



## **AFRICA FIGHTING MALARIA BULLETIN #4**

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### **DDT, Malaria Control and Anti-Chemicals Advocacy: A Response to the 'Pine River Statement'**

In May 2009, Environmental Health Perspectives (EHP) published The Pine River Statement: Human Health Consequences of DDT Use.<sup>1</sup> This Statement, authored by 15 scientists from the US and South Africa, summarizes information on the health risks of DDT use and makes recommendations for public health policy. Africa Fighting Malaria (AFM) believes that robust, evidence-based discussion and debate over the role of DDT and other man-made chemicals in malaria control is helpful, especially if such debate could help focus attention on the long-term lack of investment in the search for legitimate replacement chemicals for DDT. However, the Pine River Statement is unlikely to help in this endeavor. History has taught us that the EHP publication will be heavily misused and misinterpreted by UN organizations, public health authorities and by the general public. This paper attempts to put the EHP Statement and the resulting announcements from the United Nations Environment Program (UNEP) and the World Health Organization (WHO) into perspective and calls for a more balanced approach to malaria control that does not embrace the bias of an anti-chemicals agenda.

#### **DDT and Malaria Control**

DDT was first used in public health during World War II when it was widely used in both the European and Pacific theaters of war to control lice-spread typhus as well as other insect-borne diseases. The first major applications of DDT against malaria took place after WWII and with remarkable outcomes. To control malaria, DDT was primarily used in indoor residual spraying (IRS) programs. IRS involves spraying small amounts of insecticide on the inside walls of houses. IRS is effective where *Anopheles* mosquitoes enter houses in search of a blood meal from humans. The insecticides used in IRS can act in several ways. First, they can act as a spatial repellent, keeping mosquitoes out of houses, thereby working rather like a chemical screen. (Spatial repellency is the primary mode of action of DDT. This action has been observed, studied and published in the scientific literature from 1945 onwards). DDT is the only insecticide recommended for IRS that works as a spatial repellent compound. Insecticides can also act as a contact irritant, causing mosquitoes to exit houses sooner than they otherwise would. Lastly, insecticides can act as a toxicant, killing mosquitoes as they land on sprayed surfaces. IRS has been used in malaria control for many decades and is recognized as the most effective method of reducing man-vector contact and thereby halting disease transmission. A great advantage of IRS over other community-based approaches to malaria control is that once the insecticide is sprayed on the walls, no additional work by residents is needed for it to be effective.

DDT was used for IRS in Guyana in mid-1946 to control malaria. Malaria rates were 37% and 27% in rural and urban areas respectively and the death rate of newborns was 126 per 1000. The

health statistics from 1948 and 1949 showed that as a result of the spraying operation alone, infant mortality fell by 39% and in urban areas malaria infections declined by 96%. Between 1946 and 1950 malaria infections declined by 96% in highly endemic rural areas.<sup>2</sup> In South Africa DDT was similarly introduced in 1946, and in the Transvaal province malaria cases fell from 1,177 (1945-46) to just 61 by 1951.<sup>3</sup> In India the impact of DDT was far more spectacular. The WHO estimates that India had over one million cases of malaria in 1935; this number was reduced to 286,962 by 1969, thanks to IRS with DDT.<sup>4</sup> In Sri Lanka, when DDT was introduced in 1946, the number of cases fell from 2.8 million to just 110 by 1961.<sup>5</sup> DDT was also shown to have led to dramatic reductions in malaria cases in Uganda during pilot programs of the late 1950s and early 1960s. In the Kigezi district of Uganda, parasite prevalence rates were reduced in areas of intense seasonal transmission from 22.7% to just 0.5% in only 10 months.<sup>6</sup> Parasite prevalence was reduced in areas of less intense transmission from 12.5% to 0% over the same period.

There can be no disputing the remarkable impact that DDT has made, and continues to make, in disease control programs around the world. The remarkable degree to which DDT saved lives and allowed communities to grow and prosper resulted in some of the most significant campaigns against DDT use. While many people recognize environmental campaigners, such as Rachel Carson, as outspoken in their criticism of DDT because of potential environmental harm, campaigners against population growth were equally outspoken and arguably more sinister in attacking DDT. Paul Ehrlich, author of *The Population Bomb* and one of the founders of the Zero Population Growth movement, cautioned against the use of DDT as a method of ‘death control.’<sup>7</sup> While Ehrlich campaigned against DDT as a tool to save lives he, like Rachel Carson and other anti-DDT activists, was quick to use fear tactics as well. He wrote that “Individuals born since 1945, and thus exposed to DDT since before birth, may well have shorter life expectancies...” As it is, those born after 1945 are on track for greatly lengthened life spans.

AFM believes the Pine River Statement is in keeping with the long history of making claims that are not fully supported by scientific evidence, but which cause fear and concern among the general population, particularly those affected by malaria. Broadly, the concerns that DDT may be harmful to human health are not supported by any meaningful data on deaths or diseases as a consequence of DDT exposures, and are further contradicted by evidence over many decades of reduced disease and rising populations wherever the chemical has been used.

### **DDT and Human Health**

The Pine River Statement lists an impressive number of claims of associations between human health harm and DDT. That there are several studies from which to draw is not surprising; DDT is one of the most studied man-made chemicals in history. Indeed, the ready availability of funding for such studies contrasts sharply with a long history of an almost total lack of funding for research on chemical approaches to disease control, or research to find an alternative chemical that might be used in place of DDT in public health.

Decades ago, epidemiologists began struggling with the issue of how to prove or disprove a cause-effect relationship. Certain criteria are broadly accepted as standards of proof, and epidemiological studies are broadly accepted as the gold standard for defining a cause and effect

relationship. There are three criteria that comprise the core requirements: strength of association, biologic credibility, and consistency with other investigations. Two other important criteria, although sometimes considered weaker criteria, are: time sequence and a proportional dose-response relationship.

No claim of DDT harm, as listed in the Pine River Statement, can meet the standards of proof of even the first three criteria, let alone the full complement of all five criteria. Each of the individual claims fails on multiple elements of epidemiological criteria. Indeed, their claims uniformly fail the criterion of consistency alone.

The Pine River Statement discusses DDT and human health with respect to cancer, diabetes, fetal development, lactation, child growth, reproductive effects and neurodevelopmental effects. Some of these studies are briefly discussed below. By focusing their coverage only on recent research, they discretely avoid many past studies that produced results that were not consistent with recent findings.

As the Statement points out, humans are exposed to DDT in malaria control, and people living in houses that have been sprayed with DDT tend to have higher levels of DDT and its metabolite DDE in their serum and breast milk. The mere presence of elevated levels of DDT and DDE does not however equate with any actual human health harm. When such harm has been researched, the results have been negative; in other words, the DDT caused no actual harm.<sup>8</sup>

The associations between DDT/DDE and human health harm discussed in the Statement are almost uniformly weak or have not been replicated in scientific studies. Evidence of associations between DDT and cancer in humans is weak and for this reason the chemical is still classified by the International Agency for Research on Cancer as a possible human carcinogen.<sup>9</sup> Numerous other chemicals found in everyday foods such as bread, orange juice and coffee also share this classification. Despite decades of research and numerous studies, there is little or no evidence that DDT is a cause of cancer in humans. For instance, despite many studies over many years, no significant association that is consistent across studies has been found between non-Hodgkin's lymphoma and DDT exposure.

The Statement describes several studies that find associations between DDT and diabetes; however, the studies do not differentiate between DDT and other persistent organic pollutants (POPs). Furthermore, the Statement does not attempt to put this association into a wider context, such as the significance of POPs versus diet and lifestyle choices in the development of diabetes. Additionally, there is often no consideration of disease affecting lipid mobilization or reducing DDT catabolism in ways that influences distribution of DDT/DDE residues opposed to DDT as cause of disease.

There is little evidence of DDT causing pregnancy loss or decreased gestational length and birth weight. Evidence of reduced lactation caused by DDT/DDE is similarly weak and according to the Statement, "associations between DDE levels and early weaning may be spurious and further research is necessary."

The Statement reports on suggestions that there may be associations between urogenital birth

defects and DDT/DDE, however the odds ratios in most of the studies are close to one, meaning no association. Only one study reported more than a doubling of the odds of cryptorchidism (the absence of one or both testes) and/or hypospadias (an unusually placed urinary opening),<sup>10</sup> however other studies find no significant association between DDT, DDE and urogenital birth defects. Furthermore, it should be noted that a Scandinavian study found that maternal alcohol consumption increases the risk of congenital cryptorchidism in boys (OR = 3.10, 95% CI, 1.05-9.10).<sup>11</sup> The omission of this study and others like it is an example of how the Pine River Statement fails to place the potential human health risks of DDT into context. Additionally, none of the claims can be shown to comprise a disease that increased with advent of DDT use and subsequently declined after DDT exposures were eliminated. Furthermore, any claim that exposure did not end because residues in humans are still present is not acceptable. It is well documented that DDT residues in practically all media, to include human body fat, declined quickly after 1972.

As the Pine River Statement explains, “the evidence for the relation of maternal DDT exposure and child physical growth is weak.” The Statement reports on several conflicting studies that examine physical growth after birth and exposure to DDT. The studies presented were all conducted in non-malarial areas (US and Europe) and not in malarial areas where DDT is currently being used. The effects of malaria on child development are well known and documented, and in areas where DDT is used to interrupt transmission, improved health outcomes are routinely observed.

The Pine River Statement devotes several paragraphs to the possible impact of DDT/DDE on male fertility; however, the changes in sperm quality described are not statistically significant and tend to be within the WHO limits for sperm quality. In addition, one of the studies (Aneck-Hahn et al. 2007) found no reports of reduced fertility in the population studied.

Only a few studies have been conducted analyzing the relationship between DDT exposure and female reproduction, fertility and time to conception, and of those, most found weak or no associations.

Neurodevelopmental effects and DDT have been analyzed in the scientific literature for several years and some of these studies are reproduced in the Pine River Statement. Overall, there is limited and inconclusive evidence of significant impacts of DDT on child neurodevelopment. As with other studies, no attempts have been made to examine the difference between possible neurodevelopmental harm in children caused by DDT exposure, and the benefits of neurodevelopment in children as a result of decreased malaria incidence due to DDT spraying.

Overall, the Pine River Statement presents no new or compelling evidence that DDT or DDE are a cause of impaired human health. The many studies cited, and the many other studies not cited, in the Statement are often scientifically un-replicated or present statistically insignificant and weak correlations, or fail dismally the criterion of consistency across studies.

## Human Health & DDT Use for Malaria Control

As stated above, the public health benefits of DDT use are well known and widely documented in the scientific and popular literature. The Pine River Statement documents many studies that purport to find human health harm from exposure to DDT and despite the inconclusive nature and weakness of referenced studies, concludes that DDT use in IRS “may pose a risk for human populations.” This is not a new claim. It was recently made by Chen and Rogan in a paper that made mention of several categories of harm that are now classified as supported by weak evidence.<sup>12</sup> This repetitive process of claiming concern is reminiscent of the vocal and aggressive calls for DDT elimination as a result of the 1993 report that DDE caused breast cancer.<sup>13</sup> That association was eventually disproven; but not before the claim itself was heavily used by activists to lobby for a global DDT ban. It is an unshakable fact that during the many years of DDT use in the 1950s, 60s and 70s human health and life expectancies overall steadily improved. Specifically in areas where DDT was (and is) used in malaria control, human health improved.

DDT was used in malaria control in Sardinia between 1946 and 1950, contributing to the eradication of the disease from the island. Pierluigi Cocco, a scientist specializing in occupational medicine and epidemiology, and others studied reproductive outcomes during this period.<sup>14</sup> Cocco et al. found that,

“..stillbirth rate, infant mortality rate, and male/female ratio in newborns were apparently unaffected following widespread but focused use of DDT in Sardinia, Italy.”

The authors concluded:

“..we speculate that predictive models of the reproductive outcomes in relation to DDT use for malaria control should include a likely side-effect of a successful anti-malarial program, such as the improvement in the maternal health status and nutrition.”

In other words, Cocco and others found that the public health benefits of DDT spraying outweighed any potential harm that could have been caused to reproductive health from DDT.

Studies in Sri Lanka found that after DDT was used to control malaria in 21 districts, malaria deaths declined sharply but premature births increased slightly. The increase in premature births was greater in areas that had less malaria and as a consequence, less DDT spraying. Any increase in deaths attributable to premature birth was far outweighed by the many lives saved from malaria and malaria-related illnesses.<sup>15</sup> In Guyana after 2 to 3 years of IRS with DDT, infant deaths fell by 39% and anemia associated deaths in pregnant women fell from 10 to 2.3 per 1000. Overall health improvements related to DDT use accounted for 21% to 56% of increased population growth.<sup>16</sup>

Overall these historic improvements in human health and growing populations, as a result of DDT use in malaria control, should inform debate and current policy formulation.

## UN Malaria Control Policies

In September 2006, the WHO's Global Malaria Program announced its firm support for the use of DDT in IRS programs and indeed called for an expansion of such efforts.<sup>17</sup> Prior to the WHO announcement, the US President's Malaria Initiative (PMI) began actively supporting IRS programs and procuring DDT for those countries that sought to use it, a policy which stands to this day.<sup>18</sup> Either with US Government support or through domestically funded programs, around a dozen countries currently conduct IRS programs with DDT. The September 2006 decision of the WHO, the PMI policies, and those policies developed over many years by malaria control programs, are based on the historic and contemporary evidence that DDT is a remarkably effective and safe public health insecticide.

Yet in an apparent reversal, the WHO recently announced that in line with a "goal of reducing reliance on DDT in disease vector control"<sup>19</sup> it would work with UNEP and the Global Environment Facility (GEF) to combat malaria using 'sustainable' (for which no definition is given) alternatives to DDT. Through these statements WHO in effect abdicates its role in formulating evidence-based public health policy and adopts an environmentalist agenda over the health interests of people living in malarial areas.

The Stockholm Convention on Persistent Organic Pollutants is designed to ban or restrict the use of certain chemicals. DDT is the only chemical governed by the Stockholm Convention that is still used in public health programs and therefore the Convention grants countries that seek to use the chemical an exemption for use. However, the Convention permits the use of DDT only where no safe, effective and affordable alternatives are available. Furthermore, Parties to the Convention committed themselves:

"within their capabilities, to promote research and development of safe alternative chemical and non-chemical products, methods and strategies for Parties using DDT, relevant to the conditions of those countries and with the goal of decreasing the human and economic burden of disease. Factors to be promoted when considering alternatives or combinations of alternatives shall include the human health risks and environmental implications of such alternatives. Viable alternatives to DDT shall pose less risk to human health and the environment, be suitable for disease control based on conditions in the Parties in question and be supported with monitoring data."<sup>20</sup>

The GEF, an international partnership of 178 countries, is the financial mechanism for the Stockholm Convention. It is charged with financing alternatives to DDT, however an analysis of GEF funding to the end of 2008 shows that this partnership had only actually provided \$37 million (0.5% of total grants provided) and secured a mere \$47 million (0.17% of total co-financing provided) in the search of alternatives to DDT.

The recent announcement that GEF will secure funding of a further \$40 million to find alternatives to DDT was welcomed by the WHO and substantially increases the funding in this regard. However, it is clear that total financing for a DDT replacement is woefully inadequate and has not been a priority of the GEF nor the Parties to the Stockholm Convention. Furthermore, the activities supported by the GEF exclude chemical alternatives and as such cannot be considered alternatives to DDT.

The WHO and UNEP will be managing GEF funded initiatives which will include “securing homes with mesh screens, deploying mosquito-repellent trees and fish that eat mosquito larvae.”<sup>21</sup> While this was reported in the media as a new initiative, in fact the WHO and World Health Assemblies have discussed such alternative methods of malaria control for many years. The 1979 WHO Expert Committee on Malaria report states:

“WHO is closely collaborating with the United Nations Environment Program in carrying out investigations on environmental methods of malaria control and has, jointly with FAO, reviewed proposals for integrated control of insects of both agricultural and public health importance for consideration by UNEP.”<sup>22</sup>

Despite a dearth of scientific evidence that environmental controls can effectively control malaria, WHO and UNEP continue to promote these methods and assert that they are engaging in innovative activities, which they are clearly not. UNEP’s plans include proposals to implement malaria control strategies that were conducted in Mexico in order to reduce reliance on DDT in that country. However, the Mexican malaria control program relied heavily on widespread pharmacosuppression with chloroquine as a means of malaria control. With high levels of chloroquine resistance in almost all other malarial areas, and poor health systems that would make delivery of such treatment logistically unfeasible, this is unlikely to be a reasonable or effective alternative to DDT. Furthermore, concerns about toxicity of chloroquine and consent of individuals to such a program would argue strongly against such an approach.

Few malaria scientists would argue against the development of alternatives to DDT. However, it is highly unlikely non-chemical alternatives to DDT will be effective given the ecology of malaria vectors, high levels of transmission, along with the low levels of development in most malarial countries, particularly those in sub-Saharan Africa. Furthermore, if a true alternative to DDT is to be found, WHO, UNEP and others should recognize DDT’s unique modes of action. As described by Grieco et al. and others, DDT acts primarily as a spatial repellent, then as a contact irritant, and lastly as a toxicant.<sup>23</sup>

## **Conclusion**

The Pine River Statement offers no new evidence that DDT is harmful to human health. The conclusion that DDT may pose a threat to human health is unreasonable given the lack of evidence of actual human harm, even when DDT was used in large quantities. There have been remarkable public health benefits achieved by using DDT in malaria control. The GEF funding of \$40 million to find non-chemical alternatives to DDT is unlikely to provide any country with a high burden of malaria with an effective means of controlling malaria. The WHO and its partners have formally investigated non-chemical methods of malaria control for at least three decades. These decades have been characterized by increasing advocacy against the use of man-made chemicals and a related increase in the transmission of malaria and malaria deaths. The promotion of such non-chemical methods of malaria control as ‘sustainable’, in effect only sustains disease transmission and an intolerably high burden of malaria in poor countries.

The WHO should support the ongoing use of DDT based on scientific evidence of continued effectiveness. The promotion of environmental management as an alternative to DDT

undermines malaria control and ultimately endangers the lives of millions of people at risk from the disease. Lastly, the WHO should formally recognize the modes of action of DDT (based on over six decades of published scientific evidence) and advocate for the development of true, chemical alternatives to DDT.

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<sup>1</sup> Eskinazi, B., Chevrier, J., Rosas, L.G., Anderson, H.A., Bornman, M.S., Bouwman, H., Chen, A., Cohn, B.A., De Jager, C., Henshel, D.S., Leipzig, F., Leipzig, J.S., Lorenz, E.C., Snedeker, S.M., Stapelton, D., “The Pine River Statement: Human Health Consequences of DDT Use.” *Environmental Health Perspectives*, doi: 10.1289/ehp.11748, May 4, 2009. Available: <http://www.ehponline.org/members/2009/11748/11748.pdf>

<sup>2</sup> Giglioli, G., “Changes in the Pattern of Mortality Following the Eradication of Hyperendemic Malaria From a Highly Susceptible Community.” *Bull World Health Organ*, 1972, 46(2):181-202.

<sup>3</sup> Mabaso, M., et al., “Historical review of malarial control policies in southern Africa with emphasis on the use of indoor residual house-spraying.” *Trop Med Int Health*, 2004, 9(8):846-856, (page 852).

<sup>4</sup> World Health Organization, Executive Board, 42<sup>nd</sup> Session, Appendix 14 “The Place of DDT in Operations Against Malaria and Other Vector-Borne Diseases.” 1971, WHO, Geneva, (page 178).

<sup>5</sup> Ibid.

<sup>6</sup> De Zulueta, J., et al., “The results of the first year of a malaria eradication pilot project in northern Kigezi (Uganda).” *E Afr Med J*, 1961, 38(1):1-26.

<sup>7</sup> The stance taken by Paul Ehrlich, Zero Population Growth and other population control activists against DDT could equally be applied to other synthetic, man-made products such as vaccines and medicines, which in the 20<sup>th</sup> Century were also responsible for saving millions of lives.

<sup>8</sup> Bouwman, H., et al., “Levels of DDT and metabolites in breast milk from Kwa-Zulu mothers after DDT application for malaria control.” *Bull World Health Organ*, 1990, 68:761-768.

<sup>9</sup> International Agency for Research on Cancer (IARC), “Overall Evaluations of Carcinogenicity to Humans. Group 2B, Possibly carcinogenic to humans.” Available: <http://monographs.iarc.fr/ENG/Classification/crthgr02blist.php>

<sup>10</sup> Fernandez, M.F., Olmos, B., Granada, A., Lopez-Espinosa, M.J., Molina-Molina, J.M., Fernandez, J.M., et al., “Human exposure to endocrine-disrupting chemicals and prenatal risk factors for cryptorchidism and hypospadias: a nested case-control study.” *Environmental Health Perspectives*, 2007, 115(Suppl 1):8-14.

<sup>11</sup> Damgaard, I.M., et al., “Cryptorchidism and maternal alcohol consumption during pregnancy.” *Environmental Health Perspectives*, 2007, 115(2): 272-7.

<sup>12</sup> Chen, A., Rogan, W., “Non malarial infant death and DDT use for malaria control.” *Emerg Infect Dis*, 2003, 9:960-4.

<sup>13</sup> Wolff, M.S., et al., “Blood levels of organochlorine residues and risk of breast cancer.” *J Natl Cancer Inst*, 1993, 85(8):648-52.

<sup>14</sup> Cocco, P., et al., “Reproductive outcomes following environmental exposure to DDT.” *Repro Tox*, 2006, 22:5-7.

<sup>15</sup> Roberts, D., et al., “Malaria Control and Public Health.” *Emerg Infect Dis*, 2004, 10(6):1170-1171.

<sup>16</sup> Ibid.

<sup>17</sup> World Health Organization, News Release, “WHO gives indoor use of DDT a clean bill of health for controlling malaria.” September 15, 2006, Geneva. Available: <http://www.who.int/mediacentre/news/releases/2006/pr50/en/>

<sup>18</sup> United States Agency for International Development (USAID), “Indoor Residual Spraying (IRS).” Available: [http://www.usaid.gov/our\\_work/global\\_health/id/malaria/techareas/irs.html](http://www.usaid.gov/our_work/global_health/id/malaria/techareas/irs.html)

<sup>19</sup> United Nations Environmental Programme (UNEP), Press Release, “A Big Step Forward towards a DDT-Free World.” May 6, 2009. Available: <http://www.unep.org/Documents.Multilingual/Default.asp?DocumentID=585&ArticleID=6148&l=en>

<sup>20</sup> Stockholm Convention on Persistent Organic Pollutants, Annex B, Part II, 5(b). Available: <http://chm.pops.int/>

<sup>21</sup> UN News Service, “UN agencies launch DDT-free anti-malaria initiative.” May 6, 2009. Available: <http://www.un.org/apps/news/printnews.asp?nid=30713>

<sup>22</sup> World Health Organization Expert Committee on Malaria, Seventeenth Report, WHO Technical Report Series 640, Geneva, 1979, (page 52).

<sup>23</sup> Grieco, J.P., et al., “A new classification system for the actions of IRS chemicals traditionally used for malaria control.” *PLoS One*, 2007, 2(8): e716. doi:10.1371/journal.pone.0000716.