Journal of Scientific Research & Reports

17(1): 1-13, 2017; Article no.JSRR.37452
ISSN: 2320-0227

Adaptation to the Effects of Climate Change on Health: Cost Implications for Ghana

A. Asuming Boakye[1*] and F. A. Asante[2]

[1]FOHCREC, College of Basic and Applied Sciences, University of Ghana, Ghana.
[2]Institute of Statistical, Social and Economic Research (ISSER), University of Ghana, Ghana.

Authors' contributions

This work was carried out in collaboration between both authors. Author AAB managed the analysis, wrote the protocol and conducted the literature searches. Author FAA wrote the concept note and designed the study. Both authors read and approved the final manuscript.

Article Information

DOI: 10.9734/JSRR/2017/37452
Editor(s):
(1) Viroj Wiwanitkit, Department of Laboratory Medicine, Faculty of Medicine, Chulalongkorn University, Bangkok, Thailand.
Reviewers:
(1) Dal Singh Kharat, India.
(2) Eric S. Hall, United States.
Complete Peer review History: http://www.sciencedomain.org/review-history/22030

Original Research Article

Received 17th October 2017
Accepted 14th November 2017
Published 23rd November 2017

ABSTRACT

This study estimates the additional investment that would be required by the Ghanaian government for adaptation to climate change in the health sector. The focus is on this sector because it is possibly the most important sector that has a direct impact on the Ghanaian population in the wake of climate change effects. The intention is to foster the debate on the cost of adaptation and the required additional investments. The estimates are based on the Methodology Guidebook for the Assessment of Investment and Financial Flows to address climate change designed by the UNFCC secretariat. The results show that Ghana would require about US$ 350 million by 2020 and US$ 352.54 million by 2050 in additional investment in the health sector. In the case of malaria, the country would require an additional investment of approximately US$ 7.6 million in 2020 and US$ 7.54 million in 2050. Recommendations include building the infrastructure for carbon markets in Ghana and provisioning financial incentives for firms that adhere to standards in limiting GHG emissions.

*Corresponding author: E-mail: aasumingboakye@ug.edu.gh;

Keywords: *UNFCC - United Nations Framework for Climate Change; IF - Investment Flows; FF –Financial Flows; IC - Incremental Cost; health; malaria; climate change.*

1. INTRODUCTION

The potential adverse effects of climate change on human health have been shown to be quite significant worldwide. A study by [1] concludes that climate change will affect rates of malnutrition, diarrhoea, malaria and death as a result of changing precipitation and high temperatures. Estimations by [2] indicate that 260-320 million people will be affected by malaria by 2080 as a result of both latitudinal and altitudinal expansion of the malaria belt. In Africa, indications are that about 170 million people will be at risk of malaria alone by 2030 [3]. The effects of climate change on health will be reflected by increases in temperature, climate change-induced natural disasters and scarcity of safe drinking water due to droughts. These will be major contributors to the spread of infectious and water-borne communicable diseases in Africa, malaria not excluded. The linkage between climate change and economic development has been identified as a priority for African economies, since there are many socioeconomic implications of climate adaptation as well as mitigation effects, if climate change is not adequately addressed. The [4] indicates that Africa's vulnerability to the effects of climate change will be more devastating than other regions, manifested by the estimated death attributed to climate change being between 60% and 80% higher than the next most vulnerable region – Southeast Asia.

In Ghana, climate change is being experienced through the rise in temperatures and unpredictable rainfall across all ecological zones [5,6] endangering economic activities and eventually leading to a decline in national revenue [7]. Currently, issues on climate change in Ghana have not received much attention. Available documents related to climate change show that efforts have been made to determine how much each sector in Ghana contributes to greenhouse gas(GHG) emissions in the country, but have not explicitly focused on how much Ghana needs in terms of financial investment in order to adapt to the expected adverse effects of climate change. For example, the [8] report on Ghana estimated the levels of GHG emissions in Ghana and enumerated some policies (which were not originally formulated towards climate change and its effects in Ghana) which were indirectly linked to climate change. Again, government budgetary statements have not factored the cost of adaptation or mitigation to the effects of climate change over the years. There is virtually no national project underway which seeks to incorporate climate change considerations into national policy. However, the effects of climate change cannot be ignored, indicating the need for government to plan for it. With climate change incorporated into national policy, the government will have to look into various financing options to meet the extra demand on the budget. The [4] report indicates that 'Adaptation investments have the potential to substantially reduce the hardship from climate change in Africa'.

In this analysis, we contend that efforts to adapt to the effects of climate change should not be seen as a scenario for the future, but must be considered an existing reality which demands urgent attention in Ghana. We attempt to estimate the additional investment that would be required by the government of Ghana in adaptation costs, with a focus on the health sector. We target this sector because itis arguably the most important sector that has a direct impact on the Ghanaian population in the wake of climate change effects. The cost of adaptation to the effects of climate change due to the rise in malaria cases, and the estimated financial investment in the whole Ghanaian health sector, has motivated this research project.

We distinguish three 'generations' of studies that have made attempts at estimating the costs of adaptation to climate change in Africa. While the estimations have been increasing in their sophistication, it is important to note that even the best studies have their deficiencies and produce estimates with large differences, in part due to the vast uncertainty inherent in making such predictions. This generates considerable uncertainty in the full range of estimates, between US$ 2 billion to US$ 60 billion per year for adaptation costs in Africa. Estimates by [9], concluded that Africa needed between US$ 2.1 and US$ 4 billion per year. This study was based on the first generation method of estimation developed by the World Bank. Owing to weaknesses in the first generation estimates, the World Bank's Economics of Adaptation to Climate Change (EACC) developed the second generation methods (which were viewed as more robust that the first generation estimates) of estimation, which provided an estimate of US$ 18 billion per year for Africa between 2010 and 2050 (based on *US$ 2005 prices*, and undiscounted). However, the second generation estimates were flawed in that they did not consider adaptation and development as occurring in tandem but separated them, and treated adaptation as an additional activity.

This criticism largely led to the development of the third generation of estimates, which have tried to include adaptation needs into the development challenges of African countries so that such estimates are robust enough to assist in reducing climate impacts to acceptable levels. For example, the [10] estimated that Africa might require between US$ 13 and 17 billion per year as of 2015, and potentially between US$ 21 and 27 billion by 2030. This study noted that 'the total adaptation costs in Africa might increase up to US 60 billion if Africa's infrastructure develops more quickly than projected in earlier studies. They explicitly included the costs of 'social adaptation' - dealing with existing problems of climate vulnerability in Africa. But the [4] criticizes the methodology used because they conclude that the 'Social Adaptation costs' such as protecting long-term livelihoods from the impacts of climate events through such actions as 'crisis-transfers', financial support for the poor in regions affected by climate events, and relocation initiatives for severely affected communities, are not well researched and are particularly difficult to estimate and disaggregate from other development measures.

The preceding section explains the difficulties in using methodologies that can accurately estimate the cost of adaptation. Again, these estimates have not disaggregated and applied the discrete adaptation costs to the various economic sectors in regional terms, or individual country terms, but have lumped all adaptation needs for Africa. In this study, we try to estimate how much it will cost Ghana (in financial terms) to adapt to the effects of climate change in the health sector as a whole, as well as for malaria, identified as a major disease with likely spikes in prevalence due to climate change. We use the United Nations Framework on Climate Change (UNFCC) methodology [11]. We use this methodology because it is considered a more robust method of assessment compared to the methods employed in the three generations enumerated above.

2. METHODOLOGY FOR ESTIMATION OF ADAPTATION COSTS FOR 2020 AND 2050

Our estimates are based on the 'Methodology Guidebook for the Assessment of Investment and Financial Flows' designed by the United Nations Framework for Climate Change (UNFCC) secretariat. It provides an assessment of the Investment Flows (IF) and Financial Flows (FF) that will be necessary from the present time to 2020 and 2050 in order to meet worldwide requirements for mitigating and adapting to climate change under different scenarios of social and economic development, especially as they impact the well-being of Ghanaians. The processes leading to these estimations must be treated with caution because: adaptation will be widespread and heterogeneous; and the amount of adaptation investment needed will depend on the magnitude and the nature of climate change. Relevant investment and financial flows are projected for selected scenarios – Business as Usual (BAU) and Climate Change (CC). These future flows are compared with the current flows and the current sources of funds because projections of the sources of future flows are not available from the scenarios. It is important to note that this methodology is not the same as what would be required to assess the full (total) cost of addressing adaptation in Ghana.

The procedure for analysis employed in this report is simple. The scope of a sector under consideration is defined. Once the scope of a sector is clearly defined, the relevant investment costs for that sector are projected for two future scenarios: first, a baseline scenario, which reflects a continuation of current policies and plans, i.e., a future in which no new measures are taken to address climate change (otherwise referred to as a "business-as-usual" scenario-BAU), and second, a climate change scenario, in which new adaptation measures are taken (an "adaptation scenario"). The investment costs of the baseline and adaptation scenarios are then compared to determine the changes in investments needed to adapt to the impacts to the sector.

2.1 Assessment Period and Base Year

The assessment period is the time horizon for assessment; i.e., the number of years spanned by the baseline and climate change scenarios and the associated stream of annual

IF, and FF. The assessment period for this report is 11 years (2009-2020) and 30 years (2021-2050) with the base year being 2006. The end year is 2050 since this year aligns with typical sector development plans, and results in a reasonable assessment period length. Appropriate discounting of future costs (IF and FF costs for the baseline and climate change scenarios) are done to properly account for varying opportunity costs and time preferences of investment entities. This is particularly important given the long time frame of the Investment & Financial Flow assessments.

2.2 Method of Estimation

The method of analysis involves a calculation of changes in cumulative IF and FF by investment entity/funding source combination, for individual investment types and all investment types. These calculations are designed to determine how cumulative investments by each investment entity/funding source combination would change, for each investment type and for all investment types, between the baseline scenario and the climate change scenario.

The calculation entails estimating the incremental cumulative IF costs needed to implement each investment type in the sector, by individual investment entity/funding source combination. The two steps in this calculation which were carried out for all investment types in both the health sector and malaria separately, are:

1. For each investment type, a calculation of cumulative IF costs for each investment entity/funding source combination, in both the baseline scenario and the climate change scenario, by summing annual estimates over all years in the assessment period 2006-2030.
2. For each investment type, incremental cumulative IF costs for each investment entity/funding source combination by subtracting cumulative IF costs in the baseline scenario from cumulative IF ncosts in the climate change scenario has been calculated.

2.3 Cumulative Baseline Scenario IF for Individual Investment Types, by Funding Source/Investment Entity Combination

$$Cum\ IF(BS, IT_i, IE/FS_j) = \sum_i IF(BS, IT_i, IE/FS_j, YR_t) \quad (1)$$

Where:

$IF(BS, IT_i, IE/FS_j, YR_t)$ = annual IF for investment type (IT) *i* in the baseline scenario (BS), for investment entity/funding source combination (IE/FS) *j*, and for year (YR) *t*

$CumIF(BS, IT_i, IE/FS_j)$ = cumulative IF for investment type (IT) *i* in the baseline scenario (BS), for investment entity/funding source combination (IE/FS) *j*

2.4 Cumulative Climate Change Scenario IF for Individual Investment Types, by Funding Source/Investment Entity Combination

$$Cum\ IF(CCS, IT_i, IE/FS_j) = \sum_i IF(CCS, IT_i, IE/FS_j, YR_t) \quad (2)$$

Where:

$IF(CCS, IT_i, IE/FS_j, YR_t)$ = annual IF for investment type (IT) *i* in the climate change scenario (CCS), for investment entity/ funding source combination (IE/FS) *j*, and for year (YR) *t*

$CumIF(CCS, IT_i, IE/FS_j)$ = cumulative IF for an investment type (IT) *i* in the climate change scenario (CCS), for investment entity/funding source combination (IE/FS) *j*

2.5 Incremental Cumulative IF for Individual Investment Types, by Investment Entity/Funding Source Combination

$$\Delta Cum\ IF(IT_i, IE/FS_j) = Cum\ IF(CCS, IT_i, IE/FS_j) - Cum\ IF(BS, IT_i, IE/FS_j) \quad (3)$$

Where:

$\Delta CumIF(IT_i, IE/FS_j)$ = incremental cumulative IF for investment type (IT) *i*, for investment entity/funding source combination (IE/FS) *j*

2.6 Cumulative Baseline Scenario IF for All Investment Types, by Investment Entity/Funding Source Combination

$$Cum\ IF(BS, IT_{ALL}, IE/FS_j) = \sum_i Cum\ IF(BS, IT_i, IE/FS_j) \quad (4)$$

Where:

$CumIF(BS, IT_i, IE/FS_j)$ = cumulative IF for investment type (IT) *i* in the baseline scenario

(BS), for investment entity/funding source combination (IE/FS) *j*

CumIF(BS, IT_{ALL}, IE/FS_j) = cumulative IF for all investment types (IT_{ALL}) in the baseline scenario (BS), for investment entity/funding source combination (IE/FS) *j*

2.7 Cumulative Climate Change Scenario IF for All Investment Types, by Investment Entity/Funding Source Combination

$$Cum\ IF(CCS, IT_{ALL}, IE/FS_j) = \sum_i IF(CCS, IT_i, IE/FS_j) \quad (5)$$

Where:

CumIF(CCS, IT_i, IE/FS_j) = cumulative IF for investment type (IT) *i* in the climate change scenario (CCS), for investment entity/funding source combination (IE/FS) *j*

CumIF(CCS, IT_{ALL}, IE/FS_j) = cumulative IF for all investment types (IT_{ALL}) in the climate change scenario (CCS), for investment entity/funding source combination (IE/FS) *j*

2.8 Incremental Cumulative IF for All Investment Types, by Investment Entity/Funding Source Combination

$$\Delta Cum\ IF(IT_{ALL}, IE/FS_j) = Cum\ IF(CCS, IT_{ALL}, IE/FS_j) - Cum\ IF(BS, IT_{ALL}, IE/FS_j) \quad (6)$$

Where:

ΔCumIF(IT_{ALL}, IE/FS_j) = incremental cumulative IF for all investment types (IT_{ALL}), for each investment entity/funding source combination (IE/FS) *j*

2.9 Estimation of Changes in Annual IF costs for Individual Investment Types, for Individual Sources of Funds, and for All Investment Types and Funding Sources

The next set of estimations/calculations are designed to determine how annual investments for each investment type, and for each investment entity/funding source combination, and for all investment types and all investment entity/funding source combinations, would change between the baseline scenario and the climate change scenario.

The first calculation entails estimating the incremental annual IF costs for all investment entity/funding source combinations needed to implement each investment type in the sector, in each year of the assessment period. The steps in this calculation are:

1. For each investment type, annual total IF costs in both the baseline scenario and the climate change scenario are obtained by summing IF costs in each year over all investment entity/funding source.
2. For each investment type, a calculation of incremental annual total IF costs by year is achieved by subtracting annual total IF for the baseline scenario from annual total IF costs for the climate change scenario.

2.10 Annual Total Baseline Scenario IF for Each Investment Type

$$IF(BS, IT_i, IE/FS_{ALL}, YR_t) = \sum_i IF(BS, IT_i, IE/FS_j, YR_t) \quad (7)$$

Where:

IF(BS, IT_i, IE/FS_j, YR_t) = annual IF for investment type (IT) *i* in the baseline scenario (BS), for investment entity/funding source combination (IE/FS) *j*, and for year (YR) *t*

IF(BS, IT_i, IE/FS_{ALL}, YR_t) = annual IF for investment type (IT) *i* in the baseline scenario (BS) for all investment entity/funding source combinations.

2.11 Incremental Total Annual IF for each Investment Type

$$\Delta IF(IT_i, IE/FS_{ALL}, YR_t) = IF(CCS, IT_i, IE/FS_{ALL}, YR_t) - IF(BS, IT_i, IE/FS_{ALL}, YR_t) \quad (8)$$

Where:

ΔIF(IT_i IE/FS_{ALL}, YR_t) = incremental IF for investment type *i*, for all investment entity/funding source combinations (IE/FS_{ALL}) and for year (YR) *t*

The next step of the calculation entails estimating annual incremental IF needed to implement all investment types in the sector, for each investment entity/funding source combination, in each year of the assessment period. The steps in this calculation are:

1. Calculation of annual IF costs for all investment types, for each source/

investment entity in both the baseline scenario and the climate change scenario by summing annual IF costs for each investment entity/funding source combination overall investment types.

2. Calculation of incremental annual IF costs for each investment entity/ funding source combination by subtracting annual IF costs for the baseline scenario from annual IF costs for the climate change scenario, for each investment entity/funding source combination.

2.12 Annual Baseline Scenario IF for All Investment Types, by Investment Entity/Funding Source Combination

$$IF(BS, IT_{ALL}, IE/FS_i, YR_t) = \sum_i IF(BS, IT_i, IE/FS_j, YR_t) \quad (9)$$

Where:

IF(BS, IT_i, IE/FS_j, YR_t) = annual IF for investment type (IT) *i* in the baseline scenario (BS), for investment entity/funding source combination (IE/FS) *j* and year (YR) *t*

IF(BS, IT_{ALL}, IE/FS_j, YR_t) = annual IF for all investment types (IT_{ALL}) in the baseline scenario (BS), for investment entity/funding source combination (IE/FS) *j* and year (YR) *t*

2.13 Annual Climate Change Scenario IF for All Investment Types, by Investment Entity/Funding Source Combination – Equation 10

$$IF(CCS, IT_{ALL}, IE/FS_i, YR_t) = \sum_i IF(CCS, IT_i, IE/FS_j, YR_t) \quad (10)$$

Where:

IF(CCS, IT_i, IE/FS_j, YR_t) = annual IF for investment type (IT) *i* in the climate change scenario (CCS), for investment entity/funding source combination (IE/FS) *j* and year (YR) *t*

IF(CCS, IT_{ALL}, IE/FS_j, YR_t) = annual IF for all investment types (IT_{ALL}) in the climate change scenario (CCS), for investment entity/funding source combination (IE/FS) *j* and year (YR) *t*

2.14 Limitations in Estimating Adaptation Costs

The estimation method used yields crude estimates of costs, therefore results should be treated as indicative of preliminary order of magnitude analysis results. Estimation of the cost of adaptation under various scenarios is fraught with uncertainties which include differences in adaptive capacity; the fact that most adaptations will not solely be for the purpose of adapting to climate change; the uncertainties associated with any readily available methods to estimate adaptation costs; and the existence of an adaptation deficit. These culminate in the fact that there is uncertainty about adaptive capacity of people and societies in responding to stresses related to climate change. Therefore, all scenarios used in this study leave many key aspects of adaptive capacity undefined. Also, adaptation to climate change will most likely not be made solely to adapt to climate change. This implies that most activities that need to be undertaken to adapt to climate change will have benefits even if the predicted climate change scenario does not materialise. Thus it will be difficult to attribute all benefits of adaptation measures to responses under climate change scenarios.

3. RESULTS

The cost of implementing adaptation measures due to climate change in 2020 and 2050 has been estimated. Investments by private as well as public sources in the base year have been calculated for time horizons 2020 and 2050. The costs have been estimated based on assumption that there will be additional investment in the health sector, which will see implementation of adaptation strategies. The adaptation scenario incorporates new measures to respond to the potential impacts of climate change on health. Investment in the base year was used as the benchmark in estimating time horizons 2020 and 2050. Ghanaian Government budgetary allocation for the health sector in 2006 was appropriately discounted, and used for estimating the adaptation cost in 2020 and 2050. Scenarios were made using the Business-As-Usual (BAU) figures. In the case of malaria, the estimations have been based on costs per episode with reference to [12], and the prevalence rate for the BAU scenario.

3.1 Cost of Adaptation to Investments in the Health Sector

In the health sector, climate change is projected to increase the burden of climate-sensitive health determinants and outcomes, with the impacts being manifest in changes in the location and

Table 1. Incremental cumulative investment by sectors - adaptation in climate change (constant us dollars)

Sector	BAU	CC Scenario	Amount Needed
Adaptation			
Health (Whole Sector)**			
2006	3,026,296,286.27	2,874,981,471.96	151,314,814.31
2020	6,994,167,839.42	6,644,459,447.45	349,708,391.97
2050	7,042,217,556.47	6,690,106,678.65	352,110,877.82
Malaria*			
2003	66,556,045.48	63,228,243.20	3,327,802.27
2020	151,042,279.36	143,490,165.39	7,552,113.97
2050	150,818,247.73	143,277,335.34	7,540,912.39

*Note: * estimations based on costing of malaria in 2003 by Asante et al (2005).*
*** estimations based on government budgetary allocation in 2006 for the sector*
Discount rate (37.5%) = Bank of Ghana prime rate (18%) + Commercial Bank's margin (11.5%) which together forms the bank's base rate + margin on lending (8% - ceiling) charged by commercial banks. Discount factor = $(1/1+0.375)^n$, Average interbank rate for 2006 (US$ to GH₵) = 0.9131, BAU= Business-As-Usual scenario, CC= Climate Change.
Source: Authors' Estimation

incidence of infectious diseases and diarrhea, increases in air and water pollution, and increases in risk of heat stress. The adaptation scenario suggests specific measures that can be taken to reduce vulnerability to climate change, and these could include improved monitoring systems to detect the arrival or presence of infectious diseases and investment in heat-watch warning systems to warn the Ghanaian population about heat waves. The incremental cost of adaptation in climate change in the health sector will be about US$ 350 million by 2020. This figure will go up to about US$ 352 million by 2050 (Appendices 1 and 2).

Malaria was treated separately because its treatment forms about 50% of outpatient care in public hospitals. Health expenditure on malaria in Ghana comes from both the public and private sectors. It is a fact that government spending is a major expenditure item in malaria treatment in Ghana but the payment by the private sector in treating malaria is significant. Government expenditure mainly goes into operation of health facilities that treat malaria while the families of those affected pay for the cost of treatment. This trend is expected to change in the adaptation scenario due to the sustained operation of the National Health Insurance Scheme (NHIS) which has helped in lifting the financial burden from many households. The estimations do not include the costs of setting up new infrastructure (such as new hospitals). Additional investment in controlling malaria will be about US$ 7.6 million in 2020 and US$ 7.54 million in 2050 (Appendices 3 and 4). This additional investment is needed to avoid an episode of malaria.

4. CONCLUDING REMARKS - FINANCIAL INSTRUMENTS USED TO ADDRESS CLIMATE CHANGE IMPACTS

When considering means to enhance investment and financial flows to address climate change, it is crucial to focus on the role of private-sector investments, as they constitute the largest share of investment and financial flows [13]. Some of the major measures that have been proposed to guarantee financing of climate change investments include the need to ensure the right investment climate. The creation of a favorable investment environment can be addressed from two different angles.

First through the reduction of financing barriers posed by the local economy, and second, through the intensification of capacity building and knowledge transfer to increase the awareness of emission reduction opportunities and taking appropriate action. These measures could be made known to the private sector operators who are likely to invest in climate change related projects. Moreover, financial institutions are usually well experienced in addressing business risks. These financial institutions could therefore alert the private sector concerning risks in climate change related investments and how to avoid these risks. Another instrument for stimulating investment in climate change impact projects is the reduction in the risk of low carbon investments. Currently there are a range of barriers including lack of policy predictability as well as an absence of transparent rules and procedures needed to provide stable conditions for investment into low carbon technologies. Nevertheless, there is a variety of public finance mechanisms which are available to address these risks, including debt guarantees. The [14] suggests the creation of a mechanism whereby the home government of a foreign investor issues guarantees in order to facilitate low carbon investments in host countries. Credit risk guarantees and other risk sharing instruments can considerably lower the investment barriers for many investors and keep the risks associated with direct investments at a reasonable level.

Design of credible policy mechanisms that can boost public and private flows of finance for both mitigation and adaptation are also important. The contributions of insurance industry operators are also significant in financing climate change impacts. Insurance companies could supply climate-related risk projections to regional and national authorities in order to adapt infrastructure regulation and codes to future climatic requirements. In all these, the public sector has the overall responsibility of enabling the private finance sector to operate more effectively by providing good governance and economic stability.

Resources are generated domestically from various sources. Notable among these are: tax revenue; indirect, direct and international taxes; national health insurance tax; import exemptions and banking and private sector investments. Presently there are no specific budget allocations for climate change mitigation or adaptation from domestic resources. The few projects are either integrated into the sectors' specific projects, or standalone projects. The private sector is currently not actively involved in climate change mitigation or adaptation projects. The most potent drive in formulating potential financial instruments to address climate change impacts is the provision of national policies that can assist in shifting investments and financial flows made by private and public investors into more climate-friendly alternatives and optimize the use of available funds by spreading the risk across private and public investors [13]. A very pertinent emerging issue related to financing of climate change impacts is that of carbon markets. Carbon markets and policies to promote renewable energy sources are already playing an important role in shifting investment flows in many parts of the world. However, a thorny issue is how to shift more public investment into lower carbon, more 'climate-proof' measures, without compromising development priorities. In discussing such issues, climate change adaptation and mitigation measures must be integrated into the Ghanaian national development plans. Another potential financial instrument that could be used to address climate change is that of financial incentives. This could involve tax cuts and rebates to firms that substantially cut down on greenhouse gas emissions. These incentives would have to be made available to rural dwellers as well.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. McMichael A, Campbell-Lendrum DH, Kovats S, Edwards S, Wilkinson P, Wilson T. Climate change in comparative quantification of health risks: Global and regional burden of disease due to selected major risk factors. Ezzati, M., Lopes, A, Rodgers, A. and Murray, C., Editors. World Health Organisation, Geneva; 2004.
2. Lindsay SW, Martens WJ. Malaria in the African highlands: Past, present and future. Bulletin of World Health Organisation. 1998;76:33-45.
3. Hay SI, Andrew TJ, Guerra CA, Snow RW. Foresight on population at malaria risk in Africa: 2005, 2015 and 2030. London, Office of Science and Innovation, Foresight Project, 40 (Scenario Review Paper Prepared for the Detection and Identification of Infectious Diseases Project (DIID); 2006.
4. African Development Bank/African Development Fund. The cost of adaptation to climate change in Africa; 2011. (Accessed 30 June 2017) Available:https://www.afdb.org/fileadmin/uploads/afdb/Documents/Project-and-Operations/Cost%20of%20Adaptation%20in%20Africa.pdf
5. Ministry of Environment, Science and Technology (MEST), Republic of Ghana. Message from the Vice President of Ghana and Foreword by the Minister of Environment, Science and Technology, In Ghana Goes for Green Growth; 2010.

6. USAID & MFCS. Final report on climate change and agricultural adaptation measures in the transition zone of Mid-Ghana; 2014
7. MESTI. Ghana's second communication to the UNFCCC. Environmental Protection Agency and the Ministry of Environment Science, Technology and Innovation; 2011.
8. UNFCC: First National Communication to the United Nations Framework Convention on Climate Change (Ghana); UNFCC Secretariat; 2000.
9. Aalst V, Hellmuth MM, Ponzi D. Come rain or shine: Integrating climate risk management into African Development Bank Operations, African Development Bank, Tunis. Working Paper No 89; 2007.
10. Grantham Research Institute on Climate Change and the Environment. What drives the international transfer of climate change mitigation technologies? Empirical evidence from patent data. Working Paper 14. GRICCE; 2009.
11. UNDP. Methodology guidebook for the assessment of investment and financial flows to address climate change. Version 1.0. Work in Progress; 2009.
12. Asante FA, Asenso-Okyere K, Kusi A. The economic impact of the burden of malaria in Ghana. Technical Publication No. 66. Institute of Statistical, Social and Economic Research (ISSER), University of Ghana, Legon; 2005.
13. UNFCC. Investment and financial flows to address climate change. Information Services of the UNFCCC Secretariat; 2007.
14. UNEP Report. New science and developments in our changing environment; 2009. (Accessed 30 June 2017)
Available:http://staging.unep.org/yearbook/2009/;

APPENDIX 1: BUSINESS-AS-USUAL (BAU) SCENARIO FOR THE MINISTRY OF HEALTH (2006 US DOLLARS) – COST OF ADAPTATION MEASURES

Health sector (2006 US $)

			GOG Discretionary + Statutory						IGF + Donor					
Discount period	**Year**	**Discount factor**	**A**	**B**	**C**	**D**	**E**	Discounted Subtotal	**A**	**B**	**C**	**D**	**E**	Discounted Subtotal
0	2006	1	1,005,211,953.2	665,839,432.7	3,887.0	69,933,997.4	198,072,120.0	1,939,061,390.2	34,716,738.8	898,808,488.5	1,829.8	1,435,621.5	4,296,903.4	939,259,582.1
1	2007	0.727272727	731063238.7	484246860.1	2826.882948	50861089.02	144052450.9	1410226466	25248537.34	653678900.7	1330.761054	1044088.35	3125020.67	683097877.9
2	2008	0.52892562	386678076.7	256130570.6	1495.210816	26901733.03	76193031.87	745904907.4	13354598.26	345747517.7	703.8736151	552245.0777	1652903.495	361307968.5
3	2009	0.384673178	148744684.6	98526560.61	575.1674963	10348375.14	29309415.72	286929611.3	5137155.756	132999796.5	270.7613005	212433.8691	635827.6404	138985484.5
4	2010	0.279762311	41613156.77	27564018.32	160.9101882	2895085.348	8199669.884	80272091.24	1437182.568	37208330.46	75.74880724	59430.99022	177880.6103	38882900.38
5	2011	0.203463499	8466758.487	5608271.618	32.73934993	589044.1952	1668333.526	16332440.57	292414.1942	7570537.113	15.41211738	12092.03723	36192.2114	7911250.968
6	2012	0.147973454	1252855.497	829875.3218	4.844554688	87162.90408	246869.0742	2416767.641	43269.53829	1120238.525	2.28058424	1789.300513	5355.486526	1170655.131
7	2013	0.107617057	134828.6219	89308.74014	0.52135672	9380.215251	26567.32333	260085.422	4656.540385	120556.7736	0.245429765	192.5592561	576.3417008	125982.4604
8	2014	0.078266951	10552.62512	6989.922774	0.040805001	734.1608459	2079.343389	20356.09294	364.4532174	9435.611072	0.019209039	15.07102583	45.10850756	9860.263032
9	2015	0.056921419	600.6703939	397.8763215	0.002322679	41.78947697	118.3591758	1158.697691	20.74519422	537.0883694	0.001093406	0.857864173	2.56764025	561.2601614
10	2016	0.041397395	24.86618985	16.47104343	9.61528E-05	1.729975505	4.899761611	47.96706655	0.858797009	22.23405964	4.52642E-05	0.035513342	0.106293619	23.23470887
11	2017	0.030107197	0.748651269	0.495896945	2.89489E-06	0.052084713	0.147518087	1.444153909	0.02585597	0.669405207	1.36278E-06	0.001069207	0.003200203	0.699531951
12	2018	0.021896143	0.016392575	0.01085823	6.3387E-08	0.001140454	0.003230077	0.031621401	0.000566146	0.014657392	2.98396E-08	2.34115E-05	7.00721E-05	0.015317052
13	2019	0.015924468	0.000261043	0.000172912	1.0094E-09	1.81611E-05	5.14373E-05	0.000503554	9.01557E-06	0.000233411	4.75179E-10	3.72816E-07	1.11586E-06	0.000243916
14	2020	0.011581431	3.02325E-06	2.00256E-06	1.16903E-11	2.10332E-07	5.95717E-07	5.83188E-06	1.04413E-07	2.70324E-06	5.50325E-12	4.31774E-09	1.29233E-08	2.8249E-06
15	2021	0.008422859	2,323,996,134.2	1,539,661,705.5	828,386.0	162,446,047.7	458,590,063.7	4,485,522,337.1	80,263,238.6	2,077,997,029.4	4,230.4	3,319,079.9	9,934,210.3	2,171,517,788.6
16	2022	0.006125716	14236139.36	9431529.717	5074.456876	995098.2873	2809192.304	27477034.12	491669.7724	12729218.8	25.91417378	20331.7394	60854.14694	13302100.38
17	2023	0.004455066	63422.93879	42018.08629	22.60703972	4433.228433	12515.1368	122411.9974	2190.42123	56709.50845	0.115449352	90.57923858	271.1092341	59261.7336
18	2024	0.003240048	205.4933607	136.140613	0.073247892	14.36387255	40.54964292	396.620737	7.097069744	183.7415247	0.000374061	0.293481073	0.878406909	192.0108565
19	2025	0.002356398	0.484224244	0.320801534	0.000172601	0.033847008	0.095551117	0.934596504	0.016723524	0.43296825	8.81438E-07	0.000691558	0.002069877	0.452454091
20	2026	0.001713744	0.000829837	0.000549772	2.95794E-07	5.80051E-05	0.00016375	0.001601659	2.86598E-05	0.000741997	1.51056E-09	1.18515E-06	3.54724E-06	0.000775391
21	2027	0.00124636	1.03427E-06	6.85213E-07	3.68666E-10	7.22952E-08	2.04092E-07	1.99624E-06	3.57205E-08	9.24795E-07	1.8827E-12	1.47713E-09	4.42114E-09	9.66416E-07
22	2028	0.000906443	9.37511E-10	6.21107E-10	3.34175E-13	6.55315E-11	1.84997E-10	1.80948E-09	3.23786E-11	8.38274E-10	1.70656E-15	1.33893E-12	4.00751E-12	8.76001E-10
23	2029	0.000659231	6.18037E-13	4.09453E-13	2.20299E-16	4.32004E-14	1.21956E-13	1.19287E-12	2.1345E-14	5.52617E-13	1.12502E-18	8.82667E-16	2.64188E-15	5.77487E-13
24	2030	0.000479441	2.96312E-16	1.96309E-16	1.0562E-19	2.07121E-17	5.84708E-17	5.7191E-16	1.02337E-17	2.64947E-16	5.3938E-22	4.23187E-19	1.26662E-18	2.76871E-16
25	2031	0.000348684	1.03319E-19	6.84498E-20	3.68281E-23	7.22198E-21	2.03879E-20	1.99416E-19	3.56832E-21	9.23829E-20	1.88073E-25	1.47559E-22	4.41652E-22	9.65407E-20
26	2032	0.000253589	2.62007E-23	1.73581E-23	9.3392E-27	1.83141E-24	5.17013E-24	5.05696E-23	9.04885E-25	2.34273E-23	4.76933E-29	3.74192E-26	1.11998E-25	2.44816E-23
27	2033	0.000184428	4.83214E-27	3.20132E-27	1.72241E-30	3.37764E-28	9.53517E-28	9.32646E-27	1.66886E-28	4.32065E-27	8.79598E-33	6.90115E-30	2.06556E-29	4.5151E-27
28	2034	0.00013413	6.48132E-31	4.29392E-31	2.31026E-34	4.53041E-32	1.27895E-31	1.25095E-30	2.23844E-32	5.79526E-31	1.1798E-36	9.25648E-34	2.77052E-33	6.05608E-31
29	2035	9.75488E-05	6.32245E-35	4.18866E-35	2.25363E-38	4.41936E-36	1.2476E-35	1.22029E-34	2.18357E-36	5.65321E-35	1.15088E-40	9.02958E-38	2.70261E-37	5.90763E-35
30	2036	7.09446E-05	4.48543E-39	2.97163E-39	1.59883E-42	3.13529E-40	8.85103E-40	8.65729E-39	1.54912E-40	4.01064E-39	8.16488E-45	6.406E-42	1.91735E-41	4.19114E-39
31	2037	5.1596E-05	2.31431E-43	1.53324E-43	8.24932E-47	1.61769E-44	4.56678E-44	4.46682E-43	7.99286E-45	2.06933E-43	4.21275E-49	3.30524E-46	9.89279E-46	2.16246E-43
32	2038	3.75244E-05	8.68429E-48	5.7534E-48	3.09551E-51	6.07027E-49	1.71366E-48	1.67615E-47	2.99927E-49	7.76505E-48	1.58081E-53	1.24027E-50	3.71221E-50	8.11451E-48
33	2039	2.72905E-05	2.36998E-52	1.57013E-52	8.44778E-56	1.65661E-53	4.67665E-53	4.57428E-52	8.18515E-54	2.11912E-52	4.3141E-58	3.38476E-55	1.01308E-54	2.21449E-52
34	2040	1.98476E-05	4.70385E-57	3.11633E-57	1.67668E-60	3.28797E-58	9.28203E-58	9.07886E-57	1.62456E-58	4.20594E-57	8.56247E-63	6.71794E-60	2.01072E-59	4.39523E-57
35	2041	1.44346E-05	6.78984E-62	4.49831E-62	2.42023E-65	4.74606E-63	1.33983E-62	1.3105E-61	2.34499E-63	6.07112E-62	1.23596E-67	9.69709E-65	2.9024E-64	6.34435E-62
36	2042	1.04979E-05	7.12791E-67	4.72228E-67	2.54074E-70	4.98237E-68	1.40654E-67	1.37575E-66	2.46175E-68	6.37341E-67	1.2975E-72	1.01799E-69	3.04691E-69	6.66024E-67
37	2043	7.63484E-06	5.44205E-72	3.60539E-72	1.93981E-75	3.80396E-73	1.07387E-72	1.05036E-71	1.87951E-73	4.866E-72	9.90621E-78	7.77221E-75	2.32627E-74	5.08499E-72
38	2044	5.55261E-06	3.02176E-77	2.00193E-77	1.0771E-80	2.11219E-78	5.96278E-78	5.83227E-77	1.04362E-78	2.7019E-77	5.50054E-83	4.31561E-80	1.29169E-79	2.8235E-77
39	2045	4.03826E-06	1.22027E-82	8.08434E-83	4.34963E-86	8.52959E-84	2.40793E-83	2.35522E-82	4.2144E-84	1.0911E-82	2.22126E-88	1.74276E-85	5.21618E-85	1.1402E-82
40	2046	2.93692E-06	3.58382E-88	2.37431E-88	1.27745E-91	2.50507E-89	7.0719E-89	6.9171E-88	1.23774E-89	3.20447E-88	6.52367E-94	5.11834E-91	1.53195E-90	3.34869E-88
41	2047	2.13594E-06	7.65484E-94	5.07138E-94	2.72856E-97	5.35069E-95	1.51052E-94	1.47745E-93	2.64373E-95	6.84456E-94	1.3934E-99	1.09325E-96	3.27216E-96	7.1526E-94
42	2048	1.55341E-06	1.1891E-99	7.8779E-100	4.2386E-103	8.3118E-101	2.3465E-100	2.2951E-99	4.1068E-101	1.0632E-99	2.1646E-105	1.6983E-102	5.083E-102	1.1111E-99
43	2049	1.12975E-06	1.3434E-105	8.9001E-106	4.7886E-109	9.3903E-107	2.6509E-106	2.5929E-105	4.6397E-107	1.2012E-105	2.4454E-111	1.9186E-108	5.7425E-108	1.2553E-105
44	2050	8.21639E-07	1.1038E-111	7.3127E-112	3.9345E-115	7.7155E-113	2.1781E-112	2.1304E-111	3.8121E-113	9.8696E-112	2.0092E-117	1.5764E-114	4.7183E-114	1.0314E-111

Note:
Average inter bank rate for 2 0.9236
A=Compenstion to employees, B =Use of goods, C= Consumption of fixed capital, D= Social benefits E= Other expenditure
Source: Government of Ghana budgetary allocation to the Minstry of Health in 2006

A=Compensation to employees, B =Use of goods, C= Consumption of fixed capital, D= Social benefits E= Other expenditure, Source: Government of Ghana budgetary allocation to the Ministry of Health in 2006
Negative discount factors figures reflect the time valueof money(i.e. Government of Ghana budgetary allocation to the Ministry of Health)

APPENDIX 2: CLIMATE CHANGE (CC) SCENARIO FOR THE MINISTRY OF HEALTH (2006 US DOLLARS) – COST OF ADAPTATION MEASURES

Health sector (2006 US $)

			GOG Discretionary + Statutory						IGF + Donor						HIPC						
Discount period	**Year**	**Discount factor**	**A**	**B**	**C**	**D**	**E**	Discounted Subtotal	**A**	**B**	**C**	**D**	**E**	Discounted Subtotal	**A**	**B**	**C**	**D**	**E**	Discounted Subtotal	**Discounted Grand total**
0	2006	1	1,005,211,953.2	665,839,432.7	3,887.0	69,933,997.4	198,072,120.0	1,939,061,390.2	34,716,738.8	898,808,488.5	1,829.8	1,435,621.5	4,296,903.4	939,259,582.1	84,993.5	98,659,051.5	0	0	49,231,268.9	147,975,314.0	**3026296286**
1	2007	0.727272727	731063238.7	484246860.1	2826.882948	50861089.02	144052450.9	1410226466	25248537.34	653678900.7	1330.761054	1044088.35	3125020.67	683097877.9	61813.45722	71752037.48	0	0	35804559.23	107618410.2	**2200942754**
2	2008	0.52892562	386678076.7	256130570.6	1495.210816	26901733.03	76193031.87	745904907.4	13354598.26	345747517.7	703.8736151	552245.0777	1652903.495	361307968.5	32694.72118	37951490.9	0	0	18937948.69	56922134.31	**1164135010**
3	2009	0.384673178	148744684.6	98526560.61	575.1674963	10348375.14	29309415.72	286929611.3	5137155.756	132999796.5	270.7613005	212433.8691	635827.6404	138985484.5	12576.7823	14598920.62	0	0	7284920.907	21896418.31	**447811514.1**
4	2010	0.279762311	41613156.77	27564018.32	160.9101882	2895085.348	8199669.884	80272091.24	1437182.568	37208330.46	75.74880724	59430.99022	177880.6103	38882900.38	3518.509685	4084227.774	0	0	2038046.311	6125792.595	**125280784.2**
5	2011	0.203463499	8466758.487	5608271.618	32.73934993	589044.1952	1668333.526	16332440.57	292414.1942	7570537.113	15.41211738	12092.03723	36192.2114	7911250.968	715.8882923	830991.2743	0	0	414668.0338	1246375.196	**25490066.73**
6	2012	0.147973454	1252855.497	829875.3218	4.844554688	87162.90408	246869.0742	2416767.641	43269.53829	1120238.525	2.28058424	1789.300513	5355.486526	1170655.131	105.9324632	122964.649	0	0	61359.86119	184430.4427	**3771853.215**
7	2013	0.107617057	134828.6219	89308.74014	0.52135672	9380.215251	26567.32333	260085.422	4656.540385	120556.7736	0.245429765	192.5592561	576.3417008	125982.4604	11.40013998	13233.09369	0	0	6603.367704	19847.86154	**405915.7439**
8	2014	0.078266951	10552.62512	6989.922774	0.040805001	734.1608459	2079.343389	20356.09294	364.4532174	9435.611072	0.019209039	15.07102583	45.10850756	9860.263032	0.892254195	1035.713893	0	0	516.8254554	1553.431603	**31769.78757**
9	2015	0.056921419	600.6703939	397.8763215	0.002322679	41.78947697	118.3591758	1158.697691	20.74519422	537.0883694	0.001093406	0.857864173	2.56764025	561.2601614	0.050788375	58.95430427	0	0	29.41843819	88.42353083	**1808.381383**
10	2016	0.041397395	24.86618985	16.47104343	9.61528E-05	1.729975505	4.899761611	47.96706655	0.858797009	22.23405964	4.52642E-05	0.035513342	0.106293619	23.23470887	0.002102506	2.440554649	0	0	1.21784672	3.660503876	**74.8622793**
11	2017	0.030107197	0.748651269	0.495896945	2.89489E-06	0.052084713	0.147518087	1.444153909	0.02585597	0.669405207	1.36278E-06	0.001069207	0.003200203	0.699531951	6.33006E-05	0.073478259	0	0	0.036665951	0.11020751	**2.253893369**
12	2018	0.021896143	0.016392575	0.01085823	6.3387E-08	0.001140454	0.003230077	0.031621401	0.000566146	0.014657392	2.98396E-08	2.34115E-05	7.00721E-05	0.015317052	1.38604E-06	0.00160889	0	0	0.000802843	0.002413119	**0.049351572**
13	2019	0.015924468	0.000261043	0.000172912	1.0094E-09	1.81611E-05	5.14373E-05	0.000503554	9.01557E-06	0.000233411	4.75179E-10	3.72816E-07	1.11586E-06	0.000243916	2.20719E-08	2.56207E-05	0	0	1.27848E-05	3.84276E-05	**0.000785898**
14	2020	0.011581431	3.02325E-06	2.00256E-06	1.16903E-11	2.10332E-07	5.95717E-07	5.83188E-06	1.04413E-07	2.70324E-06	5.50325E-12	4.31774E-09	1.29233E-08	2.8249E-06	2.55624E-10	2.96725E-07	0	0	1.48067E-07	4.45047E-07	**9.10182E-06**
																					6,994,167,839.42
15	2021	0.008422859	2,323,996,134.2	1,539,661,705.5	828,386.0	162,446,047.7	458,590,063.7	4,485,522,337.1	80,263,238.6	2,077,997,029.4	4,230.4	3,319,079.9	9,934,210.3	2,171,517,788.6	196,500.4	228,094,436.8	0	0	113,820,053.9	342,110,991.2	**6999151117**
16	2022	0.006125716	14236139.36	9431529.717	5074.456876	995098.2873	2809192.304	27477034.12	491669.7724	12729218.8	25.91417378	20331.7394	60854.14694	13302100.38	1203.705705	1397241.648	0	0	697229.2791	2095674.633	**42874809.13**
17	2023	0.004455066	63422.93879	42018.08629	22.60703972	4433.228433	12515.1368	122411.9974	2190.42123	56709.50845	0.115449352	90.57923858	271.1092341	59261.7336	5.362588223	6224.803602	0	0	3106.202376	9336.368566	**191010.0995**
18	2024	0.003240048	205.4933607	136.140613	0.073247892	14.36387255	40.54964292	396.620737	7.097069744	183.7415247	0.000374061	0.293481073	0.878406909	192.0108565	0.017375043	20.16866194	0	0	10.06424454	30.25028152	**618.8818751**
19	2025	0.002356398	0.484224244	0.320801534	0.000172601	0.033847008	0.095551117	0.934596504	0.016723524	0.43296825	8.81438E-07	0.000691558	0.002069877	0.452454091	4.09425E-05	0.047525404	0	0	0.023715371	0.071281718	**1.458332313**
20	2026	0.001713744	0.000829837	0.000549772	2.95794E-07	5.80051E-05	0.00016375	0.001601659	2.86598E-05	0.000741997	1.51056E-09	1.18515E-06	3.54724E-06	0.000775391	7.0165E-08	8.14464E-05	0	0	4.06421E-05	0.000122159	**0.002499209**
21	2027	0.00124636	1.03427E-06	6.85213E-07	3.68666E-10	7.22952E-08	2.04092E-07	1.99624E-06	3.57205E-08	9.24795E-07	1.8827E-12	1.47713E-09	4.42114E-09	9.66416E-07	8.74508E-11	1.01511E-07	0	0	5.06546E-08	1.52254E-07	**3.11491E-06**
22	2028	0.000906443	9.37511E-10	6.21107E-10	3.34175E-13	6.55315E-11	1.84997E-10	1.80948E-09	3.23786E-11	8.38274E-10	1.70656E-15	1.33893E-12	4.00751E-12	8.76001E-10	7.92692E-14	9.20144E-11	0	0	4.59156E-11	1.38009E-10	**2.82349E-09**
23	2029	0.000659231	6.18037E-13	4.09453E-13	2.20299E-16	4.32004E-14	1.21956E-13	1.19287E-12	2.1345E-14	5.52617E-13	1.12502E-18	8.82667E-16	2.64188E-15	5.77487E-13	5.22568E-17	6.06588E-14	0	0	3.0269E-14	9.098E-14	**1.86133E-12**
24	2030	0.000479441	2.96312E-16	1.96309E-16	1.0562E-19	2.07121E-17	5.84708E-17	5.7191E-16	1.02337E-17	2.64947E-16	5.3938E-22	4.23187E-19	1.26662E-18	2.76871E-16	2.5054E-20	2.90823E-17	0	0	1.45122E-17	4.36196E-17	**8.924E-16**
25	2031	0.000348684	1.03319E-19	6.84498E-20	3.68281E-23	7.22198E-21	2.03879E-20	1.99416E-19	3.56832E-21	9.23829E-20	1.88073E-25	1.47559E-22	4.41652E-22	9.65407E-20	8.73595E-24	1.01406E-20	0	0	5.06018E-21	1.52095E-20	**3.11166E-19**
26	2032	0.000253589	2.62007E-23	1.73581E-23	9.3392E-27	1.83141E-24	5.17013E-24	5.05696E-23	9.04885E-25	2.34273E-23	4.76933E-29	3.74192E-26	1.11998E-25	2.44816E-23	2.21534E-27	2.57153E-24	0	0	1.2832E-24	3.85695E-24	**7.89082E-23**
27	2033	0.000184428	4.83214E-27	3.20132E-27	1.72241E-30	3.37764E-28	9.53517E-28	9.32646E-27	1.66886E-28	4.32065E-27	8.79598E-33	6.90115E-30	2.06556E-29	4.5151E-27	4.08571E-31	4.74262E-28	0	0	2.36659E-28	7.1133E-28	**1.45529E-26**
28	2034	0.00013413	6.48132E-31	4.29392E-31	2.31026E-34	4.53041E-32	1.27895E-31	1.25095E-30	2.23844E-32	5.79526E-31	1.1798E-36	9.25648E-34	2.77052E-33	6.05608E-31	5.48014E-35	6.36126E-32	0	0	3.17429E-32	9.54103E-32	**1.95197E-30**
29	2035	9.75488E-05	6.32245E-35	4.18866E-35	2.25363E-38	4.41936E-36	1.2476E-35	1.22029E-34	2.18357E-36	5.65321E-35	1.15088E-40	9.02958E-38	2.70261E-37	5.90763E-35	5.34581E-39	6.20533E-36	0	0	3.09648E-36	9.30716E-36	**1.90412E-34**
30	2036	7.09446E-05	4.48543E-39	2.97163E-39	1.59883E-42	3.13529E-40	8.85103E-40	8.65729E-39	1.54912E-40	4.01064E-39	8.16488E-45	6.406E-42	1.91735E-41	4.19114E-39	3.79256E-43	4.40234E-40	0	0	2.19679E-40	6.60292E-40	**1.35087E-38**
31	2037	5.1596E-05	2.31431E-43	1.53324E-43	8.24932E-47	1.61769E-44	4.56678E-44	4.46682E-43	7.99286E-45	2.06933E-43	4.21275E-49	3.30524E-46	9.89279E-46	2.16246E-43	1.95681E-47	2.27143E-44	0	0	1.13345E-44	3.40685E-44	**6.96997E-43**
32	2038	3.75244E-05	8.68429E-48	5.7534E-48	3.09551E-51	6.07027E-49	1.71366E-48	1.67615E-47	2.99927E-49	7.76505E-48	1.58081E-53	1.24027E-50	3.71221E-50	8.11451E-48	7.34282E-52	8.52342E-49	0	0	4.25322E-49	1.2784E-48	**2.61544E-47**
33	2039	2.72905E-05	2.36998E-52	1.57013E-52	8.44778E-56	1.65661E-53	4.67665E-53	4.57428E-52	8.18515E-54	2.11912E-52	4.3141E-58	3.38476E-55	1.01308E-54	2.21449E-52	2.00389E-56	2.32608E-53	0	0	1.16072E-53	3.48881E-53	**7.13765E-52**
34	2040	1.98476E-05	4.70385E-57	3.11633E-57	1.67668E-60	3.28797E-58	9.28203E-58	9.07886E-57	1.62456E-58	4.20594E-57	8.56247E-63	6.71794E-60	2.01072E-59	4.39523E-57	3.97724E-61	4.61671E-58	0	0	2.30376E-58	6.92445E-58	**1.41665E-56**
35	2041	1.44346E-05	6.78984E-62	4.49831E-62	2.42023E-65	4.74606E-63	1.33983E-62	1.3105E-61	2.34499E-63	6.07112E-62	1.23596E-67	9.69709E-65	2.9024E-64	6.34435E-62	5.741E-66	6.66406E-63	0	0	3.32539E-63	9.99519E-63	**2.04489E-61**
36	2042	1.04979E-05	7.12791E-67	4.72228E-67	2.54074E-70	4.98237E-68	1.40654E-67	1.37575E-66	2.46175E-68	6.37341E-67	1.2975E-72	1.01799E-69	3.04691E-69	6.66024E-67	6.02685E-71	6.99587E-68	0	0	3.49097E-68	1.04929E-67	**2.1467E-66**
37	2043	7.63484E-06	5.44205E-72	3.60539E-72	1.93981E-75	3.80396E-73	1.07387E-72	1.05036E-71	1.87951E-73	4.866E-72	9.90621E-78	7.77221E-75	2.32627E-74	5.08499E-72	4.6014E-76	5.34123E-73	0	0	2.6653E-73	8.01113E-73	**1.63898E-71**
38	2044	5.55261E-06	3.02176E-77	2.00193E-77	1.0771E-80	2.11219E-78	5.96278E-78	5.83227E-77	1.04362E-78	2.7019E-77	5.50054E-83	4.31561E-80	1.29169E-79	2.8235E-77	2.55498E-81	2.96578E-78	0	0	1.47994E-78	4.44827E-78	**9.1006E-77**
39	2045	4.03826E-06	1.22027E-82	8.08434E-83	4.34963E-86	8.52959E-84	2.40793E-83	2.35522E-82	4.2144E-84	1.0911E-82	2.22126E-88	1.74276E-85	5.21618E-85	1.1402E-82	1.03177E-86	1.19766E-83	0	0	5.97638E-84	1.79633E-83	**3.67506E-82**
40	2046	2.93692E-06	3.58382E-88	2.37431E-88	1.27745E-91	2.50507E-89	7.0719E-89	6.9171E-88	1.23774E-89	3.20447E-88	6.52367E-94	5.11834E-91	1.53195E-90	3.34869E-88	3.03022E-92	3.51743E-89	0	0	1.75521E-89	5.27568E-89	**1.07934E-87**
41	2047	2.13594E-06	7.65484E-94	5.07138E-94	2.72856E-97	5.35069E-95	1.51052E-94	1.47745E-93	2.64373E-95	6.84456E-94	1.3934E-99	1.09325E-96	3.27216E-96	7.1526E-94	6.47238E-98	7.51303E-95	0	0	3.74903E-95	1.12685E-94	**2.3054E-93**
42	2048	1.55341E-06	1.1891E-99	7.8779E-100	4.2386E-103	8.3118E-101	2.3465E-100	2.2951E-99	4.1068E-101	1.0632E-99	2.1646E-105	1.6983E-102	5.083E-102	1.1111E-99	1.0054E-103	1.1671E-100	0	0	5.8238E-101	1.7505E-100	**3.5812E-99**
43	2049	1.12975E-06	1.3434E-105	8.9001E-106	4.7886E-109	9.3903E-107	2.6509E-106	2.5929E-105	4.6397E-107	1.2012E-105	2.4454E-111	1.9186E-108	5.7425E-108	1.2553E-105	1.1359E-109	1.3185E-106	0	0	6.5795E-107	1.9776E-106	**4.0459E-105**

A=Compensation to employees, B =Use of goods, C= Consumption of fixed capital, D= Social benefits E= Other expenditure; Source: Government of Ghana budgetary allocation to the Ministry of Health in 2006
Negative discount factors figures reflect the time value of money (i.e. Government of Ghana budgetary allocation to the Ministry of Health)

APPENDIX 3: BUSINESS-AS-USUAL (BAU) SCENARIO FOR MALARIA TREATMENT (US$ 2003 CONSTANT) – COST OF ADAPTATION MEASURES

Cost of Malaria per Episode (2003 US Dollars)

				Household			**Government** Direct						
Year	**Discount period**	Malaria **Pre. Rate (A)**	**Discount Factor**	**Direct (B)**	**Indirect (C)**	**Total (Discounted)**	**Facility (D)**	**Personnel (E)**	**Treatment (Exemption) - I**	**M-Specific Exp (G)**	T. Direct **(Discounted)**	**Total Discounted (c)**	**Grand Total (d)**
2003	0	3552896	1	6.87	8.92	56100227.84	1.6118	0.4816	0.1214	0.7281	2.9429	10455817.64	**66,556,045.48**
2004	1	3416033	0.727272727	4.996363636	6.487272727	39228480.78	1.172218182	0.350254545	0.088290909	0.529527273	2.140290909	7311304.375	46539785.15
2005	2	3452949	0.52892562	2.642704733	3.431284748	20973175.91	0.620016228	0.185258603	0.046699324	0.280080541	1.132054696	3908927.13	24882103.04
2006	3	3511452	0.384673178	1.016577628	1.319923209	8204510.538	0.238503613	0.071264015	0.017963977	0.107739472	0.435471078	1529135.786	9733646.325
2007	4	3473959	0.279762311	0.284400107	0.369264768	2270805.192	0.066724322	0.019936986	0.005025644	0.030141444	0.121828395	423226.8904	2694032.083
2008	5	3460145	0.203463499	0.057865041	0.075131902	460188.6618	0.013575964	0.004056449	0.001022535	0.006132684	0.024787632	85768.79119	545957.453
2009	6	3479453	0.147973454	0.00856249	0.011117527	68475.70282	0.002008882	0.000600247	0.000151308	0.000907474	0.003667911	12762.32716	81238.02998
2010	7	3481852	0.107617057	0.00092147	0.001196436	7374.233555	0.00021619	6.45968E-05	1.62833E-05	9.76597E-05	0.00039473	1374.390876	8748.624431
2011	8	3471186	0.078266951	7.21206E-05	9.36414E-05	575.3907268	1.69205E-05	5.05579E-06	1.27445E-06	7.64353E-06	3.08943E-05	107.2398588	682.6305856
2012	9	3473817	0.056921419	4.10521E-06	5.3302E-06	32.77688004	9.63141E-07	2.87783E-07	7.25433E-08	4.3508E-07	1.75855E-06	6.108871455	38.88575149
2013	10	3477497	0.041397395	1.69945E-07	2.20656E-07	1.358315028	3.98715E-08	1.19135E-08	3.0031E-09	1.80112E-08	7.27993E-08	0.253159297	1.611474325
2014	11	3475618	0.030107197	5.11657E-09	6.64334E-09	0.040872962	1.20042E-09	3.58681E-10	9.0415E-11	5.42267E-10	2.19178E-09	0.007617799	0.04849076
2015	12	3474167	0.021896143	1.12033E-10	1.45464E-10	0.000894586	2.62846E-11	7.85373E-12	1.97974E-12	1.18735E-11	4.79916E-11	0.000166731	0.001061317
2016	13	3475644	0.015924468	1.78407E-12	2.31643E-12	1.42519E-05	4.18568E-13	1.25066E-13	3.15263E-14	1.8908E-13	7.6424E-13	2.65623E-06	1.69081E-05
2017	14	3475761	0.011581431	2.06621E-14	2.68276E-14	1.65063E-07	4.84761E-15	1.44845E-15	3.6512E-16	2.18982E-15	8.851E-15	3.07639E-08	1.95827E-07
2018	15	3475143	0.008422859	1.74034E-16	2.25965E-16	1.39005E-09	4.08308E-17	1.22001E-17	3.07535E-18	1.84445E-17	7.45507E-17	2.59074E-10	1.64913E-09
2019	16	3475190	0.006125716	1.06608E-18	1.3842E-18	8.51518E-12	2.50118E-19	7.47342E-20	1.88387E-20	1.12986E-19	4.56676E-19	1.58704E-12	1.01022E-11
2020	17	3475516	0.004455066	4.74946E-21	6.16669E-21	3.79392E-14	1.11429E-21	3.32946E-22	8.39278E-23	5.03359E-22	2.03452E-21	7.07102E-15	4.50103E-14
						127,313,848.42						**23,728,430.94**	**151,042,279.36**
2021	18	3475365	0.003240048	15.87747151	20.61529052	126825654.1	3.725081306	1.113040797	0.280571331	1.682734644	6.801428078	23637442.53	150463096.7
2022	19	3475283	0.002356398	0.03741365	0.048577839	298844.7632	0.008777776	0.002622768	0.000661138	0.003965193	0.016026875	55697.92614	354542.6894
2023	20	3475357	0.001713744	6.41174E-05	8.325E-05	512.154417	1.50429E-05	4.49475E-06	1.13302E-06	6.79533E-06	2.7466E-05	95.45403634	607.6084533
2024	21	3475388	0.00124636	7.99134E-08	1.03759E-07	0.638334211	1.87488E-08	5.60208E-09	1.41215E-09	8.46942E-09	3.42325E-08	0.118971105	0.757305316
2025	22	3475335	0.000906443	7.24369E-11	9.4052E-11	0.000578605	1.69947E-11	5.07797E-12	1.28004E-12	7.67705E-12	3.10298E-11	0.000107839	0.000686444
2026	23	3475343	0.000659231	4.77527E-14	6.20021E-14	3.81435E-07	1.12035E-14	3.34756E-15	8.4384E-16	5.06095E-15	2.04558E-14	7.1091E-08	4.52526E-07
2027	24	3475360	0.000479441	2.28946E-17	2.97263E-17	1.82877E-10	5.3714E-18	1.60496E-18	4.04571E-19	2.42643E-18	9.80736E-18	3.40841E-11	2.16961E-10
2028	25	3475355	0.000348684	7.98299E-21	1.03651E-20	6.37662E-14	1.87292E-21	5.59623E-22	1.41068E-22	8.46058E-22	3.41967E-21	1.18846E-14	7.56508E-14
2029	26	3475346	0.000253589	2.0244E-24	2.62847E-24	1.61703E-17	4.74952E-25	1.41914E-25	3.57732E-26	2.14551E-25	8.6719E-25	3.01379E-18	1.91841E-17
2030	27	3475353	0.000184428	3.73356E-28	4.84765E-28	2.98227E-21	8.75946E-29	2.61729E-29	6.59758E-30	3.95692E-29	1.59934E-28	5.55828E-22	3.5381E-21
2031	28	3461479	0.00013413	5.0078E-32	6.50213E-32	3.98414E-25	1.1749E-32	3.51056E-33	8.84931E-34	5.3074E-33	2.14519E-32	7.42553E-26	4.72669E-25
2032	29	3452737	9.75488E-05	4.88505E-36	6.34274E-36	3.87666E-29	1.1461E-36	3.42451E-37	8.63239E-38	5.1773E-37	2.09261E-36	7.22522E-30	4.59918E-29
2033	30	3443995	7.09446E-05	3.46568E-40	4.49983E-40	2.74332E-33	8.13097E-41	2.42951E-41	6.12421E-42	3.67301E-41	1.48459E-40	5.11292E-34	3.25461E-33
2034	31	3435254	5.1596E-05	1.78815E-44	2.32173E-44	1.41185E-37	4.19526E-45	1.25353E-45	3.15985E-46	1.89513E-45	7.6599E-45	2.63137E-38	1.67499E-37
2035	32	3452737	3.75244E-05	6.70993E-49	8.71217E-49	5.32485E-42	1.57425E-49	4.70379E-50	1.18571E-50	7.11136E-50	2.87433E-49	9.92431E-43	6.31728E-42
2036	33	3443995	2.72905E-05	1.83117E-53	2.37759E-53	1.4495E-46	4.29619E-54	1.28369E-54	3.23587E-55	1.94072E-54	7.84418E-54	2.70153E-47	1.71965E-46
2037	34	3443995	1.98476E-05	3.63444E-58	4.71895E-58	2.8769E-51	8.52691E-59	2.54781E-59	6.42243E-60	3.85187E-59	1.55688E-58	5.3619E-52	3.41309E-51
2038	35	3443995	1.44346E-05	5.24618E-63	6.81163E-63	4.1527E-56	1.23083E-63	3.67767E-64	9.27054E-65	5.56003E-64	2.2473E-63	7.7397E-57	4.92667E-56
2039	36	3446909	1.04979E-05	5.50739E-68	7.15079E-68	4.36316E-61	1.29211E-68	3.86078E-69	9.73213E-70	5.83687E-69	2.3592E-68	8.13194E-62	5.17635E-61
2040	37	3443995	7.63484E-06	4.20481E-73	5.45951E-73	3.32839E-66	9.86507E-74	2.94765E-74	7.43033E-75	4.45636E-74	1.80121E-73	6.20336E-67	3.94872E-66
2041	38	3444967	5.55261E-06	2.33477E-78	3.03146E-78	1.84865E-71	5.47769E-79	1.63672E-79	4.12577E-80	2.47444E-79	1.00014E-78	3.44546E-72	2.19319E-71
2042	39	3444967	4.03826E-06	9.4284E-84	1.22418E-83	7.46532E-77	2.21204E-84	6.60949E-85	1.6661E-85	9.99246E-85	4.03884E-84	1.39137E-77	8.85669E-77
2043	40	3445290	2.93692E-06	2.76905E-89	3.59533E-89	2.19271E-82	6.49658E-90	1.94115E-90	4.89319E-91	2.93471E-90	1.18618E-89	4.08672E-83	2.60138E-82
2044	41	3444643	2.13594E-06	5.91452E-95	7.67941E-95	4.68262E-88	1.38763E-95	4.14619E-96	1.04516E-96	6.26836E-96	2.5336E-95	8.72735E-89	5.55536E-88
2045	42	3445075	1.55341E-06	9.1877E-101	1.1929E-100	7.27495E-94	2.1556E-101	6.4407E-102	1.6236E-102	9.7373E-102	3.9357E-101	1.35589E-94	8.63084E-94
2046	43	3444967	1.12975E-06	1.038E-106	1.3477E-106	8.2187E-100	2.4353E-107	7.2765E-108	1.8342E-108	1.1001E-107	4.4464E-107	1.5318E-100	9.7504E-100
2047	44	3445003	8.21639E-07	8.5285E-113	1.1073E-112	6.7528E-106	2.0009E-113	5.9786E-114	1.5071E-114	9.0387E-114	3.6533E-113	1.2586E-106	8.0114E-106
2048	45	3444895	5.97556E-07	5.0962E-119	6.617E-119	4.0351E-112	1.1957E-119	3.5726E-120	9.0056E-121	5.4011E-120	2.1831E-119	7.5205E-113	4.7871E-112
2049	46	3445015	4.34586E-07	2.2148E-125	2.8756E-125	1.7536E-118	5.1961E-126	1.5526E-126	3.9137E-127	2.3473E-126	9.4873E-126	3.2684E-119	2.0805E-118
2050	47	3444955	3.16063E-07	7E-132	9.0888E-132	5.5425E-125	1.6423E-132	4.9071E-133	1.237E-133	7.4188E-133	2.9986E-132	1.033E-125	6.5755E-125
						127,125,011.70						**23,693,236.03**	**150,818,247.73**

NOTE:
NPV has been calculated for the time horizons under review
The 3 period moving average =(y1+y2+Y3)/3
The prevalence rate has been forecasted using the 3 period moving average
A=Malaria Prevalence rate under the B-A-U scenario
B= Direct cost of malaria to household
C= Indirect cost of malaria to household
D= Cost of treating an episode of malaria per public facility
E=Compensation to a health personell per malaria episode treated
F=
G= Malaria-specific expenditure
Discount rate of 37.5% is used = Discount factor(1/1+0.375)^n

Negative discount factors figures reflect the time value of money (i.e. Government of Ghana budgetary allocation to the Ministry of Health)

APPENDIX 4: CLIMATE CHANGE (CC) SCENARIO FOR MALARIA TREATMENT (2003 US DOLLARS) – COST OF ADAPTATION MEASURES

Cost of Malaria per Episode (2003 US Dollars)

					Household			Government Direct						
5% Reduction ir	**Year**	**Discount period**	**Malaria Pre. Rate (A)**	**Discount Factor**	**Direct (B)**	**Indirect (C)**	**Total (Discounted)**	**Facility (D)**	**Personnel (E)**	**Treatment (Exer**	**M-Specific Exp (**	**T. Direct (Discounted)**	**Total Discounted (c)**	**Grand Total (d)**
3375251	2003	0	3552896	1	6.87	8.92	53295216.45	1.6118	0.4816	0.1214	0.7281	2.9429	9933026.756	**63,228,243.20**
3245231	2004	1	3416033	0.727272727	4.996363636	6.487272727	37267056.74	1.172218182	0.350254545	0.088290909	0.529527273	2.140290909	6945739.156	44212795.9
3280302	2005	2	3452949	0.52892562	2.642704733	3.431284748	19924517.11	0.620016228	0.185258603	0.046699324	0.280080541	1.132054696	3713480.773	23637997.88
3335879	2006	3	3511452	0.384673178	1.016577628	1.319923209	7794285.012	0.238503613	0.071264015	0.017963977	0.107739472	0.435471078	1452678.997	9246964.008
3300261	2007	4	3473959.333	0.279762311	0.284400107	0.369264768	2157264.933	0.066724322	0.019936986	0.005025644	0.030141444	0.121828395	402065.5459	2559330.479
3287137	2008	5	3460144.667	0.203463499	0.057865041	0.075131902	437179.2288	0.013575964	0.004056449	0.001022535	0.006132684	0.024787632	81480.35163	518659.5804
3305481	2009	6	3479453.444	0.147973454	0.00856249	0.011117527	65051.91768	0.002008882	0.000600247	0.000151308	0.000907474	0.003667911	12124.2108	77176.12848
3307759	2010	7	3481852	0.107617057	0.00092147	0.001196436	7005.521877	0.00021619	6.45968E-05	1.62833E-05	9.76597E-05	0.00039473	1305.671332	8311.193209
3297627	2011	8	3471185.815	0.078266951	7.21206E-05	9.36414E-05	546.6211905	1.69205E-05	5.05579E-06	1.27445E-06	7.64353E-06	3.08943E-05	101.8778658	648.4990563
3300126	2012	9	3473816.704	0.056921419	4.10521E-06	5.3302E-06	31.13803604	9.63141E-07	2.87783E-07	7.25433E-08	4.3508E-07	1.75855E-06	5.803427882	36.94146392
3303622	2013	10	3477497.086	0.041397395	1.69945E-07	2.20656E-07	1.290399277	3.98715E-08	1.19135E-08	3.0031E-09	1.80112E-08	7.27993E-08	0.240501332	1.530900609
3301837	2014	11	3475618.173	0.030107197	5.11657E-09	6.64334E-09	0.038829314	1.20042E-09	3.58681E-10	9.0415E-11	5.42267E-10	2.19178E-09	0.007236909	0.046066222
3300458	2015	12	3474166.535	0.021896143	1.12033E-10	1.45464E-10	0.000849857	2.62846E-11	7.85373E-12	1.97974E-12	1.18735E-11	4.79916E-11	0.000158394	0.001008251
3301862	2016	13	3475643.988	0.015924468	1.78407E-12	2.31643E-12	1.35393E-05	4.18568E-13	1.25066E-13	3.15263E-14	1.8908E-13	7.6424E-13	2.52342E-06	1.60627E-05
3301973	2017	14	3475760.598	0.011581431	2.06621E-14	2.68276E-14	1.56809E-07	4.84761E-15	1.44845E-15	3.6512E-16	2.18982E-15	8.851E-15	2.92257E-08	1.86035E-07
3301386	2018	15	3475142.898	0.008422859	1.74034E-16	2.25965E-16	1.32055E-09	4.08308E-17	1.22001E-17	3.07535E-18	1.84445E-17	7.45507E-17	2.46121E-10	1.56667E-09
3301431	2019	16	3475190.374	0.006125716	1.06608E-18	1.3842E-18	8.08942E-12	2.50118E-19	7.47342E-20	1.88387E-20	1.12986E-19	4.56676E-19	1.50769E-12	9.59711E-12
3301740	2020	17	3475515.828	0.004455066	4.74946E-21	6.16669E-21	3.60423E-14	1.11429E-21	3.32946E-22	8.39278E-23	5.03359E-22	2.03452E-21	6.71747E-15	4.27597E-14
							120,948,156.00						**22,542,009.39**	**143,490,165.39**
3301596	2021	18	3475364.623	0.003240048	15.87747151	20.61529052	120484371.4	3.725081306	1.113040797	0.280571331	1.682734644	6.801428078	22455570.41	142939941.8
3301519	2022	19	3475283.033	0.002356398	0.03741365	0.048577839	283902.5251	0.008777776	0.002622768	0.000661138	0.003965193	0.016026875	52913.02983	336815.5549
3301589	2023	20	3475356.942	0.001713744	6.41174E-05	8.325E-05	486.5466962	1.50429E-05	4.49475E-06	1.13302E-06	6.79533E-06	2.7466E-05	90.68133452	577.2280307
3301618	2024	21	3475387.828	0.00124636	7.99134E-08	1.03759E-07	0.606417501	1.87488E-08	5.60208E-09	1.41215E-09	8.46942E-09	3.42325E-08	0.11302255	0.71944005
3301568	2025	22	3475334.866	0.000906443	7.24369E-11	9.4052E-11	0.000549675	1.69947E-11	5.07797E-12	1.28004E-12	7.67705E-12	3.10298E-11	0.000102447	0.000652122
3301575	2026	23	3475342.601	0.000659231	4.77527E-14	6.20021E-14	3.62364E-07	1.12035E-14	3.34756E-15	8.4384E-16	5.06095E-15	2.04558E-14	6.75364E-08	4.299E-07
3301592	2027	24	3475359.879	0.000479441	2.28946E-17	2.97263E-17	1.73733E-10	5.3714E-18	1.60496E-18	4.04571E-19	2.42643E-18	9.80736E-18	3.23799E-11	2.06113E-10
3301587	2028	25	3475355.099	0.000348684	7.98299E-21	1.03651E-20	6.05779E-14	1.87292E-21	5.59623E-22	1.41068E-22	8.46058E-22	3.41967E-21	1.12903E-14	7.18682E-14
3301578	2029	26	3475345.782	0.000253589	2.0244E-24	2.62847E-24	1.53618E-17	4.74952E-25	1.41914E-25	3.57732E-26	2.14551E-25	8.6719E-25	2.8631E-18	1.82249E-17
3301585	2030	27	3475352.526	0.000184428	3.73356E-28	4.84765E-28	2.83316E-21	8.75946E-29	2.61729E-29	6.59758E-30	3.95692E-29	1.59934E-28	5.28037E-22	3.36119E-21
3288405	2031	28	3461478.5	0.00013413	5.0078E-32	6.50213E-32	3.78493E-25	1.1749E-32	3.51056E-33	8.84931E-34	5.3074E-33	2.14519E-32	7.05426E-26	4.49036E-25
3280100	2032	29	3452736.9	9.75488E-05	4.88505E-36	6.34274E-36	3.68283E-29	1.1461E-36	3.42451E-37	8.63239E-38	5.1773E-37	2.09261E-36	6.86396E-30	4.36922E-29
3271796	2033	30	3443995.3	7.09446E-05	3.46568E-40	4.49983E-40	2.60615E-33	8.13097E-41	2.42951E-41	6.12421E-42	3.67301E-41	1.48459E-40	4.85728E-34	3.09188E-33
3263491	2034	31	3435253.7	5.1596E-05	1.78815E-44	2.32173E-44	1.34126E-37	4.19526E-45	1.25353E-45	3.15985E-46	1.89513E-45	7.6599E-45	2.4998E-38	1.59124E-37
3280100	2035	32	3452736.9	3.75244E-05	6.70993E-49	8.71217E-49	5.0586E-42	1.57425E-49	4.70379E-50	1.18571E-50	7.11136E-50	2.87433E-49	9.4281E-43	6.00141E-42
3271796	2036	33	3443995.3	2.72905E-05	1.83117E-53	2.37759E-53	1.37702E-46	4.29619E-54	1.28369E-54	3.23587E-55	1.94072E-54	7.84418E-54	2.56646E-47	1.63367E-46
3271796	2037	34	3443995.3	1.98476E-05	3.63444E-58	4.71895E-58	2.73306E-51	8.52691E-59	2.54781E-59	6.42243E-60	3.85187E-59	1.55688E-58	5.0938E-52	3.24244E-51
3271796	2038	35	3443995.3	1.44346E-05	5.24618E-63	6.81163E-63	3.94507E-56	1.23083E-63	3.67767E-64	9.27054E-65	5.56003E-64	2.2473E-63	7.35272E-57	4.68034E-56
3274564	2039	36	3446909.167	1.04979E-05	5.50739E-68	7.15079E-68	4.145E-61	1.29211E-68	3.86078E-69	9.73213E-70	5.83687E-69	2.3592E-68	7.72535E-62	4.91754E-61
3271796	2040	37	3443995.3	7.63484E-06	4.20481E-73	5.45951E-73	3.16197E-66	9.86507E-74	2.94765E-74	7.43033E-75	4.45636E-74	1.80121E-73	5.8932E-67	3.75129E-66
3272718	2041	38	3444966.589	5.55261E-06	2.33477E-78	3.03146E-78	1.75621E-71	5.47769E-79	1.63672E-79	4.12577E-80	2.47444E-79	1.00014E-78	3.27319E-72	2.08353E-71
3272718	2042	39	3444966.589	4.03826E-06	9.4284E-84	1.22418E-83	7.09206E-77	2.21204E-84	6.60949E-85	1.6661E-85	9.99246E-85	4.03884E-84	1.3218E-77	8.41386E-77
3273026	2043	40	3445290.352	2.93692E-06	2.76905E-89	3.59533E-89	2.08308E-82	6.49658E-90	1.94115E-90	4.89319E-91	2.93471E-90	1.18618E-89	3.88238E-83	2.47131E-82
3272411	2044	41	3444642.826	2.13594E-06	5.91452E-95	7.67941E-95	4.44849E-88	1.38763E-95	4.14619E-96	1.04516E-96	6.26836E-96	2.5336E-95	8.29099E-89	5.27759E-88
3272821	2045	42	3445074.51	1.55341E-06	9.1877E-101	1.1929E-100	6.91121E-94	2.1556E-101	6.4407E-102	1.6236E-102	9.7373E-102	3.9357E-101	1.28809E-94	8.1993E-94
3272718	2046	43	3444966.589	1.12975E-06	1.038E-106	1.3477E-106	7.8077E-100	2.4353E-107	7.2765E-108	1.8342E-108	1.1001E-107	4.4464E-107	1.4552E-100	9.2629E-100
3272752	2047	44	3445002.563	8.21639E-07	8.5285E-113	1.1073E-112	6.4152E-106	2.0009E-113	5.9786E-114	1.5071E-114	9.0387E-114	3.6533E-113	1.1956E-106	7.6108E-106
3272650	2048	45	3444894.642	5.97556E-07	5.0962E-119	6.617E-119	3.8333E-112	1.1957E-119	3.5726E-120	9.0056E-121	5.4011E-120	2.1831E-119	7.1444E-113	4.5478E-112
3272764	2049	46	3445014.554	4.34586E-07	2.2148E-125	2.8756E-125	1.666E-118	5.1961E-126	1.5526E-126	3.9137E-127	2.3473E-126	9.4873E-126	3.105E-119	1.9765E-118
3272707	2050	47	3444954.598	3.16063E-07	7E-132	9.0888E-132	5.2654E-125	1.6423E-132	4.9071E-133	1.237E-133	7.4188E-133	2.9986E-132	9.8135E-126	6.2468E-125
							120,768,761.11					**6.82**	**22,508,574.23**	**143,277,335.34**

NOTE:
NPV has been calculated for the time horizons under review
The 3 period moving average =(y1+y2+Y3)/3
The prevalence rate has been forecasted using the 3 period moving average
A=Malaria Prevalence rate under the B-A-U scenario
B= Direct cost of malaria to household
C= Indirect cost of malaria to household
D= Cost of treating an episode of malaria per public facility
E=Compensation to a health personell per malaria episode treated
F=
G= Malaria-specific expenditure
Discount rate of 37.5% is used = Discount factor(1/1+0.375)^n
CC Scenario = 5% reduction in annual prevalence rate of Malaria

Negative discount factors figures reflect the time value of money (i.e. Government of Ghana budgetary allocation to the Ministry of Health)

Peer-review history:
The peer review history for this paper can be accessed here:
http://sciencedomain.org/review-history/22030