasal cavity as well as Caucasian Americans (5).

Preliminary studies were previously conducted last year (2006) by the Singleton research team at Dillard University in selected New Orleans communities prior to remediation. These areas are currently being tested after remediation to determine the concentrations of bacteria and fungi present. The main objectives are to: determine if concentrations of airborne microbes are higher inside as apposed to outside buildings following remediation; determine if these concentrations can pose a risk to the residents of New Orleans; ascertain the types of organisms present; and compare the similarity of organisms discovered between this study and others.
Figure 1: Floodwater inside a building.
Materials and Methods

Sample Location and Collection

Air samples taken inside and outside of buildings were collected at a number of sites throughout post-Katrina New Orleans during spring 2007 and 2008. Bioaerosols were collected using swirling SKC liquid impingers biosamplers according to accepted methods (6). When the SKC Biosamplers were filled with 20 ml of water, it had an efficiency ranging from 79 to 100 percent. In all collections, sterilized phosphate buffered saline 10X Solution, pH 7.4 (DNase, RNase, and Protease-Free Filtered through a 0.2 Micron filter) was used as the collection medium (fluid). During sampling, flow meters were attached to each set of impingers to regulate flow rate to 12.5L. Two impingers were run in parallel and sampling was conducted inside and outside for 90 minutes. To minimize losses of reserve (samples) due to evaporation, additional phosphate buffered saline was added to the impingers using sterile syringes (This was done approximately 15-20 minutes during each sampling period). At the end of each experiment, the samples from each impinger were combined into one sterile conical flask (9).

The samples were separated into three components to be tested as follows:

1. Culturing – The count of colony forming units (CFUs),
2. Microscopy DAPI Stain – the count of DNA (Both are used to determine the concentrations of microbes present.),
3. Molecular – DNA analysis to identify the types of microbes present.
Figure 2: New Orleans East and Gentilly areas – sample collection sites.

Google Maps, 2007-GNO.
Figure 3: Westbank and Lower 9th Ward – sample collection sites.

Google Maps, 2007
Cell Counts

Five milliliters of the stock sample were used for culturing of colony-forming units. A Shaw serial dilution method was used. After samples were diluted, cultures were plated onto R2A media. The plates were incubated 48 hours at 37 degrees Celsius.

Ten milliliters of formaldehyde-preserved microbes found in sampling fluid was counted using DAPI direct count methods. Bacterial cells were fluorescently stained with 4'6-diamindino-2-phenylindole (DAPI) and filtered through 25mm black polycarbonate filters. To obtain cell counts, 10 fields were chosen randomly per slide for statistical analyses during epifluorescent microscopy and an average of the 10 fields was determined.

Culture-Independent Analysis

Microorganisms will be recovered from impinger fluids by polycarbonate filters and identified using broad range PCR amplification in a series of steps called the molecular method.

The Molecular Method

**DNA Extraction:** The sample was mixed with extraction solution and centrifuged, the supernatant was poured off, and the DNA pellet was kept.

**Polymerase Chain Reaction (PCR):** This microbiological technique was used to isolate and amplify the DNA.

**Gel Purification:** Agarose gel electrophoresis was used to determine DNA presence before continuing further in the molecular method. Once the gel was completed, a picture was taken of the gel while exposed to ultraviolet light to confirm DNA presence.

**Cloning:** In the cloning phase, bands of DNA were cut out of the gel and deposited into a TOPO vector. From there, each sample was plated for growth and deposited into overnight plates.

**Restriction Fragment Length Polymorphism (RFLP):** The restrictive fragments were separated by agarose gel electrophoresis.

**Enzymes Exonuclease I and Shrimp Alkaline Phosphatase (Exo/Sap):** This stage in the process was used to purify DNA. The exonuclease degraded any excess primer while
shrimp alkaline de-phosphorolated the DNTPs in the original PCR. Both of these enzymes are essential; it is important to purify, so you will have an accurate reading during sequencing.

The data analyses' main objective is to determine the kinds of organisms that are present in bioaerosols. Other factors will be examined such as the microbial population variance by seasonal factors and UV exposure. The ending result will provide a solid foundation for future endeavors.

**Figure 4: Shaw Serial Dilution Method.** The 5ml portion of the sample in the flask. One milliliter is withdrawn from the flask and placed in a tube with 10 ml of distilled water. Then 1ml was transferred to each succeeding tube with the same amount of water as the first tube. Google Images, 2007.
Figure 5: Impinger apparatuses set up inside and outside of buildings.

Figure 6: Top photos show inside residence before remediation. Bottom photos show inside residence after remediation.
Figure 7: Impinger samples are split to compare culturing, and molecular and microscopic analysis.
The Molecular Method

Figure 8: Molecular method used for DNA analysis.
RESULTS

<table>
<thead>
<tr>
<th>Plate</th>
<th>ml Of Dilution Plated</th>
<th>Final Dilution</th>
<th>Number of Colonies</th>
<th>Avg. CFU/ml of Sample</th>
</tr>
</thead>
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<td>1</td>
<td>1 X 10^5</td>
<td>35</td>
<td>3.5 X 10^5</td>
</tr>
<tr>
<td>Gentilly Outside</td>
<td>1</td>
<td>1 X 10^5</td>
<td>20</td>
<td>2 X 10^6</td>
</tr>
<tr>
<td>Westbank Inside</td>
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<td>40</td>
<td>4 X 10^6</td>
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<tr>
<td>Westbank Outside</td>
<td>1</td>
<td>1 X 10^5</td>
<td>Unable</td>
<td>To Do</td>
</tr>
<tr>
<td>NO East Inside</td>
<td>1</td>
<td>1 X 10^5</td>
<td>41</td>
<td>4.1 X 10^5</td>
</tr>
<tr>
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<td>1</td>
<td>1 X 10^5</td>
<td>25</td>
<td>2.5 X 10^5</td>
</tr>
<tr>
<td>9th Ward Inside</td>
<td>1</td>
<td>1 X 10^5</td>
<td>60</td>
<td>6.0 X 10^5</td>
</tr>
<tr>
<td>9th Ward Outside</td>
<td>1</td>
<td>1 X 10^5</td>
<td>38</td>
<td>3.8 X 10^5</td>
</tr>
</tbody>
</table>

Table 1: Airborne Concentration. The temperatures ranged from 75 to 85F, relative humidity ranged from 40 to 50 percent, and cloud cover ranged from slightly cloudy to sunny colony forming units counted after culturing.

The data collected showed that areas that had the most floodwater and the highest concentration of contaminants. In addition, it was determined that concentrations are higher inside the buildings than outside.
Microscopy Results (DAPI)

Figure 9: Quantitative microscopy results. Three sites are represented.

Microscopy Results (Fabian Study)

Figure 10: Quantitative data from the New Orleans study is compared to the Fabian Arkansas River, CO study, currently the only known study that is similar. Fabian, Miller, Reponen, & Hernandez. "Ambient Bioaerosol Indices for Indoor Air Quality Assessments of Flood Reclamation." *Journal of Aerosol Science* 36(2005): 763-783.
Table 2: DNA Molecular Genomic Results from Samples - Microorganisms

<table>
<thead>
<tr>
<th>Total</th>
<th>Domain</th>
<th>Phylum</th>
<th>Subphylum</th>
<th>Class</th>
<th>Order</th>
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<tbody>
<tr>
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<td>Ascomycota</td>
<td>Pezizomycotina</td>
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<td></td>
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<tr>
<td>3</td>
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<td>Cercozoa</td>
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</tr>
<tr>
<td>1</td>
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<td>Environmental samples</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Bacteria</td>
<td>Firmicutes</td>
<td>Embryophyta</td>
<td>Tracheophyta</td>
<td></td>
</tr>
<tr>
<td>1</td>
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<td>Firmicutes</td>
<td></td>
<td></td>
<td>Bacillales; Bacillaceae; Bacillus</td>
</tr>
<tr>
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<td>Bacteria</td>
<td>Firmicutes</td>
<td></td>
<td></td>
<td>Lactobacillales; Carnobacteriaceae</td>
</tr>
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<tr>
<td>8</td>
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<td>Bacteroidetes</td>
<td>Sphingobacteria</td>
<td>Sphingobacteriales</td>
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</tr>
<tr>
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<td>Bacteroidetes</td>
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<td>Environmental samples</td>
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</tr>
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<td>Alphaproteobacteria</td>
<td>Floridobacteriales</td>
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</tr>
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<td>Proteobacteria</td>
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<td></td>
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<tr>
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<td>Unclassified sequences</td>
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</table>

**Conclusion**

Infectious cases associated with affected areas have already been reported (1). The Gentilly site had the lowest amount of CFU’s (colony forming units), but the area had a large amount of airborne contamination prior to remediation. The inside concentrations were higher than the outside. The Westbank site had an average amount of microbial growth in comparison to other sites. Prior to remediation, the New Orleans East area had the highest amount of contamination. Although the inside CFUs are still high, the remediation techniques have decreased the amount of growth overall, and the microbial concentrations are closer to what the Westbank site indicated. The 9th Ward had the highest amount of flood damage after Hurricane Katrina, and the site had the highest amount of contamination inside and outside. Overall, all the sites’ inside microbial concentrations were higher than the outside concentrations.
For DAPI results, one sample was lost in transport. Therefore, three sites are represented on the graph. Inside sites ranged between $7 \times 10^3$ and $2 \times 10^6$ and outside ranges were $1 \times 10^3$ and $3 \times 10^4$ Cell/M$^3$. One inside sampling site had results two orders of magnitude higher than the other sites, but accurate conclusions cannot be drawn due to the low amount of sampling locations.

The New Orleans study was compared with the Fabian Colorado study in order to examine any correlations in data. This study was chosen because there are not many known accounts that involve bioaerosol analysis in post-flooded areas.

For future consideration, conduct further indoor and outdoor air sampling on a much larger scale will be conducted. Samples will be collected outside New Orleans in nearby communities. In addition, genetic inventory and biological concentrations will be catalogued based on the acquisition of more samples. A partnership with Dillard University’s Department of Public Health will be implemented to track respiratory diseases and other infectious cases in New Orleans. Once these plans of action have been put in place, affordable engineering interventions will be assessed and applied including HEPA filters, precipitators, and ventilation in collaboration with the University of Colorado Boulder, Department of Environmental Engineering.

**Acknowledgements**

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Louisiana Alliance for Minority Participation (LAMP) funded by the National Science Foundation

National Oceanic and Atmospheric Administration, U.S. Department of Commerce
References

An Environmental Survey of the Water Microbes in New Orleans After Hurricane Katrina

Miquell Miller, 2008, Biology; Shermett Corbett, 2008, Biology; Gabrielle High, 2009, Biology; Kristen Guilford, 2009, Biology

Faculty Mentor: J. Bernard Singleton, D.V.M, M.S., Department of Biology, Dillard University

Abstract

New Orleans and some of its surrounding areas were severely damaged by Hurricane Katrina. Massive flooding and wind damage occurred. Contaminants found in the floodwaters included microbes, arsenic, lead, toluene, herbicides, pesticides, and many others. The contamination of residential areas and canals was likely due to the Meraux Murphy oil spill, auto service stations, and other buildings where chemicals were stored. Oil spilled into the 20 Arpent, the 40 Arpent, the Meraux, the Corinnes, and the Delarond canals. The contaminants found are suspected to have effects on the microbial population of the environmental waters of New Orleans and its surrounding areas. Samples were collected in sterile containers in several neighborhoods. A serial dilution method was used on the samples and they were plated on agar plates. The colonies that were grown were then categorized based upon their color, size, shape, texture, elevation, margin, and general appearance. Light brown, white, yellow, and fuzzy colonies were observed. Their Gram stain characteristics and cell morphology were examined using a light microscope. Cells were cocci, bacilli, and spirilla. Some cell forms were both gram positive and others were gram negative. The biochemical characteristics of the bacteria were examined based on the ability of the bacteria to ferment lactose. Some of the bacteria were lactose fermenting that produced gas, lactose fermenting only, and non-lactose fermenting. Monitoring the microbial populations in the affected areas is essential. There are some obvious changes in the environments of the different areas, especially in the vegetation. These suspected changes in the microbial population are expected to have long-term effects on the ecological development of the area.

Introduction

The flooding that resulted from Hurricane Katrina caused major contamination in the New Orleans environmental water systems. The flood water was contaminated with industrial
products, raw sewage, and dead animals. Some of the chemicals found in the floodwater included lead, barium, cyanide, aluminum, manganese, and others. The major recipient of the contaminated flood water is Lake Pontchartrain.³ Another source of contamination resulted from the dislodging of the St. Bernard Parish Murphy Oil Meraux Refinery barrel that spilled more than one million gallons of crude oil into the surrounding areas.⁴ According to Pardue et al., there was high levels of arsenic in the flood waters that exceeded drinking water limits.⁴ 

The purpose of this research was to acquire a qualitative analysis or survey of the microbial population found in New Orleans environmental waters after Hurricane Katrina. The areas that were surveyed included Eastern and Western Lake Pontchartrain, Gannon Road Canal, 40 Arpent Canal, and the Industrial Canal. A map of the areas is found in Figure 1. There is reason to believe that the microbial population was affected by the many contaminants found in the floodwater.

Picture 1. Floodwaters being pumped back into Lake Pontchartrain.³
Materials and Methods

Water samples in New Orleans were collected in sterile collection tubes from Eastern and Western Lake Pontchartrain, Gannon Road Canal, 40 Arpent Canal, and the Industrial Canal. A picture of the floodwater being pumped into Lake Pontchartrain is seen in Picture 1. Each water sample collected was individually serial diluted in test tubes from 1/10, 1/100, 1/1000, 1/10000, and 1/100000 (Figure 2.) One ml of sample was taken from the stock solution and each successively diluted. It was then plated unto nutrient agar plates and incubated for 48 hours.

![Figure 1: Map of New Orleans where the water samples were collected.](image)

The dilutions plated that showed the best individual colonies were used to characterize the colonies found at each of the above locations. The colonies were described based upon their pigmentation, form, size, color, texture, elevation, and margin. Figure 3 illustrates these colony characteristics. A sample of each of the individual colonies observed was collected by a sterile flame loop and placed into lactose fermenting broth tubes. The tubes were incubated 24 hours at
37° and the results were collected. The final test to characterize the bacteria was the Gram stain. Certain colonies were chosen and stained using the Gram stain method. The cells were viewed under a light microscope. The bacteria were determined to be either Gram positive or Gram negative.

![Diagram of serial dilution](image)

**Figure 2:** This is a diagram of the serial dilution that was used. One ml from each test tube was placed on agar plates and incubated.

![Colony characteristics](image)

**Figure 3:** These images represent the various colony characteristics used to describe the colonies that were produced from each water sample site.
Discussion and Results

East and West Lake Pontchartrain showed the most prominent amount of diverse colonies, while the Arpent 40 Canal showed the least amount of diverse colonies. The colony description for each location and their corresponding pictures are shown in Table 1. The results of the Biochemical Lactose Fermenting Tests are found in Table 4. The results show that many of the bacteria could grow in the lactose broth, but only a few bacteria were able to produce gas.

The final Test was the Gram Stain test. The majority of the bacteria cultured were Gram negative. The microscopic morphology of the microbes included all three general forms of bacteria cocci, bacilli, and spirilli. The results of the Gram stain are located in the last column of Table 4.

Table 1: This table represents the characteristics of colonies and bacteria found at East Lake Pontchartrain.
Table 2: This table represents the characteristics of colonies and bacteria found at West Lake Pontchartrain and Gannon Canal.

<table>
<thead>
<tr>
<th>Water Sample Location</th>
<th>Colony Number</th>
<th>Pigmentation</th>
<th>Form</th>
<th>Size</th>
<th>Elevation</th>
<th>Margin</th>
<th>Picture of Colony</th>
</tr>
</thead>
<tbody>
<tr>
<td>West Lake Pontchartrain</td>
<td>5</td>
<td>Beige</td>
<td>Circular</td>
<td>Small</td>
<td>Undulate</td>
<td>Flat</td>
<td><img src="image1" alt="Image" /></td>
</tr>
<tr>
<td></td>
<td>6</td>
<td>White</td>
<td>Circular</td>
<td>Small</td>
<td>Convex</td>
<td>Entire</td>
<td><img src="image2" alt="Image" /></td>
</tr>
<tr>
<td></td>
<td>7</td>
<td>Cream</td>
<td>Rhizoid</td>
<td>Moderate</td>
<td>Flat</td>
<td>Lobate</td>
<td><img src="image3" alt="Image" /></td>
</tr>
<tr>
<td></td>
<td>8</td>
<td>Beige</td>
<td>Irregular</td>
<td>Moderate</td>
<td>Flat</td>
<td>Serrate</td>
<td><img src="image4" alt="Image" /></td>
</tr>
</tbody>
</table>

Table 3: This table represents the characteristics of colonies and bacteria found at the 40 Arpent Canal and the Industrial Canal.

<table>
<thead>
<tr>
<th>Water Sample Location</th>
<th>Colony Number</th>
<th>Pigmentation</th>
<th>Form</th>
<th>Size</th>
<th>Elevation</th>
<th>Margin</th>
<th>Picture of Colony</th>
</tr>
</thead>
<tbody>
<tr>
<td>40 Arpent Canal</td>
<td>9</td>
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<td>Circular</td>
<td>Pinpoint</td>
<td>Convex</td>
<td>Entire</td>
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<tr>
<td></td>
<td>10</td>
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<td>Irregular</td>
<td>Moderate</td>
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<td>Lobate</td>
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<tr>
<td></td>
<td>11</td>
<td>Beige</td>
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<td>Moderate</td>
<td>Umbonate</td>
<td>Lobate</td>
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<tr>
<td></td>
<td>12</td>
<td>Beige</td>
<td>Rhizoid</td>
<td>Large</td>
<td>Flat</td>
<td>Filamentous</td>
<td><img src="image8" alt="Image" /></td>
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Table 4: This table represents the biochemical and morphological results of the bacteria found at Eastern and Western Lake Pontchartrain, Gannon Road Canal, 40 Arpent Canal, and the Industrial Canal.

<table>
<thead>
<tr>
<th>Water Sample Location</th>
<th>Colony Number</th>
<th>Lactose Fermenting</th>
<th>Gram Stain</th>
<th>Morphology</th>
</tr>
</thead>
<tbody>
<tr>
<td>East Lake Ponchartrain 1</td>
<td>No growth</td>
<td>Gram Positive</td>
<td>Coccus</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Growth, Gas Production</td>
<td>Gram Positive</td>
<td>Bacillus</td>
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</tr>
<tr>
<td>3</td>
<td>Growth, No Gas Production</td>
<td>Gram Negative</td>
<td>Spiral</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>No growth</td>
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<td>Bacillus</td>
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<tr>
<td>West Lake Ponchartrain 5</td>
<td>Growth, No Gas Production</td>
<td>Gram Negative</td>
<td>Coccus</td>
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<tr>
<td>6</td>
<td>Growth, No Gas Production</td>
<td>Gram Negative</td>
<td>Bacillus</td>
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<tr>
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<td>Growth, No Gas Production</td>
<td>Gram Negative</td>
<td>Coccus</td>
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<tr>
<td>8</td>
<td>Growth, No Gas Production</td>
<td>Gram Positive</td>
<td>Coccus</td>
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</tr>
<tr>
<td>40 Arpent Canal 9</td>
<td>Growth, No Gas Production</td>
<td>Gram Negative</td>
<td>Coccus</td>
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<td>Growth, No Gas Production</td>
<td>Gram Negative</td>
<td>Coccus</td>
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</tr>
<tr>
<td>12</td>
<td>Growth, No Gas Released</td>
<td>Gram Positive</td>
<td>Bacillus</td>
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</table>

Table 4: This table represents the biochemical and morphological results of the bacteria found at Eastern and Western Lake Pontchartrain, Gannon Road Canal, 40 Arpent Canal, and the Industrial Canal.

Conclusion

This research provides a preliminary survey of the microbial population in the New Orleans environmental water systems after Hurricane Katrina. The bacteria found at East and West Lake Pontchartrain, Gannon Road Canal, 40 Arpent Canal, and the Industrial Canal produced Gram positive and negative bacteria. The morphology of these bacteria were either cocci, bacilli, or spiral. Some of the colonies found were yellow, white, beige, and orange with varying sizes and shapes. Also, many of the bacteria found grew in the lactose fermenting broth. These characteristics determine the preliminary identity of the bacteria found. From our results thus far, bacteria like E. coli cannot be ruled out. The microbial population surveyed is essential for its surrounding ecological balance. Natural disasters like Hurricane Katrina can alter the normal microbial environment.

The bacteria population has been noted to have an effect on the surrounding environment. Tad poles and frogs are still not prevalent in the canals and lakes that were used for water sampling. During our research, ducks progressively returned to the lakes. Certain surrounding water vegetation had not returned and some new vegetation is beginning to flourish. Further
monitoring of the microbial population is needed to determine its effects on the surrounding ecology.

For future considerations, the exact identification of the bacteria will be determined, which will include further biochemical testing. The above areas will continue to be monitored. Genetic analysis of the bacteria will be performed. The chemical composition of the lakes and canals visited will be tested. Finally, water samples from nearby communities that were not affected by Hurricane Katrina will be collected and tested to use for comparative studies.

Acknowledgements
Graduate Alliance for Education in Louisiana funded by the National Science Foundation
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Bibliography
Interpreting_Plates.shtml
