



LUND
UNIVERSITY

Bachelor of Science in
Development Studies (BIDS)

DDT: Misunderstood or Misrepresented?

***A critical discourse analysis of the competing claims on the
safety and viability of DDT for combating malaria in Africa***

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SGED10 / Spring 2017
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Abstract

The symbolic elite discourse on the safety and viability of using the insecticide DDT for combating malaria in Africa is marked by extreme dissonance. While some positions within the debate on using DDT for malaria prevention are quite nuanced, others are more extreme if not one-dimensional. The ones who tend to hold more nuanced or centrist positions on using DDT for controlling malaria are often researchers who acknowledge its capacity to simultaneously prevent and cause harmful effects. Meanwhile, symbolic elites from both the anti- and pro-DDT side competing for space within the discourse have employed certain strategies in how they present their competing claims to the truth about DDT. These strategies of persuasion have been the object of scrutiny in this thesis. With a combination of systematic review and critical discourse analysis methods, this research has explored the discrepancies between the competing claims on what ought to be considered accurate or 'true' knowledge on the use of DDT in malaria control interventions.

Keywords: DDT; indoor residual spraying; malaria control; discourse; knowledge

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List of Acronyms

ACSH: American Council on Science and Health

DDT: Dichlorodiphenyltrichloroethane

EPA: (U.S) Environmental Protection Agency

GMEP: Global Malaria Eradication Programme

IRS: Indoor residual spraying

ITNs: Insecticide-treated nets (bednets)

LDCs: Least Developed Countries

LITNs: Long-lasting insecticide-treated nets

LSM: Larval source management

POPs: Persistent Organic Pollutants

USAID: United States Agency for International Development

WHO: World Health Organization

1. Introduction

The symbolic elite discourse on the safety and viability of using the insecticide DDT for combating malaria is marked by extreme dissonance. While some positions within the debate on using DDT for malaria prevention are quite nuanced, others are more extreme if not one-dimensional. The ones who tend to hold more nuanced or centrist positions on using DDT for controlling malaria are often researchers who acknowledge its capacity to simultaneously prevent and cause harmful effects. Meanwhile, symbolic elites from both the anti- and pro-DDT side competing for space within the discourse have employed certain strategies in how they present their claims. They have done this with the intention of convincing audiences of this discourse which side holds the truth about DDT. These strategies of persuasion will be the object of scrutiny in this thesis. With a combination of systematic review and critical discourse analysis methods, this research will explore the discrepancies between the competing claims on what ought to be considered accurate or 'true' knowledge on the use of DDT in malaria control interventions.

1.1 *Background on DDT in malaria control*

DDT (Dichlorodiphenyltrichloroethane) was first synthesized in 1874 but its insecticidal properties known today were not discovered until Paul Müller found it to be very effective at killing insects in 1939 and put forward its potential for preventing the spread of insect-borne diseases such as malaria. This discovery won him a Nobel Prize. Preventing the spread of insect-borne disease by controlling the pests is nowadays also referred to as 'disease vector control'. DDT's first applications occurred in the second half of WWII, during which it was dusted onto soldiers, refugees, and prisoners of war alike in order to stifle epidemics of malaria and typhus. It proved to be extremely successful at doing so. Almost immediately after the war it also came to be seen as a miracle chemical in regards to controlling insect populations damaging the crops of the newly industrialized agriculture in the United States. DDT was sprayed inside houses across all endemic areas of the Southeastern United States until the country was declared malaria-free in 1951. The practice of spraying the interiors of home dwellings with insecticides for the purpose of controlling disease is referred to as indoor residual spraying, or IRS.

The effectiveness of IRS with DDT stood out among other insecticides on account of it being relatively inexpensive, largely due to DDT's ability to remain on surfaces for long durations of time after spraying (6-12 months). This had given the impression DDT could be effective even in

the most rural areas, enable increased coverage, and in turn make the prospect for eradicating malaria actually possible (Nájera et al. 2011). There was both a sense of optimism and urgency among its advocates, who believed DDT's potential ought to be used effectively before mosquito populations built up enough resistance to render the goal of eradication impossible (ibid). There were critics from the very outset who pointed out the diverse and adverse epidemiological settings in no way similar to those of the earlier success cases, and the basic principles of malariology were swiftly replaced by the eradication approach of spraying DDT everywhere:

“Destruction of mosquito breeding marshes, prevention of mosquito bites, and other measures traditionally used in malaria control were abandoned, depicted not only as unnecessary but as antagonistic to the higher goal of eradication. Moreover, international funds became available only to countries adopting the goal and the means set by the WHO expert committee reports.” (ibid 2011: e1000412)

Between 1955-1969, the World Health Organization (WHO) had carried out its Global Malaria Eradication Programme, which had placed IRS with DDT at the forefront of intervention strategies - regardless of local geography, climate, and overall public health situation on the ground. Incidence of malaria transmission was greatly reduced and eliminated in the United States, many parts of Europe and some of South and Central America. Interestingly enough, the Global Malaria Eradication Programme had virtually skipped over the most endemic regions of tropical sub-Saharan Africa (Baird 2000). This was largely due to a series of IRS pilot projects in Liberia and other countries south of the Sahara from the 1940s to 1960s, which were deemed unsuccessful (Webb Jr. 2011; Mabaso et al. 2004). Many of the difficulties experienced during these projects led to pessimism about DDT's capacity to be effective in endemic tropical regions. This pessimism essentially manifested into “general retreat from malaria eradication efforts across tropical Africa by the mid-1960s” (Webb Jr 2011: 376). Places where mosquitoes have breeding cycles all year round, compounded by other factors such as intense weather patterns, vast mosquito breeding sites, continuously migrating populations, poor rural accessibility, and insufficient public health infrastructure, provided poor environmental conditions for a sustained interruption of malaria transmission.

All of these factors combined led to uneven and intermittent coverage, but the paramount concern arising from the early experiences in these endemic tropical regions of Africa was the growing resistance of various mosquito species to DDT and other insecticides. Why then, would DDT suddenly become more effective under such environmental conditions now? *Why is the use of a chemical, which stirs up the amount of controversy it does, being scaled up the way it is?* If it is

not expected to have a sustainable impact on epidemiological settings which at present have some of the highest rates of malaria transmission, why then, are some actors ruthlessly advocating a moral obligation to extend IRS with DDT to every village on the African continent? I decided to look further into this debate to get a grasp on how this could be so.

Bouwman et al. (2011) view the debate as polarized, forming three categorical stances: anti-DDT, pro-DDT, centrist DDT. People tend to either be against DDT because of the human and environmental health implications, or completely in favour of DDT because it has a known record of saving lives - sometimes coupling this fact with the claim of DDT being entirely safe. Those more situated in the middle recognize the dilemma of using DDT for IRS: they can neither deny it saves lives nor the accumulating evidence on its effects on human health and the environment. To occupy the centrist position thus means to be pragmatic about whether IRS with DDT can actually succeed in eliminating malaria in endemic geographies of sub-Saharan Africa. According to Kolaczinski et al. (2007), in such high-transmission settings, interventions with IRS would need to continue indefinitely and 'at high quality' in order to sustain control, implying the requirements of better infrastructure and a constant flow of funding. This they deem very unlikely, which is why they advise caution to countries considering IRS. Others view the building of resistance to insecticides in various mosquito species as the largest threat to sustainability. They therefore argue that strategies for preventing resistance and setting up monitoring programmes are a necessity, while also stressing the need for developing new interventions (Kelly-Hope et al. 2008; Hemingway 2014; Enayati & Hemingway 2010).

The WHO initially went from recommending the *prevention* of malaria transmission through controlling mosquito populations to the *treatment* of disease through drug administration. However, they have recently made a return to advocating prevention through the use of IRS and insecticide-treated nets (ITNs) as the primary intervention strategies. The WHO is obviously an important actor which can influence how international aid agencies and donors channel their resources, as well as provide guidelines for governmental authorities on how to handle their issues of public health. In 1983, the WHO had made a call for the need for 'integrated vector control', which basically means to avoid relying on a single strategy for controlling insect-borne disease (WHO 1983). In the same document they stated the following on the status of disease vector control (emphasis my own):

“In all regions, vector control is largely being achieved through the use of chemical pesticides, with the organochlorine insecticides [such as DDT] still playing an important role. **Some vector control programmes involving the use of residual insecticides for indoor house spraying, are becoming difficult to manage, owing to the opposition by the inhabitants and, in some areas, to**

diminishing levels of supervision of spraying. The increasing number of cases of **insecticide resistance** and refractory vector behaviour, **the high cost and increased toxicity of many alternative insecticides**, and **opposition by environmentalists** to their use, are **additional problems** facing pesticide-based programmes.” (WHO 1983:8)

In the 1990s, the WHO moved towards focusing on malaria treatment through research and development of antimalarial drugs and vaccines. But it was not too long before they returned to the prevention side of things through insecticide-based control strategies. The launch of the United Nations Millennium Development Goals (MDGs), had much to do with this renewed push to eradicate malaria. Goal 4 was to reduce child mortality and Goal 6 was to halt and reverse incidence of HIV/AIDS, malaria, and other diseases. These two MDGs were interconnected to a great extent, as it is typically children under five who die from malaria. International development aid directed towards combating malaria essentially skyrocketed thereafter. Some big contributors are the Bill and Melinda Gates Foundation, the Roll Back Malaria Partnership, and the U.S. President's Malaria Initiative (PMI). The PMI is an interagency initiative led by the United States Agency for International Development (USAID) which was introduced under the Bush administration in 2005. In 2006, the WHO reverted to its original stance on DDT by recommending its use for IRS programmes and giving it a 'clean bill of health' (WHO 2006). USAID followed suit to endorsing and using it as one of its primary malaria control interventions. In a WHO position statement published by their Global Malaria Programme in 2011, the authors reaffirmed the role of DDT will not be reduced until equally cost-effective alternatives are available, as the result of switching prematurely to less cost-effective alternatives would only increase the malaria burden in high-transmission settings (WHO 2011).

1.2 Motivations, aims and objectives

What stimulated my research interest was finding out the extent to which DDT remains widely used today in the Global South to control the spread of insect-borne disease. More specifically, how its application in spraying the interiors of home dwellings has been introduced and reintroduced in several African countries in the recent decade. Under the Stockholm Convention on Persistent Organic Pollutants (POPs) put forth in 2001, DDT was listed as forbidden from agricultural use, while still being permitted for the purpose of controlling insect-borne disease – in the absence of viable alternatives. It is ultimately the main goal of the Convention to encourage the phasing out and eventual elimination of the twelve listed POPs. In spite of the Convention, the use of DDT for IRS in Africa has been increasing significantly since the ratifications (van den Berg 2009).

In my preliminary reviews of the academic literature and some remarkably influential

literary and audio-visual content on the use of DDT for IRS, I took note of how different actors within the discourse appeared to be adopting different strategies of persuasion for presenting information to the public on this topic. By different strategies I mean not only what information was disclosed and which seemed to be omitted, or which was emphasized and which more downplayed, but also the use of emotionally charged language. Language meant to evoke strong emotions were sometimes accompanied by a backdrop of profoundly disturbing images of sick and dying children. What I could gather from the presence of the very dissonant claims competing for space within the discourse was how this is nowhere near a settled debate, potentially rendering the exploitation of less-informed consumers of the discourse relatively easy. These vast discrepancies in what is considered to be accurate or 'true' knowledge on the topic of IRS with DDT is my point of entry. Therefore, it will be the overall aim of the research to explore these knowledge discrepancies with a combination of systematic review and critical discourse analysis methods.

With this research I will attempt to deconstruct the discourse by putting these dissonant claims into context through an exploration of how they are interrelated with the current epistemic repertoire, or knowledge base. Meaning, trying to situate where the knowledge is being taken from and in what manner claims to knowledge are being used by actors who stand to produce and steer the discourse on using DDT for IRS in combating malaria. By choosing to engage in critical discourse analysis, this thesis begins from the assumption that such strategies are working to communicate specific versions of reality with the intention of influencing public opinion on the topic. In discourse analysis, language is seen as the means with which truths become accepted into social realities (Bryman 2012:528). Critical discourse analysis is then about connecting discursive strategies to structures of social power and inequality.

The specific objectives of this research are the following:

- 1. To conduct a systematic review of the current epistemic repertoire (knowledge base) on the safety and viability of DDT for IRS**
- 2. To apply critical discourse analysis techniques to a sample of symbolic elite discourse regarding the use of DDT for IRS**

1.3 Research questions

1. What are the competing claims on the safety and viability of IRS with DDT in combating malaria in Africa?

- 1a. How are these claims being presented?
- 1b. How are they interrelated?
- 1c. What are the implications of this?

2. How may these competing claims be working to influence public opinion?

- 2a. Who could be the desired target recipients of these differing accounts?
- 2b. In what ways might the presentation of information be tailored to them?

2. Analytical Framework

My analytic position for examining the chosen pieces of discourse will be based upon some of the core assumptions behind a political ecology approach and the practice of critical discourse analysis. The roots of discourse analysis will be provided as well as the interlinkages between the processes behind the domination of a discourse and the acquisition, shaping, and propagation of knowledge.

2.1 *A political ecology approach*

This study can be conceived of as taking a political ecology approach to the research problems and questions at hand. Paul Robbins (2012) describes the field of political ecology as a 'certain kind of text' or a 'community of practice'. The main difference between a political and apolitical approach to environmental degradation and poverty is whether or not power relations are taken into account. An apolitical view may only take into consideration the seemingly 'naturalistic' explanations, such as the crude numbers of population growth or the rampant spread of disease. A political ecologist will ask the socioeconomic, geographic, and political questions, such as those regarding the globally unequal distribution of financial wealth, natural resources, and political power. It will be important to remember the political ecology response to any appeal to overpopulation as a pretext for 'naturalistic' population control measures later on.

Robbins (2012:17) writes how Thomas Malthus's first formulation of the 'ecoscarcity'

tradition in 1793 was explicitly a justification for a social policy of reducing welfare subsidies which would help feed the poorest groups of England. Malthus thought helping the poor was counter-productive towards the problem of starvation and famine, as it would only allow their populations to increase and lead to more starvation. In this sense, famine and starvation were presented as both a 'natural' and 'inevitable', if not *necessary* force of self-correction. The earliest 'ecoscarcity' arguments made by Thomas Malthus in his *Essay on the Principle of Population* in the late 1700s elicited some rather anti-human reformulations by elitist ecologists in the 20th century. The most well known is the notion of an imminent 'population bomb', coined and popularized by Paul Ehrlich (1968). He had warned a 'population bomb' would lead to mass starvation and a spike in death rates in the 1970s. For the Ehrlichs - his wife Anne Ehrlich was never credited - the crude numbers of overpopulation are the root of every problem in society. The neo-Malthusian logic does not consider the problem of scarcity as being linked to disproportionate consumption of resources by wealthier populations of the world, but to the developing countries where the total amount of humans is greater.

It was cited by Roberts & Tren (2010) in their book that in *The Population Bomb*, the Ehrlichs had described the use of DDT in preventing the spread of malaria as the export of 'death control' from richer to poorer countries. It is true they had postulated this, and suggested controlling fertility rates rather than death rates. However, Roberts & Tren (2010:30) present it as though both the Ehrlichs and the U.S. environmental movement as a whole fundamentally shared this outlook on DDT for malaria prevention as only allowing for the poorer populations in of the world to continue to grow unchecked. They insinuate the environmentalists viewed DDT as capable of saving so many lives it would only contribute to the 'population bomb', creating even more dire problems for the 'global' population. They utilize the extreme views of the Ehrlichs to reduce the anti-DDT side of the discourse to simply being neo-Malthusian. This will be looked at more closely in section 5.1.

2.2 Discourse analysis

Discourse analysis can be seen as an analytic position in its own right. One of the common themes of inquiry in discourse analysis involves scrutinizing ways in which different versions of social reality are made to appear as objective knowledge, or contrarily, how what seemed to be objective knowledge can become construed as false, unscientific, partial (Potter 2004: 607-11). It will be useful to follow this theme of inquiry for analyzing the discourse on the safety and viability of indoor residual spraying (IRS) since it is marked by contesting sides (anti- and pro DDT) attempting to present the other side as anti-science, fake science, junk science, or simply not science at all.

Discourse analysis has its roots in linguistics, but has been adopted into other disciplines of

the social sciences and is often carried out in an interdisciplinary manner. It can be found in social psychology, cognitive science, sociology, sociolinguistics, political science, human geography and other areas of the like. It was initially concerned with the structuring of language (form) in terms of semantics and grammatical choices and what such choices were accomplishing when conveying meaning. It has gone on to evolve into a diverse range of approaches which start from the assumption that language is not only about communicating but also about influencing a desired outcome, or accomplishing an act (Bryman 2012:529). It could be to convince someone or an audience to agree with an argument, to incite certain actions such as voting for a specific party or legislation, or even to have an effect on how a mental image forms in someone's mind when a certain word or topic arises (i.e. the 'population bomb').

2.3 Discourse and knowledge

According to van Dijk (2014:1-6), discourse encompasses our lives to the extent that virtually all of our knowledge is acquired through and influenced by public discourse in the forms of talk and text. Further, to take part in the production and comprehension of a discourse would be impossible without a cognitive activation of what he refers to as 'massive amounts of knowledge of the world'. I would personally refrain from using the word 'knowledge' in this context and simply say 'information inputs', for the question of whether or not certain information can with certainty be called knowledge is always moot. Van Dijk does acknowledge how, since Antiquity, epistemology has been about what criteria are and ought to be used to determine whether a claim may be considered a '*justified true belief*' (knowledge) or merely an opinion.

For the intents and purposes of studying how discourse and knowledge interact with each other, we can leave this debate aside and focus on “the more pragmatic conditions and empirical criteria being used in different periods, social situations and cultures in the justification, acquisition, presupposition, expression, communication and circulation of beliefs as knowledge” as is done in van Dijk's book on discourse and knowledge (ibid: 6). Knowledge in this sense is defined as relative to those who are expected to have specialist knowledge about a given area or topic, who may be called, 'members of *epistemic communities*'. Knowledge shared within an epistemic community is defined by its own terms and conditions, often not compatible with the terms and conditions of other epistemic communities. van Dijk refers to such shared knowledge as '*natural knowledge*'. In this thesis, the term 'epistemic communities' shall be used, but will instead write 'accepted knowledge' when referring to this 'natural knowledge'. Accepted knowledge thus refers to the knowledge which becomes (more or less) accepted into an epistemic community based on what its terms and conditions are. For example, that pesticides, herbicides, and fungicides produce harmful

effects for all forms of life is considered accepted knowledge within agroecology or environmental epistemic communities. 'Accepted knowledge' will be employed also because the purpose of this thesis is to identify the discrepancies between what kinds of information are accepted as knowledge by certain epistemic communities and to examine what forms of expression and justification are being used to determine what should and should not be accepted as 'true' knowledge by certain audiences.

Beyond observation and personal experience, van Dijk (ibid:16) insists how “discourse is the major source of human knowledge as well as one of its major verification criteria.” This has implications for the overall functioning and legitimation of societal structures. Those who get to steer public discourse – which I conceive of as to be able to contribute to it and actually be heard – have a degree of control over how certain groups of people will think and act, depending on which discourses they are receptive or completely ignorant to. It is obviously deemed important to us humans, van Dijk (2014:19) maintains, that we are capable of having a set of beliefs about ourselves and the world in which we are embedded which accurately portrays how things actually are. Why do we find it important? Well, simply because, “Our health, well-being, survival and daily interaction depend on correct beliefs about the natural and social environment (including ourselves).” (ibid). Speaking less generally about human civilization as a whole, it is certainly important for those within the field of development studies to work towards finding out, to the best of their abilities, what is being done in different contexts to improve quality of life for people and to question whether or not it could or ought to be done differently.

2.4 What makes discourse analysis 'critical'?

Critical discourse analysis is irrefutably about studying the interplay of discourse and power: how power, abuse of power, and social inequalities are made legitimate, normalized, and reproduced through the production of 'text and talk' in public discourse, which tends to be controlled and steered by what van Dijk (2008) refers to as '*symbolic elites*' – politicians, journalists, writers, academics, bureaucrats, lobbyist groups, and so on. Put more simply, it is not so much a method in itself as it is the “*study of the discursive reproduction of power abuse*” (ibid:6). It cannot simply be any kind of power which critical discourse studies (CDS) are aimed towards. It must entail forms of domination – broadly defined as 'abuse of social power by a social group' – which allow for social inequalities and injustices to occur (ibid:1-6). Since it is a given expectation of social scientists that they examine social issues, van Dijk (2008:6) attempts to clarify what actually makes a discourse study critical. He proclaims there ought to be first and foremost some normative aspect driving the 'socially relevant research' being undertaken, and provides some criteria, of which one or several

may be tackled in a study:

- relations of domination are looked at from the perspective of and in the interest of the dominated group
- the experiences of people in dominated groups are used as evidence to evaluate the dominant discourse
- discursive actions carried out by the dominant group can be shown to be illegitimate
- alternatives to the dominant discourses can be formulated in line with the interests of the dominated groups

This study is aiming to produce something resembling the first and third of the bullet points above. van Dijk (2008:7) goes on to elaborate on how the normative aspects of critical discourse studies are often criticized for not being 'neutral' or 'scientific' by having politicized motivations. Such politicized motivations involve taking a committed stance to be doing research which favours the interests of dominated groups, as well as being self-critical by reflecting on whether one's research may somehow be serving the interests of dominant groups in positions of power. He argues that to attempt to be neutral, to study social problems simply because they are 'interesting' without having any agenda to contribute to some kind of social change in the interests of dominated groups should also be recognized as a political stance. Nevertheless, he stresses these criticisms ought to be taken seriously. However, he emphasizes the political commitments CDS scholars typically have – which bear the potential and will to eliminate or change “illegitimate discursive practices of the symbolic elites” – do not require any less intellectual vigor and thoroughness than 'neutral' studies. On the contrary, if they are to actually contribute to the agendas they are meant to, they will require far more:

“We do not pretend to be able to study all social and political relations of power in society, but focus on illegitimate power and want to know how and why such power, and specifically its discursive dimension, is illegitimate. We want to examine the ways in which discourse may be abused, for instances by a systematic study of (and distinction between) discursive manipulation, misinformation, lies, slurs, propaganda, and other forms of discourse that are aimed at illegitimately managing the minds and controlling the actions of people with respect to the reproduction of power.” (ibid: 8)

3. Research methods

3.1 Methodological approach: exploratory study applying CDA

My research questions and analytical framework are inclined towards a qualitative, inductive approach to the research. I will frame this as an exploratory study with the object of analysis being the discourse of the symbolic elites surrounding the use of DDT for combating malaria in Africa.

3.2 Methods of data analysis and limitations

How I plan to analyze my data will firstly depend on the methods of systematic review analysis to guide my review of literature (chapter 4), as there is an enormous amount of research and information on IRS with DDT in combating malaria. The systematic review will serve as my synthesis of this epistemic repertoire to ensure the sampled data for the critical discourse analysis will not be floating out of context. Meaning, what is considered accepted knowledge and what remains inconclusive is important for the CDA to not simply be an analysis of language choice, but also an analysis of competing claims by symbolic elites against the background of current academic research. Although systematic review analysis methods are said to have the advantages of greater thoroughness and transparency, they can also bear the disadvantages of 'bureaucratization' in the sense of being overly concerned with how the researcher conducted the review (transparency) rather than the analytical interpretations they produce from it, as well as the problem of how the researcher's 'methodological judgements' can inform what articles ought to be included and excluded in the literature review (Bryman 2012:108). To counter these problems, I will try to strike a balance between my transparency of the research process and my intention to mainly engage in a theoretical analysis. As well, to try to include as many studies as possible while retaining an overall coherence.

When searching through the EBSCOhost Database for academic literature, multiple combinations of keywords and phrases were used to find as much research on the topic of IRS with DDT:

A list of examples of how I searched through EBSCOhost:

DDT + indoor residual spraying

DDT + IRS

DDT + IRS + malaria

DDT + IRS + disease vector control

DDT + IRS + environment
 DDT + IRS + environmental persistence
 DDT + IRS + public health
 DDT + IRS + insecticide resistance
 DDT + IRS + alternatives
 DDT + IRS + cost-benefit analysis

3.3 Sources of data collection

My analyses will rely only on various sources of secondary data. I will be incorporating different kinds of material into the analyses: academic articles, official and informal publications from intergovernmental and private sources, two books and two documentary films. The majority of this audio-visual and textual data will be accessed and collected online, hence be found in digital form. Academic research articles found through the EBSCOhost Online Research Databases which are situated within the broader topic of DDT for IRS will be of much use to me for the systematic review of literature.

The sampled data for the critical discourse analysis section will consist of two books and two documentaries. The books will be Rachel Carson's *Silent Spring* and Roberts & Tren's *The Excellent Powder: DDT's Political and Scientific History*. The documentary films will be '3 Billion and Counting: The Death Toll is Mounting', released in 2010; and 'Silent Snow: The Invisible Poisoning of the World', first screened in 2011 at a conference in Nairobi organized by the UNEP. *Silent Spring* will be important as it was the work which had initiated the discourse on DDT. *The Excellent Powder* will be equally so, as it aims to provide a counter-narrative which 'sets the record straight' on DDT. Together they represent the diametrically opposed claims within the discourse and contain elements of discursive significance. '3 Billion and Counting' attempts to present a narrative which is strikingly similar to that of *The Excellent Powder*, and even featured interviews with three out of its four authors at the beginning and end of the documentary film. These three authors (Richard Tren, Donald Roberts, and Roger Bate) all sit on the Board of a non-profit advocacy group based out of Washington and South Africa called Africa Fighting Malaria. Silent Snow was directed by Jan van den Berg and Pipaluk Knudsen-Ostermann. It is stated on the website for their film as a documentary project "investigating, together with the people who are affected the most, what turns out to be a structural pollution of the entire global environmental system." It is intended as educational material for schools and appears to be distributed for this purpose, while also being

screened at environmental conferences. Both documentaries have been screened at several festivals and private events. It is distributed to private individuals through renting or purchasing online.

3.4 Analyzing documentary films

The process of making documentaries inevitably involves the director, writer/s, and producer/s creating a narrative. They are always telling a story from their own perspective and their positionality affects how this story is told, much in the same way a researcher's positionality is likely to affect access to and responses from interview subjects when conducting a field study. Storytelling techniques used for shooting and editing a documentary film can even be seen as the construction of an argument (Long 2013), trying to convince the viewer about its validity. It was difficult to find analytical tools or guidelines on how to analyze documentaries specifically from the field of critical discourse analysis. Although, I did find a framework for analyzing documentary films which I found simple, well-written, and appropriate. Pulling from this framework, I have applied the following to both documentaries (ibid):

- 1) Identify main arguments/claims and overall purpose/thesis of the film
- 2) Provide a brief summary, the 'main characters', and the 'plot'
- 3) Examine the ways the purpose/thesis of the film is supported by its 'rhetorical and persuasive strategies': i.e. how facts are presented and counterfactual information dismissed.
 - Are there logical fallacies, contradictions, inconsistencies in the overall construction of their argument?
 - Attitude/viewpoint of the filmmaker? What is their general tone?
 - Cinematic techniques used to further emphasize their arguments/claims
 - How does the structure of the film work towards achieving its overall purpose?
- 4) Focus on a selection of scenes to analyze which best represent the techniques used to further the thesis of the film. Discuss why they seem the most convincing and persuasive parts and how the filmmaker employs them to construct the film's argument

4. DDT and indoor residual spraying: A systematic review

This systematic review of literature will begin by outlining the competing claims on DDT's potential to impact human health, the environment, and wildlife put forth by *Silent Spring* and *The Excellent Powder*. It will then follow with a synthesis of existing research related to indoor residual spraying (IRS) with DDT, divided up into the following sections: environmental and public health studies; how DDT has affected malaria incidence and mortality rates; insecticide resistance; existing alternatives to IRS with DDT and some cost benefit analyses.

4.1 Initiating the discourse on DDT safety

Rachel Carson (2002) raised public alarm about the potential harms being inflicted on humans and ecosystems by the new agricultural arsenal against insects in the infamous book *Silent Spring* published in 1962. DDT was one of several chemicals – divided into two main groups: chlorinated hydrocarbons and organic phosphates – which she took upon herself to research and inform the public about at a time when citizens of the U.S. had little to no knowledge about how ubiquitous these chemicals had become. The major claims about the chemical properties of DDT made in the book were the following: it persists for long periods of time in the environment before breaking down into similar compounds; and, it both accumulates in the fatty tissues of animals and becomes passed along the upper stratas of the food chain with the potential to cause harmful physiological effects. Roberts & Tren (2010) view these claims as pure mythology which demonized DDT and had aroused groundless fear among the American public, eventually resulting in the U.S. Environmental Protection Agency (EPA) imposing a politicized federal ban on DDT in 1972. The Stockholm Convention on Persistent Organic Pollutants (POPs) from 2001 is also viewed by Roberts and Tren (2010) as not being based upon real scientific grounds.

Roberts & Tren's (2010) arguments regarding the chemical properties and health aspects of DDT are that it is neither harmful to human health nor the environment: that it is actually entirely safe. They claim DDT is only a few times more toxic than salt, a few times less than nicotine. When used with proper management techniques during indoor residual spraying (IRS), it does not leach out into the environment. They also claim no person has ever died or become ill from an *environmental* exposure to DDT. The original claims made by Carson (2002) along with those of Roberts and Tren (2010) on the safety and viability of DDT will be contextualized with a systematic review of the current epistemic repertoire on indoor residual spraying with DDT.

4.2 Environmental and public health studies

POPs are organic compounds which have been classified as toxic and persistent in the environment. 'Persistent' meaning they have long half-lives in soils, sediments, air and animals, and can be transported over very long distances through volatilization and run-off from warmer to colder climates and end up deposited in Arctic regions (Gevao et al. 2010). Depending on temperatures, DDT is very resistant to metabolism which is why it breaks down very slowly into its breakdown products (metabolites) DDE and DDD, which have similar physicochemical properties (van den Berg 2009). Vieira et al. (2001) found traceable levels of DDT in outdoor soil samples, sediments, and chicken eggs collected from an area of Rio de Janeiro, Brazil, where the latest instances of IRS had been nine years prior. The levels of DDT found in the homestead chicken eggs were twice the Food and Agriculture Association's (FAO) residue limits at the time, making DDT's capacity to bioaccumulate 'a question of concern' (ibid). DDT is classified as being very lipophilic, meaning it becomes dissolved in and absorbed by fats, oils, and other fat-soluble molecules, while not having the capacity to be dissolved by water (not water-soluble)

DDT is widely used both in and out of compliance with the Stockholm Convention in the Global South for disease vector control (Ahrens & Weber 2009). Camenzuli et al. (2016) compiled data of DDT and its metabolites from agricultural and background soils from 73 peer-reviewed studies, covering a span of two decades (1993-2012). From their statistical analysis they found that the mean concentrations in agricultural soils for the period 2003-2012 were significantly higher than in background soils, while overall measurements did not live up to their expectations of a global decrease in DDT and DDE concentrations in the second decade. They therefore suggest 'new and/or illegal emissions' ought to be taken into consideration when collecting soil samples for monitoring contamination (ibid:19). A study carried out by Hinojosa-Garro et al. (2015) attests to DDT's capacity to end up far from where it is not used: in Mexico they took samples from two species of fish and sediments from both a nature reserve and agricultural land, and found concentrations of DDT in the fish and sediments at both sites, albeit lesser amounts at the nature reserve.

Some communities have shown it is possible to be exposed to high levels of DDT and its metabolites directly from IRS (Gaspar et al. 2015; Bouwman et al. 2006; Bouwman et al. 2012). There can be various 'environmental pathways' – both dietary and nondietary – through which people may become exposed to DDT through IRS, including household dust, air, outdoor soils, food, and water (Herrera-Portugal et al. 2005; Van Dyk et al. 2010; Barnhoorn et al. 2009). A study in which 50 samples of undisturbed dust were taken from 50 homes in Limpopo, South Africa, significantly higher levels of DDT, DDE, and DDD were found in the dust samples of buildings where IRS for malaria control had occurred. In addition, a positive correlation between these higher

levels in dust samples to higher concentrations of DDT and DDE in serum samples from women residents was found (Gaspar et al. 2015). Singh et al. (1991) conducted a study to determine how much and for how long DDT particles could float and disperse in the air after spraying in an area where IRS was applied in India. They found DDT residues in this particulate phase in the air up to 64 days after DDT was applied to the walls, implying the potential for DDT particles to land on food, water, and eating utensils, hence contribute to oral intake. Battu et al. (1989) contend that earlier studies downplayed the significance of possible contamination within households from IRS (WHO 1971; Spindler 1983) and conducted a study carried out in two districts in Punjab State, India, wherein DDT residues were found on food and fodder stored in sprayed homes. In a study of two communities in Mexico, where DDT has been used in large quantities for malaria control, samples of outdoor soils, indoor soils, and indoor dust were taken, along with blood samples from a total of 60 children (30 + 30) living in a highly exposed and less exposed community. It was found that the concentrations of DDE and DDT in the blood of children from the highly exposed community were higher (by six and eight times respectively) while DDT levels increased in both communities along with increased consumption of fish (Herrera-Portugal 2005).

Bouwman et al. (2006) point out how the presence of DDT in breastmilk has been known to be detectable in both malaria endemic and non-endemic areas for some time now (Bouwman et al. 1992; Savage et al. 1991), and found DDT and pyrethroid insecticides in 152 breastmilk samples from three towns in South Africa—one of which had no need for DDT in malaria control. They note, "None of the mothers had any accidental or occupational exposure to pesticides, other than working on lands, or through malaria control" (ibid: 905). They also stress they do not suggest abstaining from breastfeeding since, despite the residues, it remains the healthier option for supplying infants with essential nutrients and given the 'deadly implications' of malaria. However, they wish for more research on the public health implications of insecticide exposure to infants through breastfeeding. Similar results were found in another study from South Africa, the authors of which conclude with the need for more research into exposure levels of DDT and other insecticides in cases wherein IRS is applied selectively and with very limited doses (Channa et al. 2012).

An informal publication written by Hayes (1971) for the WHO gives an overview of what the status on the safety of DDT for humans and wildlife was around that time period. The report was called, 'THE DEGREE OF HAZARD TO MAN OF DDT AS USED AGAINST MALARIA'. Hayes (1971) argues how, given humans have been exposed to vast amounts of DDT in almost every conceivable way through agriculture, forestry, and public health, it can be deemed 'remarkably safe' for humans. The only cases of DDT poisoning, he adds, were caused by either accidental or suicidal ingestion, and that there were admittedly a few cases of death by unknown

dosages. It was found from some experiments on volunteers that DDT becomes excreted from the body more 'efficiently' when ingested in greater doses relative to smaller doses. Meaning, most of the DDT gets excreted when ingested in large doses above a certain threshold, while some will be absorbed through the intestines. In sum, the Hayes (1971) report concludes the only case against DDT in terms of safety is in regards to wildlife (especially fish, hawks, and eagles) while remaining entirely safe for humans. This is not because of human immune systems being more equipped to handle the compound, but because of our capacity to limit our exposure to it through the controlling of dosages.

In humans, it is mainly the nervous system which becomes targeted by extremely high dosages of DDT. Such high dosages can result in nausea, diarrhea, vomiting, confusion, and body convulsions, with amount of time depending on the dosage (Mercier 1981). In this review report published for the Commission of the European Communities compiling many studies, no long-term negative health effects could be associated with small daily dosages of DDT (ibid). The Pine River Statement is a more recent systematic review wherein almost 500 studies on human exposure to DDT and associated health risks were synthesized (Eskenazi et al. 2009). The authors concluded that although there is starting to become mounting evidence of DDT and DDE showing correlations to liver cancer, pancreatic cancer, diabetes, decreased semen quality, spontaneous abortions, and impaired brain development in children, there is still a considerable lack of knowledge on how DDT exposure might be affecting health in communities which are *currently* experiencing spraying for malaria control. This is because many of these studies are based out of North America and Europe. Associations between DDT exposure and breast cancer are weak as the studies often exhibited methodological limitations. The authors recommend that researchers work towards making up for these knowledge deficiencies as well as the development of new alternatives (Eskenazi et al. 2009). Roberts & Tren (2010) make an attack on the Pine River Statement in *The Excellent Powder*, discounting all 500 of these studies.

4.3 How DDT has affected malaria incidence and mortality rates

According to the WHO's approximations, malaria incidence – defined as the rate of new malaria cases – fell by 37% between 2000-2015, marking the achievement of the target related to combating malaria in Millennium Development Goal #6, to begin to reverse global incidence of malaria by 2015 (WHO 2016). The WHO estimates that since 2000, malaria mortality rates in the 'WHO African Region' for children under five-years old have fallen by 71% and by 66% for all age groups, while having fallen 60% globally and 65% globally for children under five. Still, an estimated 3.2 billion people are deemed at risk of malaria. 2015 saw 214 million new cases and more than 400

000 malaria related deaths (ibid: 6).

4.4 Insecticide resistance

In 2012 the WHO's Global Malaria Programme stated that these positive trends of reduced malaria incidence and mortality were under the threat of insecticide resistance. Hence, they put forth a global plan for managing insecticide resistance to preserve the effectiveness of the most commonly used insecticides in disease vector control, DDT and pyrethroids (WHO 2012). It has been proven possible for vectors to develop cross-resistance. This means mosquitoes which develop resistance to the pyrethroids used for insecticide-treated nets (ITNs) can simultaneously become resistant to DDT, rendering both less effective (ibid). Development of resistance in *Anopheles* mosquitoes is becoming of particular concern across sub-Saharan Africa and India (ibid). In a study by Wanjala et al. (2015), they found *Anopheles gambiae* had acquired a high level of resistance to pyrethroids and DDT across western Kenya, but did not look into whether this resistance could result in decreased operational efficacy of these insecticides. Resistance does not always result in the insecticides completely losing their efficacy (Chandre et al. 2000; Henry et al. 2005), but it can result in a significant decrease (N'Guessan et al. 2007). It seems to remain a widely held view that the sustainability of insecticide-based strategies will deteriorate without monitoring systems and routines for responding to resistance in the earlier stages to ensure continued susceptibility to the current arsenal of insecticides (Hemingway et al. 2016; Hemingway 2014; Kelly-Hope et al. 2008). However, one of the major claims made by Roberts & Tren (2010) is how this fear that DDT will cease to work once resistance is established in mosquito populations is based on a fundamental misunderstanding of how DDT 'actually works', which will be explained further in section 5.1.

4.5 Alternatives to DDT and cost-benefit analyses

The growing presence of resistance to DDT and pyrethroids in mosquito populations is prompting searches for new alternatives. Alternatives to IRS with DDT and ITNs with pyrethroids already exist, both with and without the use of synthetic insecticides. Unfortunately, there is scanty evidence on the cost-effectiveness of alternatives to these, but there are a couple of studies which have conducted comparative cost-benefit analyses which shall be mentioned.

As briefly touched on in the introduction chapter, one alternative to IRS is the traditional way of reducing mosquito populations: the removal of mosquito breeding sites through environmental management and killing of larvae in place (or larval source management: LSM). These were the techniques used in the early twentieth century before becoming more or less

superseded by IRS with DDT. Fillinger & Lindsay (2011) argue large-scale LSM remains a very effective tool for reducing malaria transmission yet is often denounced and not even considered a plausible malaria control method for African settings due to large numbers of widely dispersed, inaccessible, and temporary mosquito breeding sites. They point out the extent to which LSM has been used for decades by the United States, Canada, throughout Europe, Brazil, and Singapore, and how it is still used very intensively in the United States to control mosquito populations comparable to the scales found in African settings. They add that LSM has contributed to all successful cases of elimination and vector control programmes worldwide, which is why they wish to see the biases aimed towards it overcome in the future of integrated vector control strategies in Africa (ibid). The potential of LSM to greatly reduce vector populations in tropical regions of Africa is considered especially high in urban to semi-urban settings (Walker & Lynch 2007). Larvicides are not always synthetic chemicals. Some bacteria which produce toxins specifically affecting mosquitoes have shown great potential (Lacey 2007; Fillinger et al. 2008). Even neem, a plant extract, has shown to have strong larvicidal effects (Okumu et al. 2007).

An alternative which does not require insecticides nor attractants is called the 'Lehmann's funnel entry trap', which basically collects, traps, and eventually kills all mosquitoes entering a home. It has been tested both where there is low and high vector density and has been able to reduce mosquito density by a range of 70-80% in both high and low density settings. Apparently mosquitoes caught had high resistance to pyrethroid insecticides (Diabaté et al. 2013). There are also some plant extracts which appear to have had good results in terms of insect repellency (Elango et al. 2011; Seyoum et al. 2003), roughly 40 plant species from the tropics are known to exhibit repelling properties (Tisgratog et al. 2016).

As stated before, DDT is still considered the most cost-effective tool in relation to alternatives mainly due to it being relatively inexpensive when compared to other insecticides. Walker (2000) conducted a study to see whether DDT still holds the highest cost advantages by comparing price quotes from DDT manufacturers and WHO suppliers to those of nine other insecticides. The comparison revealed DDT to still be the least expensive on a cost-per-house basis, however found the prices of DDT to be rising while those of pyrethroids declining, making some of the latter only slightly more expensive than DDT. They note such a global comparison cannot reflect the local costs of implementation nor the significant fluctuations in prices which can occur within open markets. It seems studies on cost-effectiveness have only gone so far as to compare the cost-effectiveness of IRS with ITNs. ITNs show a tendency to be more cost-effective in highly endemic settings (Goodman et al. 2001; Guyatt et al. 2002; Yukich et al. 2008), whilst cost-comparison studies on DDT versus non-chemical alternatives seem unbeknownst. Studies

comparing DDT to other insecticides for IRS are also generally lacking (Kolaczinski et al. 2007). Despite the lack of cost-comparison data and the high operational costs of implementing IRS programmes for an indefinite amount of time, DDT is still touted as the most cost-effective alternative on account of it remaining on sprayed walls for the longest amount of time compared to other insecticides (WHO 2011).

5. Critical Discourse Analysis (CDA) of influential works

From this process of reviewing the academic literature I found an abundance of nuanced and balanced positions which exist in the domain of scientific research, in contrast to the diametrically opposed claims put forth in Carson's *Silent Spring* and Roberts and Tren's *The Excellent Powder: DDT's Political and Scientific History*. I thought it would be interesting to analyze and discuss their dissonant claims because I imagine it quite unlikely for people occupying the same epistemic communities to have read both of these works which arguably carry equal discursive significance. People who have read *Silent Spring* would probably never read anything as pro-DDT as Roberts and Tren's book, while people who read *The Excellent Powder* are fed an invalidation of Carson's work, therefore will probably never feel the need to read *Silent Spring* themselves.

5.1 'Silent Spring' and 'The Excellent Powder'

An 'Emotional' and 'Alarmist' Book: 'Heavy on Poetry'; 'Light on Science'

An important problem with Rachel Carson's *Silent Spring* is indeed the lack of a referencing system to sources. It is sometimes difficult to know where she was receiving her information from. She does note, for example, when she is referring to the learned experiences of malaria control operations carried out by the WHO, or the public statements of prominent experts and authorities. She wrote the book as a warning to the public, and did not write the book entirely on her own: in the acknowledgements section she thanked a long list of specialists for their insights (Carson 2002: ix).

Carson's use of poetic prose was equally to her advantage as to her discredit, if not moreso the latter. It brought much attention to an issue which had been previously been quite invisible. Environmentalists heralded it as a masterpiece and accepted every word of it without question. The choices of language she made brought many setbacks for the credibility of her work and is still to this day used as a way to discount every claim put forth in the book. She wrote in a dramatized manner which could instill fear in the reader, indeed it seemed to be partially intended to do so in

order to compel the reader to read on through the more dense material. She had depicted imaginative scenarios of a future America bereft of the sound of songbirds (hence the title). The imagery she had evoked was so powerful that in retrospect it can probably be seen as a bad move. Countless white middle-aged men in positions of power had tried to dampen the political-cultural effects she had put into motion by denouncing her authority on the topic, starting with U.S. President Kennedy setting up a special panel of his Scientific Advisory Committee geared towards dismissing every claim put forth in *Silent Spring* about synthetic pesticides (Carson 2002: xi). Media outlets also jumped on opportunities to calm the public. Edwin Diamond, Senior Science Editor of Newsweek Magazine, wrote in the Saturday Evening Post the following sub-headline in an editorial he had titled, 'The myth of the "Pesticide Menace"'. This excerpt was presented in the documentary '3 Billion and Counting', which will be analyzed in section 5.2:

“Thanks to an emotional, alarmist book called, 'Silent Spring', says this science writer [himself], Americans mistakenly believe their world is being poisoned.”
(Edwin Diamond, Saturday Evening Post)

Silent Spring goes into great detail about the organic chemistry of many different synthesized compounds, although Roberts and Tren (2010) describe Carson's book as a manifesto featuring DDT as public enemy number one. They write about the book as if it were the launching of an environmental campaign against the use of insecticides in public health: "To elevate DDT to national prominence, she conjured fear through conjectures and speculations disguised as science." (Chp. 4, 'Summary': par. 1). According to Roberts and Tren, Carson had argued insecticides should never be used *period*. A quick glance through the first few pages shows this to be inaccurate, as was made clear in a disclaimer in the first pages of her book:

“It is not my contention that chemical insecticides must never be used. I do contend that we have put poisonous and biologically potent chemicals indiscriminately into the hands of persons largely or wholly ignorant of their potential for harm. We have subjected enormous numbers of people to contact with these poisons, without their consent and often without their knowledge.”
(Carson 2002: 11)

Again, despite clarifying the book was not arguing the use of pesticides ought to be stopped altogether, her use of dramatic poetic prose was what made it possible to vilify her personal character and call the book outright unscientific. Carson was often dismissed as not being a real scientist. Roberts and Tren (Chp. 4, 'Foundations of Environmentalism: Fear and Uncertainty', par.

#5) describe *Silent Spring* as 'heavy on poetic prose but light on science'. This is but one of countless instances of symbolic elites within the discourse either denouncing her scientific integrity or alluding to the book as a manuscript of superstitious beliefs calling for a witchhunt on DDT. Carson did indeed claim with a high degree of certainty about the potential for chlorinated hydrocarbons (such as DDT) to inflict harm, but had conceded it could not be denied how some insects pose enormous problems for humanity which create the need for some degree of control:

“Over the course of time since man's advent, a small percentage of the more than half a million species of insects have come into conflict with human welfare in two principal ways: as competitors for the food supply and as carriers of human disease. Disease-carrying insects become important where human beings are crowded together, especially under conditions where sanitation is poor, as in time of natural disaster or war or in situations of extreme poverty and deprivation. Then some sort of control becomes necessary.” (Carson 1962: 7)

Malaria, Poverty, and Economic Development

Carson's point about how the spread of disease becomes more significant when humans are crowded under poor environmental conditions is relevant to the debate within international development epistemic communities about malaria being the poverty disease. Typically, malaria is either seen as the cause or the effect of poverty, sometimes both. If only something could be done about malaria hindering development, people could finally climb the ladder out of poverty without falling back down (Sachs 2005). Roberts and Tren (2010) also hold the view that malaria 'contributes to and sustains poverty'. They do however note how the countries which are 'developed' today only succeeded in keeping malaria eliminated on account of the improved standards of living which came with economic development:

“The eradication program saved millions of lives and lifted the threat of this age-old disease from many hundreds of millions more. In countries that benefited from economic growth and development, the eradication lasted. Less-developed countries with poor medical infrastructure and an inability to sustain their house-spraying programs because of continual pressures from environmentalists and international donors meant that slowly but surely, the disease crept back in those areas.” (Roberts and Tren 2010: 39)

They acknowledge how in cases like the United States, improvements in housing along with the destruction of mosquito breeding sites through transformations in land use for agricultural development had already been underway since the beginning of the 19th century. Around a million hectares of wetlands were drained. With better housing came better sanitation and hygiene. The

spread of malaria was already declining in the United States and Europe before DDT was implemented as the 'final step', as they say.

There are tensions between how they concede it was the benefits of economic development which allowed for DDT to contribute to a successful elimination of malaria from the now developed countries and how they vehemently argue the use of DDT for IRS in Africa is what will remove the hindrances to economic development malaria brings. In the United States, it was mostly economic development in itself which could overcome the burdens of malaria. But as written in their citation above, if less-developed countries lack the socioeconomic preconditions for full eradication, then the only solution is to continue spraying programs indefinitely to prevent poor people from becoming even poorer. It would seem necessary, according to Roberts and Tren (2010), that IRS with DDT ought to be used until African countries also reap the benefits of economic development such as better housing and medical infrastructure. This implies it must be funded and provided by international development aid for an indefinite amount of time. As was stated by (Kolaczinski et al. 2007), for IRS to achieve control in high-transmission settings would require indefinite spraying at high quality, hence require continuous financial inputs for training and employment of spray operators, equipment maintenance and logistics support; medical infrastructure and road accessibility; along with community acceptance among other things.

How DDT 'Actually Works'

The reason why Roberts and Tren (2010) give the reader the impression Carson was completely against the use of insecticides was probably because Carson had problematized the tendency for insects to develop resistance, often creating the demand for stronger insecticides. She warned they will always be needed once this 'endless spiral' of pesticide use has been initiated. Roberts and Tren view this claim as based on an inherently flawed logic when it comes to DDT, for they argue DDT does not become less effective once mosquitoes start to exhibit resistance. The chemicals need not be stronger, they say, but possess different 'modes of action'. A major point they emphasize through many parts of the book is that DDT does not only work by *killing* mosquitoes (its 'toxic action'), but also by *repelling* (without contact) and *irritating* (with contact). Their claim is the 'spatial repellent action' and 'contact-irritant action' never lessen with the development of resistance, and this might very well be accurate. That DDT was only deemed effective insofar as mosquitoes were still being killed is what they claim was merely popular scientific opinion at the time of the planning of the WHO's Global Malaria Eradication Programme (GMEP). This fear of losing the effectiveness of DDT through the building of resistance was and still is, according to Roberts and Tren (2010), based on a misunderstanding of how DDT 'actually works' and a result of the 'real science' being ignored.

In the WHO position statement from 2011, the authors had indeed recognized the repellent and irritant effects of DDT (how it 'actually works'), while still emphasizing the need to ensure insecticide resistance never becomes a compromising issue (WHO 2011).

The 'Natural vs. Synthetic' Dichotomy

Roberts and Tren describe Carson's understanding of chemicals as though she only perceived the 'man-made chemicals' as harmful and failed to recognize how naturally occurring compounds could also be dangerous. This is also not true as she wrote how naturally occurring compounds such as arsenic, copper, manganese, nicotine sulphate and so on, were indeed capable of producing harmful effects. She had actually gone into great detail about arsenic being a highly toxic substance. Present in chimney soot, discovered two centuries ago by an English physician to be carcinogenic, arsenic was still being used both in herbicides and insecticides despite the known dangers of arsenical poisoning:

“Farmers using arsenic dusts over long periods have been afflicted with chronic arsenic poisoning, livestock have been poisoned by crop sprays or weed killers containing arsenic. Drifting arsenic dusts from blueberry lands have spread over neighboring farms, contaminating streams, fatally poisoning bees and cows, and causing human illness. ‘It is scarcely possible...to handle arsenicals with more utter disregard of the general health than that which has been practiced in our country in recent years,’ said Dr. W. C. Hueper, of the National Cancer Institute, an authority on environmental cancer.” (Carson 2002: 16)

What she did claim, however, was how the modern pesticides were 'still more deadly', that they were different in that they possessed 'enormous biological potency' and were becoming far more ubiquitous in everyday life. Her concern was entrenched in how there were over two hundred new chemicals which were being released into the surrounding environments and on the produce Americans ate, without any knowledge of how they interacted with human physiological processes. While Roberts and Tren would have their readers believe she was ignorant to the complexity of organic compounds, Carson spends a good deal of pages explaining how it is not the elements in themselves which are dangerous but the exact arrangements of the atoms which determine the chemical nature of a molecule. She brings up methane as an example, one carbon atom and four hydrogen atoms: take away three hydrogen atoms and substitute chlorine and the result is anesthetic chloroform:

“By seemingly slight changes the whole character of the substance is changed; for example, not only what is attached but the place of attachment to the carbon atom

is highly important. Such ingenious manipulations have produced a battery of poisons of truly extraordinary power.” (Carson 2002:17)

'You Are Chemistry'

Roberts and Tren (2010: chp. 1) dedicate an entire chapter called 'Chemicals and Life' to explain to the reader about the nature of chemicals and dispel the fear surrounding the claims put forth by Carson about the toxicity of DDT. They argue a proper look at the chemistry of DDT and 'the chemistry of natural chemicals and processes' explains why these claims of DDT harm were mere fearmongering. They write, “DDT is a few times more toxic than table salt²², but far less toxic than nicotine²³. There has been no known human death or illness from an environmental exposure to it.” The sources they cited at the part about salt were Bennett (2001) from a page on a website created by the same author dedicated to pest control (where nothing was said about a comparison of DDT to salt) and the website for The Salt Institute, under “Salt FAQs”, the page of which could no longer be found. The part about nicotine referenced a webpage titled “Nicotine” on the website www.inchem.org. Citing a website called www.chemforlife.org, they write,

“As stated on a popular website, in reference to an individual human, “you are chemistry – all life develops from and consists of (bio)chemical processes.” At least thirty thousand chemicals are known to be present in humans. In the big scheme of natural and man-made chemicals, DDT is a very simple and easily produced compound.” (ibid).

The point they seem to be making here is that since we are made of chemicals, and all life is governed and handled by biochemical processes, we should not be afraid of them. And apparently the fact that DDT is a 'simple' and 'easily produced' compound is a mark of its safety. They state the dosages of DDT to which insects are susceptible are completely safe for humans. They later emphasize this point of dosage and toxicity by noting how one must consume large amounts of alcohol to experience its toxic effects, and that it is not very toxic when consumed in moderation: “Humans consume a great amount of alcohol, but death is rare because alcohol is not very toxic.” This can, of course, be true of any substance as they say. One can die from eating too much salt as one can die from drinking too much water in too short period of time, but using this kind of argumentation does not negate the mounting evidence on moderate alcohol consumption having the capacity to produce negative longterm effects on health.

DDT Dosage and Storage

Carson (2002) also understood the significance of dosage, pointing out that a quantity of iodine as

miniscule as two ten-thousandths of a gram marks the difference between health and disease. Her major claim about pesticides was how small amounts could accumulate in the body and become 'cumulatively stored and only slowly excreted', making the threat of “chronic poisoning and degenerative changes of the liver and other organs very real.” (ibid: 18). She follows up by noting how scientists have not reached consensus on precisely how much DDT becomes stored in the body: Dr. Arnold Lehman, chief pharmacologist of the Food and Drug Administration at the time claimed there was neither a floor beneath which DDT is not absorbed nor a ceiling beyond which DDT ceases to be absorbed; Dr. Wayland Hayes, of the United States Public Health Service, contended that there was a threshold of uptake beyond which the excess DDT became excreted. This is the same Hayes (1971) who wrote 'The degree of hazard to man of DDT as used against malaria' which was brought up in the systematic review (section 4.2). Roberts and Tren (2010) reference to the report by Hayes (1971) to support their claim that DDT will not accumulate and become stored in fatty tissues, while using an example of how vitamin D gets stored in the body to make their case:

“Vitamin D is an essential, fat-soluble vitamin. It can be stored in body fat, a process sometimes referred to as compartmentalization, in very large amounts, but beyond a certain threshold level, vitamin D will be metabolized and eliminated from the body. In a similar fashion, the fat-soluble molecule DDT will not accumulate, that is to say, be compartmentalized in fat cells, in the human body indefinitely. Beyond a certain threshold level, it too is metabolized and eliminated from the body.²⁶” (Chp. 1, par. 24)

It is difficult for this to not seem like a misuse of Hayes (1971) to make this point, because as was elaborated on in the review of literature, Hayes had reported on how when large amounts of DDT are consumed under short periods of time, the body will excrete more DDT more efficiently. This is indeed true of vitamins as well: take more than the body can take up, and the result is very expensive urine. This was, again, not the kind of consumption which concerned Carson, and as mentioned above she did not claim it would stay in the body 'indefinitely', but be 'slowly excreted'. Roberts and Tren (2010) do not deny that people have received environmental exposures to DDT, but they claim such environmental exposures have never produced ill effects. They extend this claim to wildlife, despite the document by Hayes (1971) admitting to DDT posing a threat to other species. Referencing Goklany's (2007) *The improving state of the world*, Roberts and Tren (2010: Chp. 1, par 26.) maintain, “those years of higher DDT exposures were marked with continual improvements in human health, wealth, and longevity.”

DDT and Wildlife: A 'campaign based on fear'

Similar argumentation is used to denounce Carson's claims about DDT having the potential to negatively impact the reproduction of bird populations through eggshell thinning. Roberts and Tren (2010) bring up statistics about the most famous cases against DDT in regards to the robin and the bald eagle (Chp. 4, 'DDT: Totemic Villain of the Environmental Movement'). They state the populations of these bird populations had actually been increasing before the ban of DDT in 1972, yet the environmental movement to this day would still falsely attribute this victory as their own. They argued this obfuscated the true reasons behind why these bird populations were increasing. The robins were doing well largely because of the suburban sprawl of America in the 1950s-60s: robins had an easier time surviving and reproducing in such semiurban environments of lawns and trees. The real threats to the bald eagles were sport hunting and the inadequacy of the legal protection put in place under the Endangered Species Act, and that it was not until serious changes in legislation, implementation, and funding for restoration programs allowed for their populations to increase again. The main issue Roberts and Tren have with the projections made by Carson was the lack of discussion about these other factors, yet they rule out entirely the possibility that DDT could have harmed wildlife enough to affect their reproductive capabilities. This is a classical case of framing causality in terms of either-or, rather than factoring in all possible explanations.

Roberts and Tren do admit to how, in regards to the case brought up by Carson wherein DDT was used on the campus trees of Michigan State University to prevent the spread of Dutch Elm disease, many robins had died of acute DDT poisoning. This part is especially interesting because of the way they describe how Carson viewed upon these events. Carson had argued the need for spraying the Elm trees was created by the planting of a single species of tree, making it more susceptible to insect-borne disease if there were to come an insect which would be able to sustain itself off that specific tree. A plantation of diversity would allow for more diversity of animals, hence would create the conditions for natural pest and disease control. However, Roberts and Tren find this argument to be rubbish and simply say Carson would blame the problem on the humans who obviously would want to save their beloved Elm trees.

Roberts and Tren's bottomline is that DDT posed no real existential threat to wildlife whatsoever and that increases in bird populations had absolutely nothing to do with the federal ban imposed on DDT by the Environmental Protection Agency (EPA). In addition to convincing DDT was a real threat, they write, 'one of her great successes was in helping to establish the belief that finding a chemical residue in the environment is equivalent to finding harm.' (Chp 4. under 'Robins and DDT: The Whole Story', par. 9). Roberts and Tren finish this chapter by declaring the anti-DDT campaign as based on fear and ideology, leading into what are arguably their strongest discursive

techniques used repetitively throughout the whole book:

“As with any campaign based on fear, when truth and objectivity are set aside, opportunities arise for horrible things to happen. As those who opposed any and all uses of DDT succeeded in closing DDT factories and changing public-health policies, they didn't save wildlife, but they did gradually and inexorably increase the risk of sickness and death for billions of poor people around the world.”
(Chp. 4: 'Summary', par. 3)

Hypocrisy of the Global North

Roberts and Tren (2010) extensively use moral philosophical argumentation to convince the reader to be on righteous side of the debate, rather than a careless believer in the religion of the anti-DDT 'environmental crusade' who would accept or be ignorant to the unnecessary suffering of millions of people. In the Preface, they wrote Europe and the United States had used DDT to “rid themselves of diseases and then pulled up the ladder, denying Africans, Asians, and Latin Americans the benefits of those same insecticides.” The metaphor of privileged Westerners pulling up a ladder for poor people in developing countries can easily evoke strong feelings of guilt in the reader, likely followed by a desire to not be associated with such hypocrisy. In all fairness, Roberts and Tren may also be accused of alarmism and playing on emotions to the same degree as Carson has been:

“The United States should take the lead in reforming public health insecticide policy because it is morally right to prevent countless deaths in poor countries. But if morality is not enough, reforming public-health policy abroad will eventually also save the lives of Americans travelling abroad as tourists, business travelers, or deployed military. It may even save lives at home by reducing the risks of disease introductions in the United States.” (Preface, par. 11)

The use of morality extends beyond trying to make the reader feel as though they have a moral imperative to be aware of what kind of foreign aid their taxes are being spent on and how their government's domestic policies may be influencing public health policies abroad. They also force the reader to consider how they may be endangering themselves along with other American citizens. This makes little sense and is clearly a fear tactic, as Americans travelling abroad obviously have access to preventative malaria medication. Even less so when considering the fact that U.S. governmental authorities already expend a great deal of resources on environmental management to keep mosquito populations at bay (see section 4.5). What they say about how the U.S. government should lead in reforming public health insecticide policies is also quite irrelevant, as there are no

political hindrances pressuring countries with endemic malaria to abstain from IRS with DDT. The only requirement for governments which have ratified to operate within compliance the Stockholm Convention is that they report their usage of DDT for malaria control to the Stockholm Secretariat. Governments which have not become signatories to the Convention are not obliged to follow any rules at all. In addition, since the WHO has reverted to its original stance on endorsing IRS with DDT as one of the primary control strategies in combating malaria, African governments are likely to follow their official recommendations. USAID, which is the governmental development aid agency, has supported IRS with DDT through the President's Malaria Initiative (PMI) ever since this change. Even the big green actors which were against the use of DDT for IRS such as the Environmental Defense Fund (EDF) and the Sierra Club are now for the use of DDT in malaria control campaigns.

All throughout *The Excellent Powder*, a version of reality is presented which would make it appear to the reader as though there are still great impediments imposed on IRS with DDT, resulting in innumerable deaths and immeasurable suffering which could have easily been avoided. An almost identical situation is represented in the documentary '3 Billion and Counting', which will be further elaborated on in section 5.2.

'Malaria as Population Control'

Lastly, morality is also used when formulating one of their main arguments in the book: that a 'basic building block' of the environmental movement was the fear of overpopulation as the root cause of humanity's problems and as threatening all life on earth. They propose most environmentalists at the time carried an innate desire to see the crude numbers of people on the planet be reduced by natural population control mechanisms such as malaria epidemics. They do this by alluding to the rhetoric of top proponents of the ecoscarcity tradition such as the Ehrlichs ('population bomb'), George M. Woodwell, and Garrett Hardin. These proponents have indeed spoken out publicly on a number of occasions about the need for population control. Their statements are inarguably problematic. Garrett Hardin wrote the infamous, 'Lifeboat Ethics: the Case Against Helping the Poor', in which he criticized the notion of Earth being like a 'spaceship' in which resources ought to be used conservatively and shared equally. He argued environmentalists, in their naive idealism, mistaken this spaceship for a 'lifeboat' with 'limited capacity', meaning not enough room on it for everyone:

“The spaceship metaphor can be dangerous when used by misguided idealists to justify suicidal policies for sharing our resources through uncontrolled

immigration and foreign aid...If we divide the world crudely into rich nations and poor nations, two thirds of them are desperately poor, and only one third comparatively rich, with the United States the wealthiest of all. Metaphorically each rich nation can be seen as a lifeboat full of comparatively rich people. In the ocean outside each lifeboat swim the poor of the world, who would like to get in, or at least to share some of the wealth. What should the lifeboat passengers do?" (Hardin 1974)

Hardin (1974) stressed that generous immigration policies and emergency food aid ought to be denied from poor people in poor countries on account of the 'reproductive differences between the rich and poor': "The people inside the lifeboats are doubling in numbers every 87 years; those swimming around outside are doubling, on the average, every 35 years, more than twice as fast as the rich." Hardin used this demographic reasoning to argue against the proposal to create a World Food Bank. He assumed it would become a 'commons in disguise', which would be taken from more than added to: "The less provident and less able will multiply at the expense of the abler and more provident, bringing eventual ruin upon all who share in the commons." Everything Hardin said echoed the words of Malthus: helping the poor was counterproductive in the long run. As an ecologist, he put a tremendous amount of his efforts towards specifically criticizing two things: immigration from developing countries and communism. As was introduced in section 2.1, the Ehrlichs were against anything which would allow populations of developing countries to increase, DDT being one of them. George M. Woodwell was another ecologist who was a prominent ideologue in the anti-technology, anti-population growth movement. All of these pioneers of the U.S. ecology movement are people who used seemingly apolitical arguments - population pressures on the environment - to justify their political beliefs and goals. Garrett Hardin and the Ehrlichs' held political beliefs which can with certainty be regarded as both racist and imperialist. Woodwell was at the least a critic of industrial civilization as a whole.

Roberts and Tren (2010) take the 'population bomb' arguments made by the Ehrlichs about DDT as the exportation of 'death control' to weave them into a conspiracy of environmentalists represented by the big green actors of the United States at the time: the newly formed EPA, the EDF, Sierra Club, etc. Their claims are that those within the environmental movement who wanted to see less people on the planet had a misguided motivation to shut down domestic DDT factories and stop the export of DDT from the U.S. to developing countries. This motivation stemmed from a perceived need to kill off some parts of the global population, thinly veiled by their cause to reduce the release of persistent toxic chemicals which could harm human health and wildlife. This was, according to their book, no more than a will on the part of environmentalists to believe the anti-

science fear campaign propagated by these elite environmental actors during their 'environmental crusade'. They equate being against DDT as being against science, which is a category people typically do not want to be placed in. While waving their banner of objectivity and positivism, they also argue that research on possible effects of DDT on human health, wildlife, or the environment ought to be put to rest. They declare it a waste of resources leading nowhere. To say with authority that a given topic should not be studied by scientists any longer is a rather anti-science position in itself, with the potential to make researchers censor themselves. When Roberts and Tren (2010) bring up the Pine River Statement by Eskenazi et al. (2009), which is a systematic review of about 500 studies, they discount the credibility of *all* of these studies. It would be pretty incredible if they had actually gone through the methodology and findings sections of every single one of these studies thoroughly enough to declare all of them insufficient and/or irrelevant.

5.2 '3 Billion and Counting: The Death Toll is Mounting...'

The main arguments of '3 Billion and Counting' are similarly that DDT is a life-saving chemical which never ought to have been banned; that the banning of DDT resulted in millions of poor people in developing countries dying; that the DDT ban was a politicized decision grounded in environmentalist superstition and propaganda initiated by Rachel Carson rather than being based on real science; and that the environmental movement ultimately desired an outcome of population control in developing countries as a result of withholding DDT. The last point is conveyed without reserve towards the end of the film, culminating into the claim that the banning of DDT was really about 'white men killing black, brown, and yellow babies' of the world, arguing the positions and decisions against DDT were ultimately loaded with racism.

Dr. Rutledge Taylor is a doctor in Preventative Nutrition and Age-Less Medicine from California who says to have been urged to make an independent documentary about malaria and DDT after having read about how many people were estimated to be infected by malaria every year in an article in *Nature*. This article had stated approximately 300-600 million infections had occurred in 2002, although Dr. Rutledge narrates this by saying, 'half a billion *every year*'. He was astonished by how such staggering numbers of people, mainly children under five, were 'in this day and age' *dying* from malaria. He frames his need for an investigative journey in search of the truth about malaria and DDT, after being told by a friend named Arthur Robinson, whom he calls a 'world-renowned scientist with a lot of integrity', his take on things:

“The number of people slaughtered by the ban of DDT is greater than any other genocide in world history. DDT is a preventative measure, it just turns malaria on

and off like a switch. This is a technological genocide by the withdrawal of technology. These people are simply killing these kids, and they know it.”
(Arthur Robinson, Founder of Oregon Institute)

Dr. Rutledge was apparently not convinced by this argument at the outset but had believed it to be, for the most part, just 'conspiracy theory', and thought with the film he would prove it to be just that. The arc of the film is marked by his self-proclamation to have proven it was actually 'not conspiracy', meaning what Arthur Robinson had said was the true story of DDT. The structure of the film can be seen as divided into two parts. The first half works towards convincing the viewer that DDT is a force of good which fights poverty and alleviates suffering, but is being held back by political and environmental pressures. The second half is spent on attacking Rachel Carson, the big green actors, the EPA's William Ruckelhaus, and debunking the 'myths' surrounding DDT harm. It finishes off with a compilation of the opinions of Washington-based interviewees (including the co-authors of *The Excellent Powder*) describing the banning of DDT as a racist genocide. One of the very last shots the viewer is left with is of Dr. Rutledge mixing a solution with three grams of DDT and drinking it in order to prove to the viewer it is not harmful.

'Malaria Breeds Poverty'

As is done in *The Excellent Powder*, malaria is blamed as a primary cause of poverty in the first scenes of Dr. Rutledge's investigative journey. The viewer is bombarded with images of writhing, crying, and eerily motionless children suffering from all kinds of malaria. The hospitals he visits are understaffed and overwhelmingly filled with people waiting to have their malaria treated. “Malaria breeds poverty, that's for sure.” The scene closes with a shot of an infant with cerebral malaria, and as his eyes roll backwards as it fades to white, transitioning to Dr. Rutledge speaking in the car:

“What the normal people don't see, my *god!* How many people are infected! You think that doesn't-- isn't oppressive, that that's not poverty, that that doesn't keep people socked in poverty. If that doesn't keep people socked in poverty I don't know what does. You *cannot* wipe out poverty, *at all*, without addressing these diseases that are so rampant and *plagueing* this society! You just can't do it.”

Bednets vs. Indoor residual spraying

One of the scenes which contained the strongest strategies used to convince the viewer that DDT is a force of good is the one in which Dr. Rutledge compares the two most commonly used methods of malaria control: indoor residual spraying (IRS) and bednets. Each part of this scene either portrays bednets as laden with corruption, ineffective, or simply inferior to the cost-efficient, long-lasting

effects of DDT. They do not mention how bednets are most often treated with long-lasting insecticides to increase protection, hence the name long-lasting insecticide-treated nets (LITNs). Dr. Rutledge goes around interviewing different international aid workers about what they do, one of whom was Jenny Peters of Population Services International in Mozambique. She stated they mostly did distribution of bednets to pregnant women and families with children under five, and that all of their bednets were for sale. At this point, a rewind effect is used when she said, “all of our products are for sale”, followed by text over black narrated by Dr. Rutledge:

WAIT A MINUTE...

THEY SELL THE NETS INSTEAD OF GIVING THEM AWAY?

Desmond Chavez, Global Director of the Malaria Control unit of Population Services International, responds to this question by stating there are several reasons for why a commercial approach is taken to bednet distribution. Firstly, that people who invest in a net will be more likely to use the net, and secondly that many people in African countries “can actually afford to buy a net.” He adds that those who cannot afford to buy a net can be eligible for a voucher scheme targeted at high-risk groups (pregnant women and children under five) who can use them as a 'part-payment'. At, 'part-payment', the same rewind effect is used repetitively (three times) to add emphasis. Dr. Rutledge is thereafter interviewing Tim Freeman, the Malaria Project Officer representing UNICEF in Mozambique. He asks Freeman, “What about when they go outside of the net?...They don't have the protection they need when they have to go to the restroom or bathroom, that sort of thing...” Tim Freeman responds, “The reality is, people who use nets alone with always get malaria.” Again, text over black with Dr. Rutledge's narration:

WHAT DID HE SAY?

The clip of Tim Freeman's response is played a second time, then pauses. Melancholic piano music starts to play in the background. Dr. Rutledge appears to be in utter disbelief and extremely skeptical. It then cuts back to the interview with Desmond Chavez, who admits the nets do not provide complete protection and need to stay treated. Dr. Rutledge adds, “They've got to stay intact...”, with a look of shock and disapproval. Dr. Rutledge is then filming inside the home of a family who have a bednet, muttering: “Look, there's a fly in there...I saw a hole here...if a fly can get in, so can mosquitoes.” His friend Helene Udy then says, “Yeah it seems to me that if you're

gonna give them a bednet, you should also give them a needle and thread, and *teach them* how to sew up those holes.” Dr. Rutledge responds to this (with a seemingly sarcastic tone): “Yeah or you could, you know, just keep a needle and thread on you at all times and *wear* the bednet...everywhere you go!...” Helene laughs, and the scene closes with a child sleeping under the damaged net.

'Everyone *Wants* to Use it [DDT]'

In the scene that follows, Dr. Rutledge is interviewing Elizabeth Streat of the LSDI Malaria Control Program in Mozambique. He asks her what kind of insecticides are being used in their program, to which she responds Ficam. This prompts him to ask, “Have you considered using DDT?” She makes a stern expression of discomfort, as though she did not wish to be asked that question, and gestures to the others in the room to leave. Once they've left, she responds: “It's difficult to talk about DDT here. It's quite a sensitive issue”. It then intercuts to another interview with Abdul Hamid Mussa, Maputo Provincial Health Director in Mozambique, who says that because they have external funding, they are not using DDT. In a shot with only Dr. Rutledge speaking, he says, “What's surprising is that I've found that everyone here wants to use DDT. Everyone *wants* to use it, but they're not using it, and it's mainly because of *political pressures*.” Towards the end of the scene, Dr. Rutledge is interviewing Dr. Samuel Ochola, Head of the Division of Malaria Control in Nairobi, Kenya. Dr. Rutledge asks about the subject of DDT being an option for future malaria control. Dr. Samuel Ochola responds by saying DDT has been used there in the past but that there are mounting environmental concerns as well as effective, environmentally friendly alternatives. Dr. Rutledge responds, shaking his head, “As we are looking for these alternatives, people are dying every twelve seconds. These kids could have been the next you. Would you use DDT, to save these kids?” Shots of happy looking children play in the background. Dr. Samuel Ochola stutters and says he cannot provide a straightforward answer to that, looking down, away from the camera, with a sombre expression on his face.

Banning of DDT: A Racist Genocide

One of the last scenes of the film which is composed of a compilation of interviews with people representing various commercial lobby groups and neo-conservative think-tanks which act as informants to U.S. policymakers in relation to public health, food and agriculture, environmental regulation, and climate change. They unanimously agree the banning of DDT was more about killing off large swathes of human populations in the Global South than about protecting the environment, wildlife, or humans. This scene is meant to convince the viewer that environmentalists

have been misleading the public about a number of issues in addition to DDT, such as organic farming. Elizabeth Whelan, who founded the American Council on Science and Health (ACSH), a science education non-profit funded by corporate interests, stated the following:

“Pesticides and other agricultural chemicals actually promote public health, by keeping our produce supply varied, plentiful, and inexpensive on a year-round basis. We seem to have this complete double standard on chemicals. If they're synthetic, they're highly suspect.” (Elizabeth Whelan, co-founder of ACSH)

Just as in *The Excellent Powder*, the debate becomes reduced to 'natural vs. synthetic', postulating environmentalists always equate natural with good and synthetic with bad. Roger Bate, a co-author of Roberts and Tren (2010), follows Elizabeth Whelan's statement with, “Natural doesn't mean safe. Synthetic isn't always dangerous.” Roger Bate is also a board member of DDT advocacy group Africa Fighting Malaria, a fellow of the American Enterprise Institute, and has lobbied for the tobacco industry among others according to SourceWatch.org. Dennis Avery, director of the Centre for Global Food Issues at the Hudson Institute, argued that, “when the World Wildlife Fund says we should go back to organic farming, basically what they're saying is that half of the human population should be eliminated. They would starve.” Gilbert Ross, also from the ACSH, said he thinks “a lot of the environmental groups deep down believe that the world would be a much better place if there were fewer people on it.”

The 'malaria as population control' argument is employed in almost the same manner as in *The Excellent Powder*; but they do not discuss the Ehrlichs or Garrett Hardin, only the neo-Malthusian ideologies they represented and a misguided environmental movement concerned with ecoscarcity. Richard Tren appears in this scene as well, saying:

“If you think that we should reduce population, then why don't *you* get rid of half of your children or your nieces or nephews? There's an inherent racism in this. People with lighter skins that think the population growth problem is all in Africa.” (Richard Tren, Africa Fighting Malaria)

It is repeated by many others in this scene that Westerners either simply do not care if poor people in developing countries die from the banning of DDT or see this as a convenient outcome for the planet. Arthur Robinson, the one who had apparently urged Dr. Rutledge to do the documentary, finishes with, “It's basically white men killing black, brown, and yellow babies. It's pretty ugly, but there are 50 million dead black, brown, and yellow babies killed by the decisions of white men in Washington.” To emphasize the safety of DDT, Dr. Rutledge drinks a solution of DDT, stating two

years have passed since he drank it and that he was fine. He then adds, while sprinkling a bowl of berries with DDT powder, “So, with vector-borne disease on the rise...Should we bring back DDT?” He takes a bite, the camera zooms in, and he shrugs while nodding in affirmation. It then fades to black, with the following message:

481 men, women and children died of malaria while you watched this film.

The film then tries to end on a more uplifting note, with all of these same interviewees being asked what they think the greatest natural resource is, to which they *all* respond positively, 'human beings', 'people', or 'human intelligence'. This is clearly meant to emphasize all human life should be valued, implying that to be against DDT is to deny all human lives are of equal worth.

5.3 Silent Snow: The Invisible Poisoning of the World

The film begins on the premise of Greenland being situated on the receiving end of a globalized pollution of POPs, with the primary chemical of interest – at the outset – being DDT. The film solely follows the travels of an Inuit woman named Pipaluk, who is prompted by the pollution of her home to go a quest to find out why DDT is winding up in her 'cold heaven'. This journey eventually unravels into a general critique of pesticide use, travelling to places in Tanzania and Uganda where DDT is used for malaria control, to a DDT factory in Kerala, India, where the contaminated waste water is dumped in the Periyar river, and a village in Central America where mosquito control has been attained with environmental management (without chemicals).

In the beginning of the film, Pipaluk and her two cousins are watching an interview of Henrietta Rasmussen (former minister of Greenland) discussing the health warnings aimed at locals telling them to not eat the fat of seals and fish. Pipaluk narrates into this clip saying, “Greenland is in the news *a lot*, and it's *bad* news.” In this interview clip, Henrietta Rasmussen problematizes the fact that women are being told by doctors to abstain from eating these essential 'oily foods' if they are going to be breastfeeding given it was the activities of North America and Europe which had caused this pollution. The use of this interview with Henrietta Rasmussen, most likely played on the tv for the purpose of making this film (not live), intercut with shots of melting ice, seals, and polar bears, further emphasizes Pipaluk's point about the extent to which their natural diet and health is seen as being threatened by pesticides. Pipaluk's overall attitude to the situation comes off as grave

concern and calm indignation. The tone is set by how she frames it with her wording at the start: “...But now, an invisible enemy is threatening our homeland. It silently comes down with the snow.” Pipaluk continues her narration after the clip of Henrietta Rasmussen over images of her hometown and children singing/playing:

“Our life is threatened by dangerous pesticides. They travel up North by ocean winds and currents. It has horrifying effects on peoples' health, causing all sorts of cancer and fertility problems. The poison never leaves your body, and is passed on to the next generation. Recent studies have proven that children with high levels of pesticides in their blood have a lower IQ.”

This is the justification for her journey, to, “find out where and why these pesticides are still being used”.

'Malaria Control Experts Held'

Her first visit is in Tanzania, where DDT is apparently forbidden but still illegally obtainable everywhere. It is then explained how DDT is used to spray houses for malaria control, and very soon after this, the scene flips to being situated in Uganda and goes directly into the corruption aspect of this practice. This scene seems instrumental in convincing the viewer that this is something *bad* or *immoral* and inextricably linked to forces of *corruption*. Pipaluk narrates over some footage of a man pumping a spray container of DDT (out of focus) with children (in focus) watching in the background: “I interviewed Dr. Mayers, the head of the malaria campaign in Uganda...” It then cuts to Mr. Mayers presenting the economic rationale for using DDT, while intercutting with the footage of the man about to spray a house gesturing to the children to go somewhere else (emphasis my own):

“In a country like Uganda, where we have indicators that we lose about 320 persons everyday. I repeat, 320 persons *everyday*, due to one disease: malaria. You'd spray once a year and you'd use almost ten times less money than if you went for other options. So, it has a cost benefit analysis, which as a developing country, one can bear in mind.”

It then cuts again to footage of a man spraying the outside of a house, while Pipaluk narrates again to introduce another interviewee: “Eladi Muyambee from Toxic Free Uganda opposes the government policy”:

“But we all know, that when you consider what we call the operational costs of DDT, DDT is much more expensive than other insecticides, than other alternatives. Like, for example mosquito nets to protect people from mosquito-human contact. In Uganda, we are 30 million people but only 6 million have mosquito nets.”

Directly after it is said to be the least expensive option, which is the strongest argument for using DDT in malaria control programs in developing countries, another interviewee says this argument is false. The viewer is left with a choice of who to believe since they are unlikely to have enough knowledge within this area to make their own calculated judgement. Then, Eladeen Muyambi adds, “But for sure we know that people who initiated the process, they *gained* something. Some companies from the U.S. who came to Uganda and met with those people, and they gave them something.” After he had implied there had obviously been some corruption involved, Pipaluk's narration returns while the images from the interview of Dr. Mayers are played again: “He was proved right. Dr. Mayers had been arrested. He had not only profited from the spraying of DDT, but also sold *donated* malaria pills to private clinics in Uganda and abroad.” It then cuts to show a newspaper article with the heading, 'Malaria control experts held', and an image of Dr. Mayers sitting with some other men (some in business suits like he, others in military apparel). After this back and forth, the viewer is most likely to have sided with Eladeen Muyambi and Pipaluk and to cease believing the argument for DDT as being the cheapest alternative.

'If You Refuse, We Are Going to Arrest You'

What then follows is the most vital part of the scene for convincing the viewer about IRS with DDT being a bad thing, as it ensures the viewer will sympathize with those whose houses become sprayed and lose all trust in the authorities' actions as being intended to protect people from harm. Pipaluk interviews a woman who was forcefully arrested after refusing to have her house sprayed:

“Me and my family, I refused. They never sprayed my house with DDT. On that day, they arrived at my place here and 'said madam, open your house. We want to spray your house'. I said: 'for what? I don't want it. You are not going to spray my house'. They said: 'why, are you against government policy?' I said: 'no, no. You are not going to spray my house with chemicals'. 'Why?' 'I have organic farm and I have my food there and everything is there. You are not going to spray my house'. 'If you refuse we are going to arrest you.' I said, 'you can arrest me if you want'. They called the police from the sub county, the police come, they've arrested me and took me to the sub county, and put me in a cell for 7 hours...When I was already in the cell for 7 hours..they released me, and said: 'you go back, we don't want you to say anything more about DDT.'”

Thereafter, Pipaluk narrates about how in this village (it is unclear whether they are now in Tanzania or Uganda) they had tried to grow organic cotton but could not sell it after traces of DDT had been found on the raw materials. She asks the first woman she interviewed to translate for a couple of women. When asked what they thought of the spraying, one woman replied the children were still getting malaria because the spraying only worked for some time and that they did not want to buy their eco-cotton anymore, while another woman describes how they had sprayed while she was not home and that when the chickens had eaten directly after the spraying they had found them dead the next morning. The closure of this scene leaves the viewer with the feeling that DDT had not benefited anyone at all and had also affected people's livelihoods. Pipaluk finishes with saying, 'Long after the spraying, the level of pesticides in these sprayed houses is sometimes dangerously high, and the milk of breastfeeding women becomes pure poison', over some final shots of children standing around in the village.

Those Directly Affected

The structure of the film works to convince the viewer about its main thesis by first showing the faces and voices of people who are directly affected by the actual spraying of DDT. It later goes on to show those of communities affected by the production of DDT where the factories reside and by pesticides sprayed on banana plantations in Costa Rica. It then finishes with presenting a case wherein alternative methods were used so the viewer may be left with something concrete to work with in terms of solutions, rather than possibly leaving them feeling as though DDT (and pesticides more generally) is the better of two evils. To put it more succinctly, the film starts with POPs and DDT more specifically, to later broaden out to encompass the rest of the pesticides. They use a similar argument to that which was put forth by Rachel Carson about the 'endless spiral' of pesticide use. Of the persuasive strategies used in the film, the editing choices regarding the responses from the interviewees were by far the strongest, as they leave no room for even the slightest positioning on the pro-DDT side of the argument. However, these strategies bear a weakness in that they would probably have little influence on viewers who do not weigh the opinions and experiences of people very heavily.

6. Findings and discussion

3 Billion and Counting and *The Excellent Powder* share many of the same premises, the main one being how the banning of DDT (both in 1972 by the EPA as well as by the Stockholm Convention) has led to millions of poor people dying from malaria when it could have 'easily' been eradicated. Roberts and Tren's (2010) rhetorical strategy used to explain how Carson's *Silent Spring* along with

Paul Ehrlich's *Population Bomb* gave rise to an 'environmental crusade' – wherein the true motives of the U.S. environmental movement were actually neo-Malthusian – was also played out in Dr. Rutledge's documentary. However, an added layer of emphasis was placed on the racist motives behind the banning of DDT in *3 Billion and Counting*.

Both of these works seem to give a false impression to the reader/viewer of what the overall status of DDT use in Africa is, in contrast to how things actually are on the ground. They blame external political pressures from international development aid agencies, big green actors, and governments of the West for a gaping deficiency in the use of DDT for IRS in Africa. According to their narratives, African governmental agencies, NGOs, and local communities all *want* DDT, but cannot have it as a direct result of these pressures. This narrative clashes with the fact that the use of DDT for IRS has been increasing significantly in Africa over the last decade in the push to meet the Millennium Development Goals. The United Nations Environment Program's (UNEP) Stockholm Convention had never made the use of DDT forbidden from malaria control, and in 2006 the WHO had recommenced endorsing DDT as remaining the most viable alternative for combating malaria in all kinds of transmission settings. At the time the WHO had made this position statement, which was four years prior to the publishing of *The Excellent Powder* and release of '*3 Billion and Counting*', Admiral R. Timothy Ziemer (Coordinator of the PMI at the time), stated the following:

“I anticipate that all 15 of the country programs of President Bush's 1.2 billion commitment to cut malaria deaths in half will include substantial indoor residual spraying activities, including many that will use DDT...USAID supports the spraying of homes with insecticides as a part of a balanced, comprehensive malaria prevention and treatment program.” (WHO 2006)

Statements like these, along with other indications that IRS with DDT had actually been increasing before the authors of *The Excellent Powder* and the producers of '*3 Billion and Counting*' were putting out heavy criticisms towards USAID, the WHO, and the Roll Back Malaria Partnership, make this debate really quite puzzling. It renders it difficult to comprehend the discourse without consuming every part of it. If one were to only take the arguments of Roberts and Tren (2010) and Dr. Rutledge at face value, they would be under the impression that people are dying of malaria every twelve seconds due to the denial of technology by Westerners. They would also be convinced it is mainly the anti-science, anti-progress, environmentalist propaganda initiated by Rachel Carson which is to blame for this. If one wishes to be on the side of solid science, they would have to accept their counter-narrative of DDT as a misunderstood and demonized chemical. If one were to only have watched *Silent Snow*, one would think DDT is not a viable solution for reducing malaria

transmission, given the existence of safer and equally effective alternatives such as environmental management. DDT is presented as either a deeply misunderstood or misrepresented chemical.

Much of what Rachel Carson had put forward is still considered accepted knowledge within environmental epistemic communities, especially those within the field of agroecology, the UNEP, and other big green actors such as Greenpeace and the Pesticide Action Network. However, the big green actors which were against DDT in the 1960s/70s are now for DDT use in malaria control, such as the Environmental Defense Fund (EDF) and the Sierra Club. *Silent Snow* can be seen as having served the function of supporting all of the presupposed accepted knowledge upon which the Stockholm Convention on Persistent Organic Pollutants is based on. *Silent Snow* began as an investigation into the use and production of DDT mainly from the perspectives of those directly affected by them, to later broaden out to an overall critique of why pesticides are, to a large extent, a self-created necessity. The point made by Carson about the 'endless spiral' of pesticide use was also discussed in *Silent Snow*. Rachel Carson had discussed how under certain environmental conditions, pesticides become necessary. From her biological standpoint, she emphasized how it is the lack of biodiversity in specifically agriculture and forestry which often creates the problems requiring stronger pesticides. However, Carson agreed that under conditions of poor sanitation and hygiene, coupled with the crowdedness of spaces inhabited by people living in poverty, insect-borne diseases bring about enormous challenges which do require control.

Roberts and Tren (2010) conceded the U.S. and many European countries were already benefiting from improvements in living standards such as sanitation and hygiene, which allowed for significant decreases in malaria incidence and mortality *before* DDT was implemented as the 'final step'. In the film '3 Billion and Counting', however, such details were not provided. It was instead presented as though it was DDT alone which enabled the United States to eliminate malaria. Both in *The Excellent Powder* as well as in '3 Billion and Counting', they blame the poverty on the disease rather than the conditions of poverty which enable the spread of disease to become out of control. Eradicating the disease is equated with eradicating poverty so to speak, and DDT is presented as the only means by which eradication – of both malaria and poverty – may be achieved. This is in opposition to the currently accepted knowledge of best practice within the international malaria control epistemic community today. That is, the need for so-called 'integrated vector management': to not rely on a single strategy, but a comprehensive, context-specific *integration* of complementary control strategies. There are very few researchers within the international malaria control epistemic communities which advocate using *only* indoor residual spraying (IRS) with DDT until eradication is achieved. The hindsight of the pilot projects in sub-Saharan Africa solely using IRS with DDT and the subsequent inability to overcome environmental and logistical factors leaves many to

consider the need for a range of measures in these kinds of settings. Most researchers tend to hold centrist-DDT views in such that DDT is seen as capable of being very effective at *temporarily* interrupting malaria transmission, while also accepting there is mounting evidence on its potential to inflict harm on humans, the environment, and wildlife. As well, that there is a general lack of studies which look at the health of communities who are exposed to DDT through IRS *right now*, while there is also an overreliance on public-health studies based out of North America and Europe.

Despite Roberts and Tren (2010) being so vehemently on the side of science, they argue that research into the potential of DDT harm is a waste of resources and should be stopped altogether. This is a rather anti-science, political position in itself, which is a state of being they spend their entire book criticizing. They wish to settle the debate on DDT and declare it a closed case. But this is not how science is meant to work. Information which has become accepted as knowledge is always subject to new data and new findings. Even the authors of a WHO position statement informed the risks which DDT poses to human health will be re-evaluated whenever there is 'significant new scientific information.' (WHO 2011:2). It would be easier to believe the authors of *The Excellent Powder* were truly in favour of scientific integrity if Richard Tren and Roger Bate were not active members of the Competitive Enterprise Institute (CEI). The CEI is, according to SourceWatch.org, an institute which claims to advocate 'sound science' to inform public policy. while having a history of disseminating disinformation on the safety of tobacco and having more recently been involved in distorting scientific studies in order to spread denial about climate change.

When people are told by influential symbolic elites within the discourse, *this* is the *real science*, while *that* science is *junk science*, it becomes a matter of choosing who to believe rather than examining the issues themselves. When a great deal of argumentation is spent on convincing consumers of discourse that the other contributions to the discourse are faulty or unscientific, it can make them more susceptible to believing their claims are based on the 'real' science. Roberts and Tren's (2010) rhetorical strategies were clearly aimed at convincing U.S. citizens DDT had made America prosperous, and now Americans were denying the poorest populations of the world that same prosperity. A combination of morality and fear was used, stating Americans bear the responsibility to be leading the way for other countries abroad in deciding on their public health policies, while also warning for the possibility of a resurgence of malaria 'at home' if changes in domestic policy were not made. '3 Billion and Counting' had employed the same combination of morality and fear, as well as a vilification of environmental epistemic communities which would accept everything put forth in *Silent Spring* and *Silent Snow* as knowledge. Given the strategies of persuasion used by these symbolic elites of the anti- and pro-DDT sides competing for space within the discourse, there does not seem to be much room left for any sort of reconciliation between the

epistemic communities which would be receptive to one or the other.

6.3 Concluding remarks

This thesis has attempted to deconstruct the symbolic elite discourse on the safety and viability of indoor residual spraying (IRS) with DDT for combating malaria in Africa. It has done so by putting the competing claims into context with a systematic review of academic literature surrounding the use of DDT for IRS, from various fields of research. Meaning, trying to situate where knowledge was being taken from and in what manner claims to knowledge were being used by symbolic elites who stand to produce and steer the discourse on using DDT for malaria control.

It has found more nuanced or centrist views on using DDT for malaria prevention within the academic literature than within the symbolic elite discourse. The researchers who hold more nuanced or centrist positions on using DDT for malaria control tend to acknowledge its capacity to simultaneously prevent and cause harmful effects. Contrarily, the dissonant claims of symbolic elites competing for space within the discourse would either acknowledge the first or the latter, never both. The strategies of persuasion used to present these claims in a few influential works which represent the anti- and pro-DDT sides of the discourse were analyzed by practicing some of the core assumptions behind political ecology and critical discourse analysis (CDA). It found in the pro-DDT works (*The Excellent Powder* and *3 Billion and Counting*) a description of the banning of DDT as an unrecognized genocide in history. Malaria was presented as a root cause of poverty, rather than as a symptom. They also presented the anti-DDT side as being anti-science, fearmongering environmental propaganda, while at the same time calling for an end to allocating resources towards researching the effects of DDT. The anti-DDT works (*Silent Spring* and *Silent Snow*) presented a world wherein unknown chemicals - of unknown origin and unknown potential to cause harm - are circulating throughout environmental and atmospheric pathways. Both of these opposing sides competing for space within the discourse make claims to holding the truth about DDT safety. The strategies employed were convincing enough to render the exploitation of less-informed consumers of the discourse relatively easy. If anything, to carry out this study has only made it more difficult to know which of these representations ought to be accepted as knowledge and which as misinformation, disinformation, or unequivocally propaganda. Questions surrounding whether DDT is misunderstood or misrepresented should therefore continue to be asked, across disciplines and epistemic communities. Given the context of increasing use of DDT for combating malaria in Africa, the field of development studies also ought to continue pursuing these questions.

Wordcount: 19 384

References

- Ahrens, R. & Weber, C. (2009) DDT and the Stockholm Convention: states on the edge of non-compliance. Hamburg, Germany: Pesticide Action Network Germany. 1-38.
- Alonso PL., Brown G., Arevalo-Herrera M., Binka F., Chitnis C. et al. (2011) A Research Agenda to Underpin Malaria Eradication. *PLoS Medicine*, 8(1): 31000406.
- Baird, K. J. (2000) Resurgent Malaria at the Millennium: Control Strategies in Crisis. *Drugs*, 59(4): 719-743.
- Barnhoorn, I.E.J.; Bornman, M.S.; Rensburg C.J. Van; Bouwman, H. (2009) DDT residues in water, sediment, domestic and indigenous biota from a currently DDT-sprayed area. *Chemosphere*, 77: 1236-1241.
- Battu, R.S.; Singh, P.P.; Joia, B.S.; Kalra, R.L. (1989) CONTAMINATION OF STORED FOOD AND FEED COMMODITIES FROM INDOOR USE OF HCH AND DDT IN MALARIA CONTROL PROGRAMMES. *The Science of the Total Environment*, 78: 173-78.
- Bornman, R.; Jager, C. De; Worku, Z.; Farias, P.; Reif, S. (2009) DDT and urogenital malformations in newborn boys in a malarial area. *BJU International*, 106: 405-11.
- Bouwman, H.; Bornman, R.; van Dyk, C.; Barnhoorn, I. (2015) First report of the concentrations and implications of DDT residues in chicken eggs from a malaria-controlled area. *Chemosphere*, 137: 174-77.
- Bouwman, H.; Kylin, H.; Sereda, B.; Bornman, R. (2012) High levels of DDT in breast milk: Intake, risk, lactation duration, and involvement of gender. *Environmental Pollution*, 170: 63-70.
- Bouwman, H.; van den Berg, H.; Kylin, H. (2011) DDT and Malaria Prevention: Addressing the Paradox. *Journal of Environmental Health Perspectives*, 119(6): 744-747.
- Bouwman, H. & Kylin, H. (2009) Malaria Control Insecticide Residues in Breast Milk: The Need to Consider Infant Health Risks. *Environmental Health Perspectives*, 117(10): 1477-80.
- Bouwman, H.; Sereda, B.; Meinhardt, H.M. (2006) Simultaneous presence of DDT and pyrethroid residues in human breast milk from a malaria endemic area in South Africa. *Environmental Pollution*, 144(3): 902-17.
- Bouwman, H. (2004) South Africa and the Stockholm convention on persistent organic pollutants. *SA. J. Sci.*, 100: 323–328.
- Bouwman, H., Becker, P.J., Cooppan, R.M., Reinecke, A.J. (1992) Transfer of DDT used in malaria control to infants via breast milk. *Bulletin of the World Health Organization* 70, 241-250.
- Brooke, B.; Robertson, L.; Kaiser, M.; Raswiswi, E.; Munhenga, G. (2015) Insecticide resistance in the malaria vector *Anopheles arabiensis* in Mamfene, KwaZulu-Natal. *South African Journal*

of Science, 111(11/12): 190-2.

- Bryman, A. (2012) *Social research methods*. 4. ed. Oxford: Oxford University Press
- Camenzuli, L.; Scheringer, M.; Hungerbühler, K. (2016) Local organochlorine pesticide concentrations in soil put into a global perspective. *Environmental Pollution*, 217: 11-18.
- Carson, R. (2002). *Silent spring*. Fortieth anniversary edition Boston: Houghton Mifflin Co.
- Casimiro, S. L.R.; Hemingway, J.; Sharp, B.; Coleman, M. (2007) Monitoring the operational impact of insecticide usage for malaria control on *Anopheles funestus* from Mozambique. *Malaria Journal*, 6: 142.
- Chanda, E.; Hemingway, J.; Kleinschmidt, I.; Rehman, A.; Ramdeen, V. et al (2011) Insecticide Resistance and the Future of Malaria Control in Zambia. *PLoS ONE*, 6(9): e24336.
- Chandre F.; Darriet F.; Duchon S.; Finot L.; Manguin S.; Carnevale P.; et al. (2000) Modifications of pyrethroid effects associated with kdr mutation in *Anopheles gambiae*. *Med Vet Entomol*, 14(8):1-88.
- Channa, K.; Röllin, H.B.; Nøst, T.H.; Odland, J.Ø.; Sandanger, T.M. (2012) Prenatal exposure to DDT in malaria endemic region following indoor residual spraying and in non-malaria coastal regions of South Africa. *Science of the Total Environment*, 429: 183-90.
- Cisse, M.; Keita, C.; Dicko, A.; Dengela, D.; Coleman, J. et al. (2015) Characterizing the insecticide resistance of *Anopheles gambiae* in Mali. *Malaria Journal*, 14:327.
- Conteh, L.; Sharp, B.; Streat, E.; Barreto, A.; Konar, S. (2004) The cost and cost-effectiveness of malaria vector control by residual insecticide house-spraying in southern Mozambique: a rural and urban analysis. *Tropical Medicine and International Health*, 9(1): 125-32.
- Diabaté, A.; Bilgo, E.; Dabiré, R.K.; Tripet, F. (2013) Environmentally friendly tool to control mosquito populations without risk of insecticide resistance: the Lehmann's funnel entry trap. *Malaria Journal*, 12: 196.
- Elango, G.; Zahir, A.A.; Bagavan, A.; Kamaraj, C.; Rajakumar, G. et al. (2011) Efficacy of indigenous plant extracts on the malaria vector *Anopheles subpictus* Grassi (Diptera: Culicidae). *Indian J Med Res*, 134: 375-83.
- Enayati, A. & Hemingway, J. (2010) Malaria Management: Past, Present, and Future. *Annual Review of Entomology*, 55: 569-91.
- Eskenazi, B.; Chevrier, J.; Goldman Rosas, L.; Anderson, H.; Bornman, M. et al (2009) The Pine River Statement: Human Health Consequences of DDT Use. *Environmental Health Perspectives*, 117(9): 1359-67.
- Feachem, R. & Sabot, O. (2008) A new global malaria eradication strategy. *Lancet*, 371: 1633- 35.
- Fillinger, U. & Lindsay, S. W. (2011) Larval source management for malaria control in Africa: myths and reality. *Malaria Journal*, 10: 353.
- Fillinger, U.; Kannady, K.; William G.; Vanek, M.J., Dongus, S., Nyika, D., et al. (2008) A tool box for operational mosquito larval control: preliminary results and early lessons from the Urban

Malaria Control Programme in Dar es Salaam, Tanzania.. *Malar J* 7(20): 7-20.

- Gaspar, F. W.; Chevrier, J.; Bornman, R.; Crause, M.; Obida, M. et al. (2015) Undisturbed dust as a metric of long-term indoor insecticide exposure: Residential DDT contamination from indoor residual spraying and its association with serum levels in the VHEMBE cohort. *Environmental International*, 85: 163-7.
- Gevao, B. et al. ed., (2010) Persistent Organic Pollutants in the Developing World. In: *Persistent Organic Pollutants*. West Sussex: Blackwell Publishing Ltd. pp.137-69.
- Goodman, C.; Mnzava, A.E.P.; Dlamini, S.S.; Sharp, B.L.; Mthembu, D.J. & Gumede, J.K. (2001) Comparison of the cost and cost-effectiveness of insecticide-treated bednets and residual house-spraying in KwaZulu-Natal, South Africa. *Tropical Medicine and International Health*, 6: 280–295.
- Grieco, J. P.; Achee, N. L.; Chareonviriyayhap, T.; Suwonkerd, W.; Chauhan, K. Sardelis, M. R.; Roberts, D. (2007) A New Classification System for the Actions of IRS Chemicals Traditionally Used For Malaria Control. *PLoS ONE*, 8: e716.
- Guyatt, H.L.; Kinnear, J.; Burini, M. & Snow, R.W. (2002) A comparative cost analysis of insecticide-treated nets and indoor residual spraying in highland Kenya. *Health Policy and Planning*, 17: 144–153.
- Hamusse, S. D.; Balcha, T. T.; Belachew, T. (2012) The impact of indoor residual spraying on malaria incidence in East Shoa Zone, Ethiopia. *Global Health Action*, 5: 11619.
- Hardin, G. (1974) Lifeboat Ethics: the Case Against Helping the Poor. *Psychology Today*, 8: 38–43.
- Hayes jr., W. J. (1971) THE DEGREE OF HAZARD TO MAN OF DDT AS USED AGAINST MALARIA. WHO Library: a 66009.
- Hemingway, J.; Shretta, R.; Wells, T. N. C.; Bell, D.; Djimdé, A.A.; Achee, N. Qi, G. (2016) Tools and Strategies for Malaria Control and Elimination: What Do We Need to Achieve a Grand Convergence in Malaria? *PloS Biol.*, 14(3): e1002380.
- Hemingway, J. (2014) The role of vector control in stopping the transmission of malaria: threats and opportunities. *Phil. Trans. R. Soc. B* 396: 20130431.
- Henry M.C.; Assi S.B.; Rogier C.; Dossou-Yovo J.; Chandre F.; Guillet P.; et al. (2005) Protective efficacy of lambda-cyhalothrin treated nets in *Anopheles gambiae* pyrethroid resistance areas of Cote d'Ivoire. *Am J Trop Med Hyg*, 73: 859–864.
- Herrera-Portugal, C.; Ochoa, H.; Franco-Sánchez, G.; Yáñez, L. Díaz-Barriga, F. (2005) Environmental pathways of exposure to DDT for children living in a malarious area of Chiapas, Mexico. *Environmental Research*, 99: 158-63.
- Hinojosa-Garro, D.; Burgos Chan, A.M.; Rendón-von Osten, J. (2016) Organochlorine Pesticides (OCPs) in Sediment and Fish of Two Tropical Water Bodies Under Different Land Use. *Bull Environ Contam Toxicol*, 97: 105-11.
- Hlongwana, K. W.; Mavundza, E. J.; Mohapi, E. P.; Kruger, P.; Urbach, J. et al (2013) Vector-

- control personnel's knowledge, perceptions and practices towards insecticides used for indoor residual spraying in Limpopo Province, South Africa. *Parasites & Vectors*, 6:118.
- Kelly-Hope, L.; Ranson, H.; Hemingway, J. (2008) Lessons from the past: managing insecticide resistance in malaria control and eradication programmes. *Lancet Infect Dis*, 8: 387-89.
- Kolaczinski, K.; Kolaczinski J.; Kilian, A.; Meek S. (2007) Extension of indoor residual spraying for malaria control into high transmission settings in Africa. *Transactions of the Royal Society of Tropical Medicine and Hygiene*, 101: 852-853.
- Lacey L.A. (2007) *Bacillus thuringiensis* serovariety *israelensis* and *Bacillus sphaericus* for mosquito control. *J Am Mosq Control Assoc*, 23(suppl 2): 133–163.
- David Long/Lake Sumter State College (2013) *Essay - Documentary Film Analysis*. [ONLINE] http://www.lssc.edu/faculty/david_long/Documents%20%20Downloads/SYG2010%20-%20Social%20Problems/Assignments/Essay%20-%20Documentary%20Film%20Analysis%20-%202013SP.pdf [Accessed 12 April 2017].
- Mabaso, M. L.H.; Sharp, B.; Lengeler, C. (2004) Historical review of malarial control in southern African with emphasis on the use of indoor residual house-spraying. *Tropical Medicine and International Health*, 9(8): 846-56.
- Martinez-Alier, J. (2002) *The environmentalism of the poor: a study of ecological conflicts and valuation*. Cheltenham: Edward Elgar.
- Munguambe, K.; Pool, R.; Montgomery, C.; Bavo, C.; Nhacolo, A. et al. (2011) What drives community adherence to indoor residual spraying (IRS) against malaria in Manhiça district, rural Mozambique: a qualitative study. *Malaria Journal*, 10: 344.
- Murray, C. J.L.; Rosenfeld, L. C.; Lim, S S.; Andrews, K. G.; Foreman, K. J. (2012) Global malaria mortality between 1980 and 2010: a systematic analysis. *The Lancet*, 379: 413–31.
- Nájera, J.; González-Silva, M.; Alonso, P. (2011) Some Lessons for the Future from the Global Malaria Eradication Programme (1955-1969). *PloS Medicine*, 8(1): e1000412.
- N'Guessan R.; Corbel V.; Akogbéto M.; Rowland M. (2007) Reduced efficacy of insecticide-treated nets and indoor residual spraying for malaria control in pyrethroid resistance area, Benin. *Emerg Infect Dis*, 13:199–206
- Niang, A. E.H.; Konaté, L.; Diallo, M.; Faye, O.; Dia, I. (2016) Patterns of insecticide resistance and knock down resistance (kdr) in malaria vectors *An. arabiensis*, *An. coluzzii* and *An. gambiae* from sympatric areas in Senegal. *Parasites & Vectors*, 9: 71.
- Nixon, R. (2011) *Slow violence and the environmentalism of the poor [Elektronisk resurs]*. Cambridge, Mass.: Harvard University Press.
- Okumu, F.O.; Knols, B. G.J.; Fillinger, U. (2007) Larvicidal effects of a neem (*Azadirachta indica*) oil formulation on the malaria vector *Anopheles gambiae*. *Malar J*, 6(63): 6-63.
- Pedercini, M.; Movilla Blanco, S.; Kopainsky, B. (2011) Application of the Malaria Management

- Model to the Analysis of Costs and Benefits of DDT versus Non-DDT Malaria Control. *PloS ONE*, 6(11): e27771.
- Potter, J. (2004). 'Discourse Analysis', in M. Hardy and A. Bryman (eds), *Handbook of Data Analysis*. London: Sage
- Ratcliffe, D A. (1967) Decrease in eggshell weight in certain birds of prey. *Nature*, 215: 208–210.
- Robbins, P. (2012) *Political Ecology: A Critical Introduction*. 2nd ed. Chichester, U.K.: Wiley.
- Roberts, D. & Tren, R. (2010) *The Excellent Powder: DDT's Political and Scientific History*. Indianapolis, IN: Dog Ear Publishing.
- Röllin, H.B.; Sandanger, T.M.; Hansen, L; Channa, K; , Odland, J.Ø. (2009) Concentration of selected persistent organic pollutants in blood from delivering women in South Africa. *Science of the Total Environment*, 408: 146-52.
- Sachs, Jeffrey (2005). *The end of poverty: how we can make it happen in our lifetime*. London: Penguin
- Sadasivaiah, S.; Tozan, Y.; Breman, J. G. (2007) Dichlorodiphenyltrichloroethane (DDT) for Indoor Residual Spraying in Africa: How Can It Be Used for Malaria Control? *Am. J. Trop. Med. Hyg.*, 77: 249–63.
- Savage, E.P.; Keefe, T.J.; Tessari, J.D.; Wheeler, H.W.; Applehans, F.M.; Goes, E.A.; Ford, S.A. (1981) National study of chlorinated hydrocarbon insecticide residues in human milk, USA. *American Journal of Epidemiology* 113, 413-422.
- Seyoum A.; Killeen, G.F.; Kabiru, E.W.; Knols, B. G.J.; Hassanali, A. (2003) Field efficacy of thermally expelled or live potted repellent plants against African malaria vectors in western Kenya. *Trop Med Int Health*, 8: 1005–1011.
- Sibanda, M. M.; Focke, W. W.; Labuschagne, F. J.W.J.; Moyo, L.; Nhlapo N. S. et al. (2011) Degradation of insecticides used for indoor spraying in malaria control and possible solutions. *Malaria Journal*, 10: 307.
- Silent Snow: The Invisible Poisoning of the World* (2011) [video] Netherlands: drsFILM. Accessed on Vimeo.
- Singh, P.P.; Udeaan, A.S.; Battu, S. (1992) DDT and HCH residues in indoor air arising from their use in malaria control programmes. *Sci Total Environ*, 116(1-2): 83–92.
- Spindler M. (1983) DDT: Health aspects in relation to man and risk/benefit assessment based thereupon. In: Gunther F.A., Gunther J.D. (eds) *Residue Reviews*. Residue Reviews, vol 90. Springer, New York, NY
- Talisuna, A.; Noor, A. M.; Okui, A.; Snow, R. (2015) The past, present and future use of epidemiological intelligence to plan malaria vector control and parasite prevention in Uganda. *Malaria Journal*, 14: 158.
- Tangena, J-A. A.; Adiamoh, M.; D'Allessandro, U.; Jarju, L.; Jawara, M. (2013) Alternative

- Treatments for Indoor Residual Spraying for Malaria Control in a Village with Pyrethroid- and DDT Resistant Vectors in The Gambia. *PLoS ONE*, 8(9): e74351.
- Tisgratog, R.; Sanguanpong, U.; Grieco, J.P.; Ngoen-Kluan, R.; Chareonviriphap, T. (2016) Plants traditionally used as mosquito repellents and the implication for their use in vector control. *Acta Tropica*, 157: 136-144.
- Van den Berg, H. (2009) Global Status of DDT and Its Alternatives for Use in Vector Control to Prevent Disease. *Environmental Health Perspectives*, 117(11): 1656-1663.
- Van Dyk, J.C.; Bouwman, H. Barnhoorn, I.E.J., Bornman, M.S. (2010) DDT contamination from indoor residual spraying for malaria control. *Science of the Total Environment*, 408: 2745-2752.
- Vieira, E. D.R.; Torres, J. P.M.; Malm, O. (2001) DDT Environmental Persistence from its Use in a Vector Control Program: A Case Study. *Environmental Research Section A*, 86: 174-82.
- Walker, K.; Lynch, M. (2007) Contributions of Anopheles larval control to malaria suppression in tropical Africa: review of achievements and potential. *Med Vet Entomol*, 21: 2–21.
- Walker, K. (2000) Cost-comparison of DDT and alternative insecticides for malaria control. *Medical and Veterinary Entomology*, 14: 345-54.
- Wanjala, C.; Mbugi, J; Ototo, E.; Gesuge, M.; Afrane, Y.A. et al. (2015) Pyrethroid and DDT Resistance and Organophosphate Susceptibility among Anopheles spp. Mosquitoes, Western Kenya. *Emerging Infectious Diseases*, 12(12): 2178-81.
- Webb Jr., J L. A. (2011) The First Large-Scale Use of Synthetic Insecticide for Malaria Control in Tropical Africa: Lessons from Liberia, 1945-1962. *Journal of the History of Medicine and Allied Sciences*, 66(3): 347-76.
- World Health Organization (2016) Eliminating Malaria. WHO/HTM/GMP/2016.3.
- World Health Organization (2012) Global Plan for Insecticide Resistance Management in Malaria Vectors. WHO Library Cataloguing-in-Publication Data, Geneva. Date published: 15/05/2012. Date accessed: 08/04/2017.
- World Health Organization (2011) The use of DDT in malaria vector control: WHO position statement. Global Malaria Programme. WHO/HTM/GMP/2011
- World Health Organization (2006) 'WHO gives indoor use of DDT a clean bill of health for controlling malaria'. Online press release. Date published: 16/09/2006. Date accessed: 27/11/2016.
- World Health Organization (1971) The place of DDT in operations against malaria and other vector-borne diseases. Official Records of World Health Organization, Geneva, No. 190, App. 14, pp. 176-182.
- Yukich, J.O.; Lengeler, C.; Tediosi, F.; Brown, N.; Mulligan, J.A.; Chavasse, D.; et al. (2008) Costs and consequences of large-scale vector control for malaria. *Malar J*, 7: 258.

3 Billion and Counting: The Death Toll is Mounting... (2010) [video] United States: Frogbite Productions. Accessed on Vimeo.