The PMI Africa IRS (AIRS) Project

Indoor Residual Spraying (IRS)

SUPPLEMENTAL ENVIRONMENTAL ASSESSMENT

FOR IRS NATIONWIDE IN MALI, USING PYRETHROIDS, CARBAMATES, ORGANOPHOSPHATES, AND CHLORFENAPYR (WHEN RECOMMENDED BY WHOPES) 2016-2021

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Submitted to: The United States Agency for International Development/President's Malaria Initiative

The views expressed in this document do not necessarily reflect the views of the United States Agency for International Development or the United States Government.

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ACRONYMS

AIRS	Africa Indoor Residual Spraying Project
CDC	Centers for Disease Control and Prevention
COP	Chief of Party
COR	Contracting Officer's Representative
DECS	Director of Environmental Compliance and Safety
DDT	Dichlorodiphenyltrichloroethane
DNACPN	National Directorate of Sanitation, Pollution Control and Nuisance
EC	Environmental Compliance
ECC	Environmental Compliance Coordinator
ECO	Environmental Compliance Officer
EEM	Enhanced Entomological Monitoring
EOSR	End of Spray Report
IRS	Indoor Residual Spraying
LLIN	Long-lasting insecticide-treated nets
MEADD	Ministry of Environment, Sanitation and Sustainable Development
M&E	Monitoring and Evaluation
MOHPS	Ministry of Health and Public Sanitation
MRTC	Malaria Research and Training Center
MSP	Mobile Soak Pit
NDSPPC	National Directorate for Sanitation and Pollution and Pest Control
NMCP	National Malaria Control Program
PMI	President's Malaria Initiative
PPE	Personal protective equipment
PSECA	Pre-Spray Environmental Compliance Assessment
SEA	Supplemental Environmental Assessment
SOP	Spray Operator
USAID	United States Agency for International Development
USG	United States Government
WHO	World Health Organization
WHOPES	World Health Organization Pesticide Evaluation Schemes

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EXECUTIVE SUMMARY

This document has been prepared to serve as the Supplemental Environmental Assessment (SEA) for Indoor Residual Spraying (IRS) in Mali for the period 2016-2021. Previous environmental documentation for PMI-supported IRS in Mali authorized the use of the pyrethroid, carbamates and organophosphates classes of the WHOPES-recommended pesticides nationwide in Mali from 2011 to 2015, and was prepared in accordance with the provisions of USAID 22 CFR (216) regarding the use and application of pesticides. This SEA proposes to reauthorize the use of the same three classes of WHOPES-recommended insecticides, and to expand the authorization to include the use of chlorfenapyr (when recommended by WHOPES). This SEA also seeks to maintain the nationwide geographical coverage of authorized PMI-supported IRS, including a new district, Fana, and also requests authorization of small-scale, closely-supervised hut trials using new IRS insecticides, such as chlorfenapyr, once the insecticide has been submitted for Phase III WHOPES evaluation and country-level required documentation has been submitted.

Mali was selected as a PMI focus country in FY 2007. Malaria is a major public health problem in Mali. Although dramatic progress in malaria control has been made in recent years with the scale-up of malaria prevention and treatment interventions, nearly all 15.8 million people are still at risk of infection.

Changing or rotating insecticides of different classes over time is a leading way to manage vector resistance. In Mali, entomological monitoring has demonstrated that local mosquitoes have developed some level of resistance to pyrethroid, carbamate and organochlorine (DDT) class of insecticides, but have full susceptibility to the organophosphate, pirimiphos methyl, which is currently being used for IRS.

The proposal to include chlorfenapyr is prompted by the need to increase the options for recommended insecticides available for spray activities. Chlorfenapyr, an active ingredient (AI) in the pyrrole chemical class is under WHOPES review and if recommended for use will offer an additional option for insecticide rotation.

This SEA for IRS in Mali outlines the monitoring and mitigation measures that will be employed by the PMI Implementing Partner (IP) to minimize or reduce the unintended adverse impacts of pesticide application. Those measures are found in the Safer Use Action Plan (Section 7), and summarized in the Environmental Mitigation and Monitoring Plan (EMMP) found in Annex A. All PMI IRS operations in Mali will be performed according to the protocols and procedures found therein. These procedures do not change with the use of different classes of authorized pesticides, with the following exceptions:

1. The potential cumulative effects of organophosphate exposure (cholinesterase depression) require increased emphasis and training on the ability and responsibility of team leaders and senior personnel to daily monitor the appearance and behavior of their team members, and to recognize the symptoms of organophosphate exposure, in order to implement the appropriate response protocols. Biomonitoring is not required for the use of pirimiphos methyl formulations for IRS at the present time, but increased vigilance is essential.
2. Pirimiphos methyl formulations are supplied in plastic bottles, which if not controlled carefully may be used inappropriately once emptied of the insecticide formulation. In addition, incineration of the bottles may cause harmful emissions. Because of these potential problems, the following procedures and protocols have been established:
    a. A triple rinse for the plastic bottles has been incorporated during the insecticide make-up procedure, whereby the insecticide container is emptied into the spray tank and then three times it is partially filled with clean make-up water, capped, shaken, and emptied

into the spray tank. This ensures that the insecticide is used more efficiently, the container is thoroughly rinsed of pesticide, and it is safe for handling and subsequent processing. The risk of exposure due to insecticide residue in the container is essentially eliminated; however, the following procedures are also followed.

b. Containers are punctured multiple times to eliminate the ability to reuse the containers, and,
c. Recycling programs have been established to turn the plastic into usable products. As long as a suitable recycling program is available, through close supervision and chain of custody, and in partnership with the Mali National Malaria Control Program (NMCP) the IP will ensure that the plastic remains segregated from other materials, and is recycled appropriately.

The PMI IP will implement the EMMP in Annex A, with guidance from PMI and NMCP, and with the assistance and involvement of the local communities. All senior staff in charge of implementation of IRS will be trained to monitor operations when in the field, in order to maximize supervisory oversight and ensure effectiveness of the mitigation measures during spraying operation. District coordinators will monitor environmental compliance during the IRS campaign. The IP completes the annual EMMR Form in Annex C, and submits it to USAID along with the annual end of spray report.

On an annual basis, a letter report will be submitted to the BEO (regional and pillar). It must contain information regarding program changes, entomological/resistance monitoring results and data, and program response to those results. It should also contain the results of environmental monitoring and how the program will improve any areas of deficiency. In the year that a new SEA is prepared and approved, the Letter Report is unnecessary.

The following assessment draws heavily on the Programmatic Environmental Assessment (PEA) for Integrated Vector Management (IVM), updated in September 2012, and many other references, as indicated in this document.

1 PRINCIPAL PROPOSALS & CLEARANCE

1. The Mali Supplemental Environmental Assessment (SEA) (2009), as amended in 2011 (amendment #1) was valid for implementing PMI-supported IRS in selected regions of Mali, using all WHO-recommended pesticides in the pyrethroid, carbamate and organophosphate classes for the period 2011-2016.
2. In order to continue with PMI IRS, PMI is seeking approval for a new SEA for a further 5 years (2016-2021), and for the SEA scope to be maintained at nationwide.
3. It is proposed in this SEA to expand the permissible insecticide options to include chlorfenapyr, when recommended by WHOPES, in addition to carbamates, pyrethroids, and organophosphates.
4. It is further proposed to allow for small studies or hut trials to evaluate new IRS insecticides such as chlorfenapyr, once the insecticide has been submitted for Phase III WHOPES evaluation, and country-level required documentation has been submitted.
5. This SEA contains the condition that spraying will not be performed by PMI IPs within 30 meters of natural water bodies, wetlands or marshes, organic farming areas, beekeeping areas or core areas within protected forests, parks or habitats.
6. The Safer Use Action Plan in Chapter 7 provides detailed guidance on the performance of all activities associated with IRS. The attached, updated Environmental Mitigation and Monitoring Plan (EMMP) (Annex A) summarizes the key required mitigation measures, as well as the monitoring and reporting requirements and schedule.
7. The preparation of this SEA renders a Letter Report unnecessary for 2016. In subsequent years, provided there are no changes to the program outside the scope of this SEA, a Letter Report will be submitted to PMI annually that will discuss significant changes in the IRS program for that particular year's spray campaign.
8. It is PMI policy that the first use of organophosphates in a given country requires the signature of the Africa Bureau and Global Health BEOs on the annual Letter Report. Use of organophosphates in subsequent years does not require BEO signatures. As organophosphates have been used in Mali since 2014, BEO signatures are not required on the annual Letter Reports.
9. This SEA contains an updated Pesticides Procedures section, which, together with the Safer Use Action Plan, constitute the elements of a PERSUAP.

APPROVAL OF ENVIRONMENTAL ACTION RECOMMENDED

2016-2021 SUPPLEMENTAL ENVIRONMENTAL ASSESSMENT FOR PRESIDENT'S MALARIA INITIAVE- INDOOR RESIDUAL SPRAYING (IRS) FOR MALARIA CONTROL IN MALI

The United States Agency for International Development, Global Health Bureau has determined that the proposed IRS effort, as described in the 2016-2021 Supplemental Environmental Assessment: Indoor Residual Spraying for malaria control in Mali responds to the needs of the community and country as it relates to managing malaria in Mali, and also conforms to the requirements established in 22 CFR 216.

This document does not mandate the execution of the proposed IRS, rather, it documents the environmental planning and impact analysis executed by the IRS team in preparation for the proposed action. The design and standards of operation of the IRS program are established to avoid and reduce any potential impact. USAID has concluded that the proposed action, when executed as described in the Supplemental Environmental Assessment and the PMI Programmatic Environmental Assessment for IVM (2012), is consistent with the Government of Mali's and PMI's goal of reducing malaria incidence in Mali while minimizing negative impact to the environment and to human health.

The proposed actions recommended for approval in this 2016 SEA are:

1. The continuation of IRS implementation using pyrethroids, carbamates, organophosphates, and/or chlorfenapyr when recommended by WHOPES, where appropriate, based on the evaluation of criteria such as transmission rate, vector susceptibility, residual effect, appropriate home and wall structure, economic factors, and ecological/human health impacts.
2. This SEA will maintain nationwide coverage (including the new district, Fana) where IRS may be implemented as decided by the National Malaria Control Program and PMI for the 5-year period from 2016 to 2021.
3. This SEA authorizes small, closely supervised studies or hut trials to study new IRS insecticides such as chlorfenapyr, once the insecticide has been submitted for Phase III WHOPES evaluation and country-level required documentation has been submitted.
4. Due to the need to protect the population in buffer zones of protected areas from malaria, and given the successful record of PMI in implementing IRS in Africa without significant environmental consequences, it is proposed to allow IRS in buffer zones if needed and required by the PNLP to protect the population in these areas from malaria, using the strict protocols and procedures contained in the PMI Best Management Practices (BMP) manual, and observing all precautions and prescriptions in this SEA. However, spraying in these areas will not be done unless approved by the relevant Malian environmental authorities and all other competent agencies.

The Safer Use Action Plan (Section 7) and the updated Environmental Mitigation and Monitoring Plan (EMMP) for Mali (Annex A) provide detailed guidance on the performance of all activities associated with IRS. Through the use of this and other guidance, PMI has maintained an excellent record of success in executing IRS without substantial environmental or human health impact.

CLEARANCE:

Mission Director: _____ Date: 6/16/2016

USAID/Mali Gary C. Juste

CONCURRENCE:

Global Health Bureau Environmental Officer _____ Date: _____

Rachel Dagovitz

ADDITIONAL CLEARANCES:

Africa Bureau Environmental Officer _____ Date: _____

Brian Hirsch

Acting Health Office Director: ___-signed-___ Date: 05/05/2016
USAID/Mali Bijou Muhura

PMI Resident Advisor: ___-signed-___ Date: 05/03/2016
PMI/Mali Jules Mihigo

Deputy Mission Environmental Officer: ___-signed-___ Date: 05/03/2016
USAID/Mali Souleymane Sogoba

Regional Environmental Officer: _____ Date: 06/15/2016
USAID/Sahel Regional Office Jean W. Camilien Saint-Cyr

Acting Deputy Mission Director: _____ Date: 16 June 16
USAID/Mali Loraine Sherman

CLEARANCE:

Acting Mission Director: _____ Date: _____

USAID/Mali Erin Pacific

CONCURRENCE:

Global Health Bureau Environmental Officer _____ Date: _____

Rachel Dagovitz

ADDITIONAL CLEARANCES:

Africa Bureau Environmental Officer _____ Date: _____

Brian Hirsch

Acting Health office Director _____ Date 5/5/2016

USAID Mali Bijou Muhura

CDC PMI Advisor: _____ Date: 05/03/2016

PMI/Mali Jules Mihigo

Deputy Mission Environmental Officer: _____ Date: 05/03/16

USAID/Mali Souleymane Sogoba

Regional Environmental Advisor: _____ Date: _____

USAID/West Africa Henry Areetey

USAID
FROM THE AMERICAN PEOPLE

Kristen George <kgeorge@usaid.gov>

SEA

Rachel <racheldagovitz@hotmail.com> Mon, Jun 13, 2016 at 1:53 PM
To: Kristen George <kgeorge@usaid.gov>

Hi Kristen,
That language works regarding the buffer zones. My loaner computer wasn't imaged right so I can't use Wifi. I used an older word version at the lodge to review the SEA.. I am pretty sure that a group picture is loaded upside down. I just highlighted the language so don't worry about seeing the attachment. With that change I give my email concurrence.
Rachel

Sent from my T-Mobile 4G LTE Device
[Quoted text hidden]

2 BACKGROUND & PURPOSE

2.1 PRESIDENT'S MALARIA INITIATIVE

When it was launched in 2005, the goal of PMI was to reduce malaria-related mortality by 50% across 15 high-burden countries in sub-Saharan Africa through a rapid scale-up of four proven and effective highly malaria prevention and treatment measures: insecticide-treated mosquito net (ITN); indoor residual spraying (IRS); accurate diagnosis and prompt treatment with artemisinin-based combination therapies (ACTs); and intermittent preventive treatment for pregnant women (IPTp). With the passing of the Tom Lantos and Henry J. Hyde Global Leadership against HIV / AIDS, Tuberculosis, and Malaria Act in 2008, PMI developed U.S. Government Malaria Strategy for 2009-2014. In 2015, PMI launched the next six-year strategy, setting forth a bold and ambitious goal with specific objective. The PMI Strategy for 2015-2020 takes into account the progress over the past decade and the new challenges that have arisen.

PMI will assist Mali to achieve the following targets in populations at risk for malaria by the end of 2020:

- Reduce malaria mortality by one-third from 2015 levels in PMI-supported districts, achieving an 80 percent reduction from PMI's original 2000 baseline levels.
- Reduce malaria morbidity in PMI-supported districts by 40 percent from 2015 levels.

2.2 HISTORY AND SCOPE OF IRS IN MALI

In 2013, a five-year strategic plan (2013–2017) was developed and published by the NMCP and partners. Its goal is to "reduce the burden of malaria to a level that will not constitute a major cause of morbidity and mortality nor a barrier to economic and social development."

The new NMCP Strategic Plan aims to achieve the following targets by 2017:

- Reduce malaria mortality to near zero
- Reduce malaria morbidity by at least 75% as compared to 2000 levels
- Reinforce/strengthen the NMCP coordination and management capacity

Expected results to be achieved by the 2013-2017 strategic plan are as follows:
- At least 80% of the population at risk of malaria is using ITNs, including pregnant women and children under five years old;
- At least 80% of pregnant women have received three sulfadoxine-pyrimethamine (SP) doses as intermittent preventive treatment for pregnant women (IPTp) during their pregnancy;
- At least 80% of children under five received the four full courses of seasonal malaria chemoprevention (SMC) in selected zones;
- At least 90% of suspected malaria cases are confirmed using microscopy or RDTs before treatment, at all levels of the health system including the ASC level;
- At least 90% of confirmed malaria cases receive appropriate malaria treatment both for severe and uncomplicated cases as indicated in the national guidelines;
- At least 80% of the population is protected by indoor residual spraying (IRS) in IRS target zones;

- At least 80% of the general population knows what interventions are recommended to prevent malaria;

- At least 90% of emergency cases and malaria epidemics are detected within two weeks and receive an appropriate response.

To contribute to the NMCP Strategic plan (2013–2017), a National IRS Strategy was refined in 2015 and its goal is to scale up well-targeted, efficient and cost-effective IRS operations and build capacity for national scaling up of IRS to all at-risk populations by 2019. This strategy will operate under the auspices of IVM on the basis of sound local evidence on disease eco-epidemiology. As malaria transmission continues to decline in Mali, stratification of malaria epidemiology using both parasitological and entomological data will be important in order to address potential disease outbreaks. The stratification will show high malaria transmission foci which will allow for targeted IRS application and hence rational use of resources. In addition, with the threat of insecticide resistance, routine monitoring for effectiveness of IRS will be undertaken. The specific objectives of the strategy are:

1) To strengthen capacity for IRS operations in Mali
2) To deploy evidence-based high quality IRS operations in high malaria transmission and epidemic prone districts so as to disrupt transmission
3) To establish a sound mechanism of insecticide resistance management among malaria vectors
4) To strengthen advocacy, communication and social mobilization for IRS
5) To promote public-private-partnerships and community support for IRS

The President's Malaria Initiative has provided technical and financial support to the Mali NMCP to implement IRS since 2008. IRS was implemented in the districts of Koulikoro and Bla from 2008 to 2010 and then expanded to the district of Baroueli in 2011. The districts of Koulikoro, Bla, and Baroueli continued to benefit from IRS until 2015, when IRS was discontinued in Bla District. In 2016, Fana

district in Koulikoro region was added to Koulikoro and Baroueli, due to its high malaria burden. PMI is the only donor supporting IRS in Mali.

From 2008 to 2010, pyrethroids were the insecticide class used for IRS in Mali; in response to the development of resistance by the *Anopheles* vector, pyrethroids were replaced with carbamates between 2011-2013, followed by organophosphates in 2014 in the intervention zones.

2.3 IRS Country Coverage

Since 2008 IRS has been implemented in two regions in Mali, namely Koulikoro and Segou. In Koulikoro, Koulikoro District has been the only district to benefit from the operations, but expansion to a second district (Fana) is planned for in the 2016 campaign. In Segou, two districts were covered from 2008 to 2014, but only Baroueli is continuing from 2015-2016.

The principal IRS objectives in Mali in the 2015 campaign were:

- Cover at least 85% of the structures to be sprayed;
- Cover at least 85% of the population in both districts (Koulikoro and Baroueli).

Results fully reflect the success of the IRS 2015 campaign in Mali with a spray coverage rate of 99.68% for Koulikoro district and 99.29% for Baroueli district. Altogether, 133,527 structures were treated in both districts including 62,289 in Koulikoro and 71,238 in Baroueli. The number of people protected was estimated to be 494,205 including 220,524 people in Koulikoro and 273,681 people in Baroueli.

2.3.1 2016 Campaign Scope

In 2016, PMI will implement IRS as a vector control strategy in three districts. In addition to Koulikoro and Baroueli, PMI will spray a new third district, Fana. PMI in collaboration with NMCP selected Fana district because it had the highest malaria incidence rate in Koulikoro region in 2015. In addition, geographically it is located close to Bamako and on the way to Baroueli district, which will result in cost savings.

The goal of the 2016 campaign will be to cover up to 232,988 eligible structures in Baroueli, Koulikoro and Fana districts (73,528, 66,927 and 92,533 respectively). An organophosphate (Pirimiphos-methyl CS) will be used.

FIGURE 1: 2016 SCOPE OF PMI IRS IN MALI

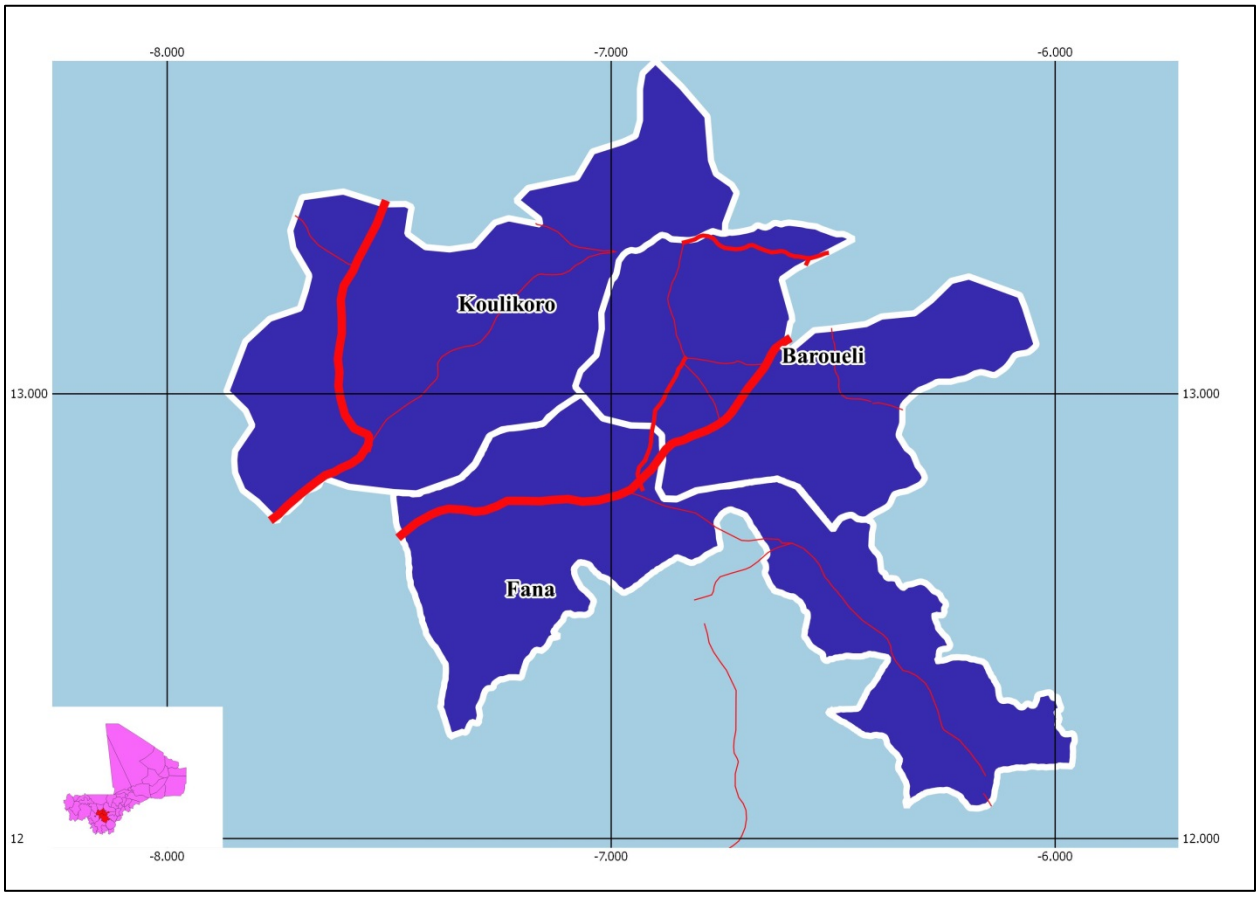


TABLE 1: 2016 PROPOSED SPRAYING SITES

District	Sites
KOULIKORO	Tienfala, Koula, Kolébougou, Sirakorola, Doumba, Chola, Kamani, Koulikoroba, Gouni, Tamani, Sinzani, Monzombala, Tombougou, Sirakorobougou, Nyamina, Tougouni, Kénékoun, Massala (18)
BAROUELI	Baroueli Central, Dougoufé, Boidié, Dotembougou, Garna, Gouendo, Kalake, Konobougou, Moabougou, Nianzana, Sanando, Seguela, Somo, Tamani, Tesserela, Wondobougou, N'gassola, Banido, N'djila, M'pebougou, Yerebougou, Dioforongo, Tigui (23)
FANA	Beléko, Dandougou, Diébe, Djelé, Djoumazana, Falako, Fana, Kerela, Koni, Markakoungo, Mena, Nangola, Seyla, Tingole, Bougoukourala, Kotoula, Kangoni, Konkon, Farakoro, Fougadougou, Sirakorodje, Toukoro (22)
TOTAL	**63**

FIGURE 2: BAROUELI HEALTH CENTERS

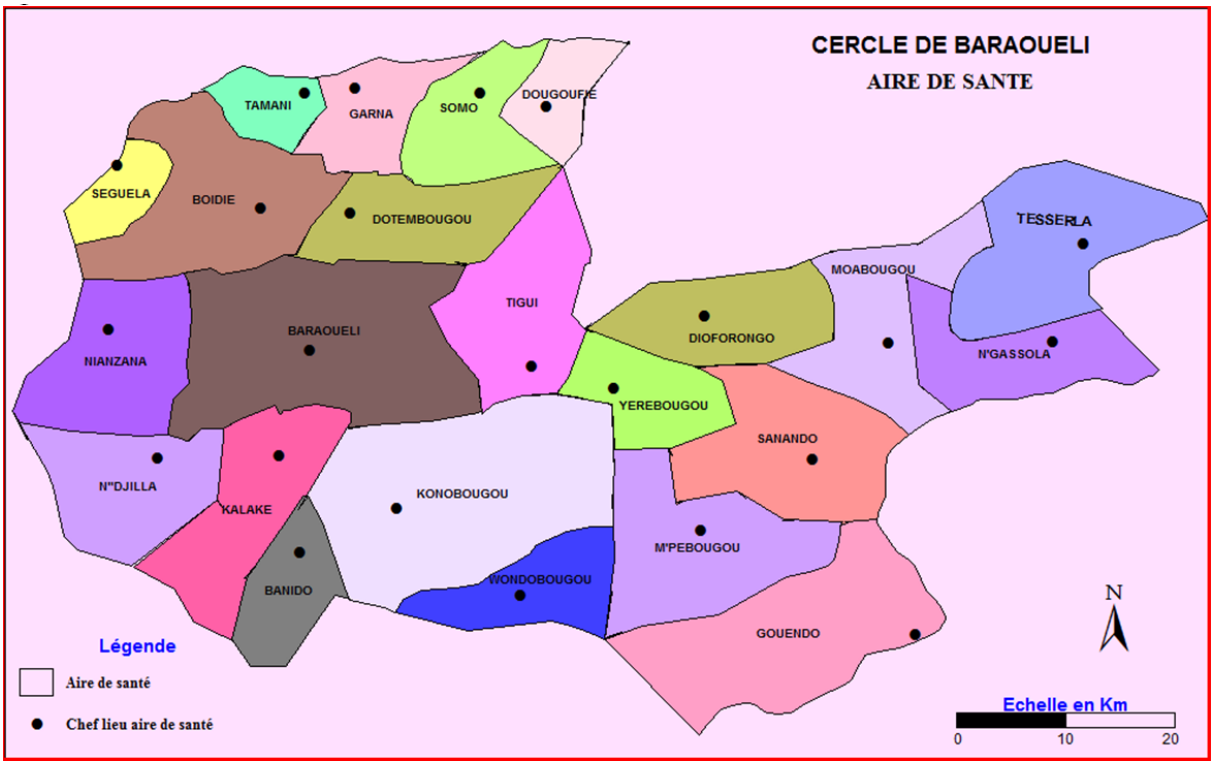


FIGURE 3: KOULIKORO HEALTH CENTERS

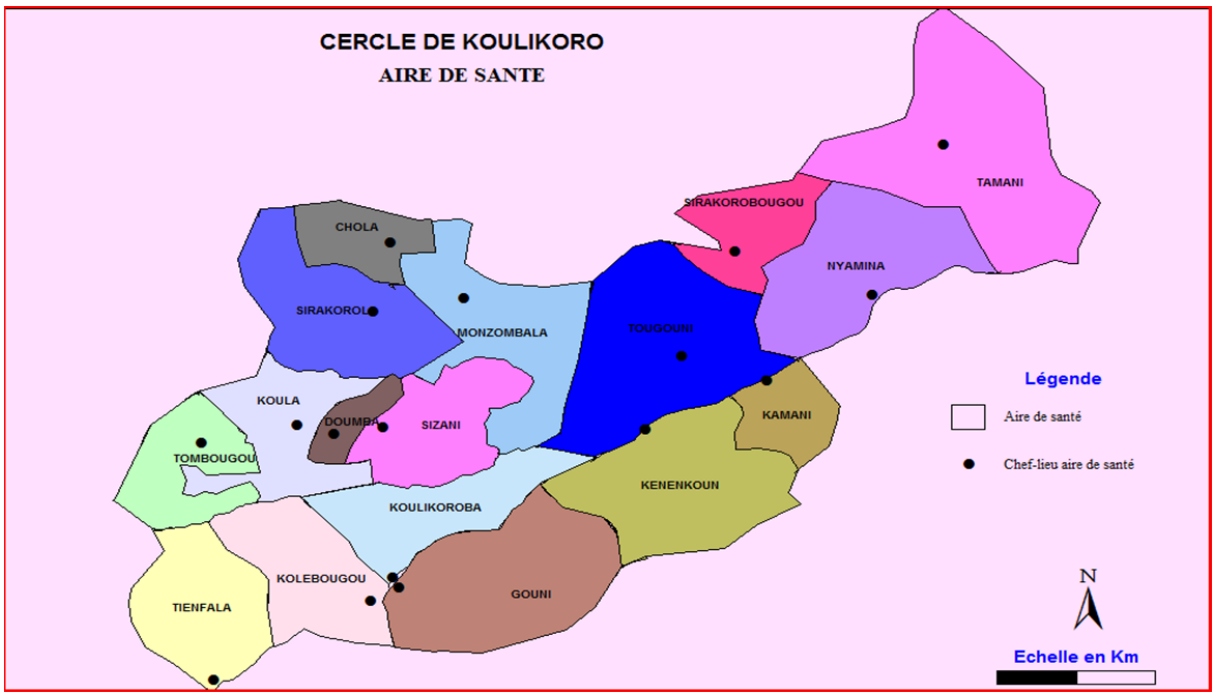
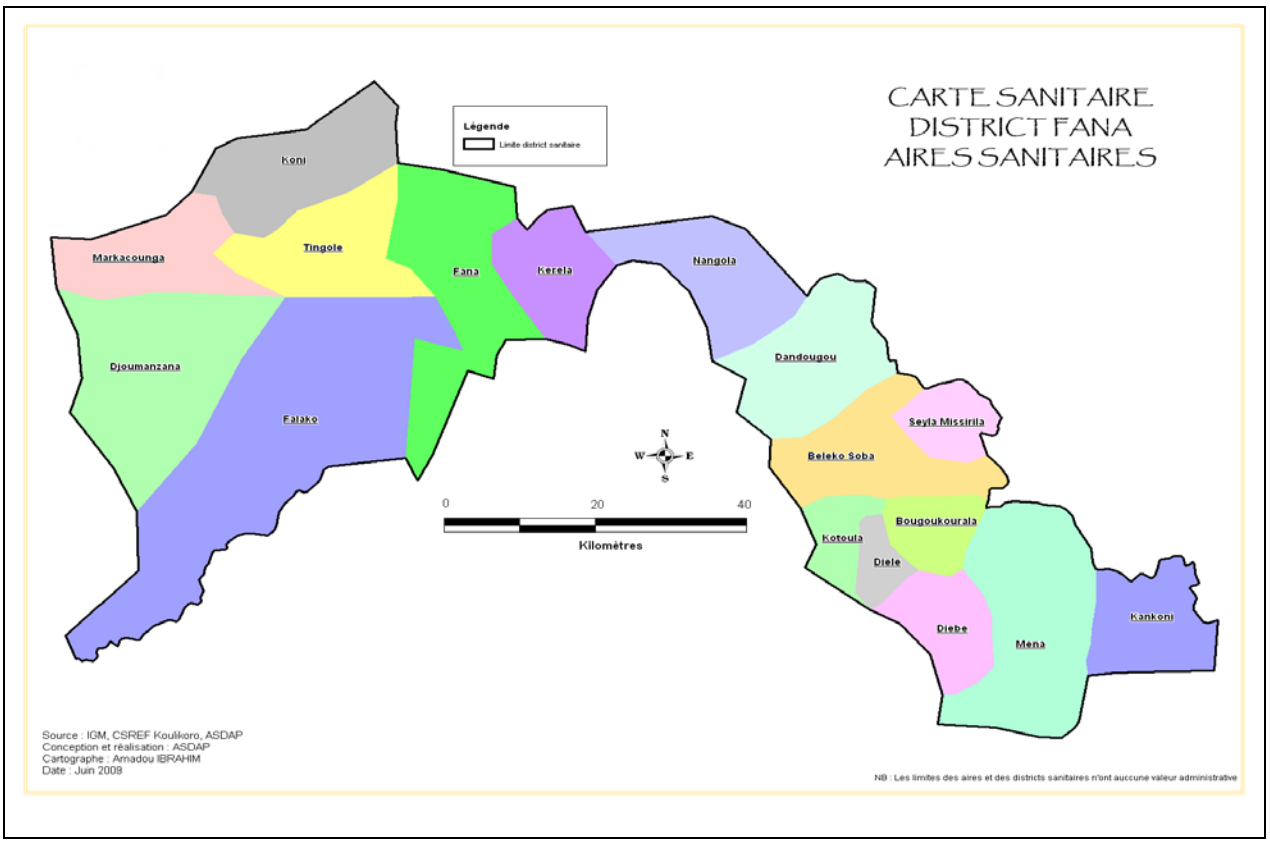


FIGURE 4: FANA HEALTH CENTERS



2.3.2 THE 2016 IRS CAMPAIGN ACTIVITIES PLANNING

Tables 2, 3, and 4 provide staffing plans, and highlight fixed and/or mobile soak pit (MSP) sites. The number of eligible structures is about 73,528 in Baroueli, 66,927 in Koulikoro and 92,533 in Fana.

Innovations to be made during the 2016 IRS campaign are using a "village approach"[1](in rural areas) and "area/quarter approach"[2] (for peri-urban areas). Both approaches are participatory and community-based because they enable community members to take ownership of IRS activities in situ. Advantages of these two approaches are:

- Saving in logistics (reducing transportation);
- Saving in salaries of actors involved in IRS;
- People's easier access and acceptance of IRS awareness messages.
- Continuing the replacement of "sotramas" by taxinis as means of transport will considerably reduce transport costs of sprayers, pesticides or any other equipment required for the success of operations.

[1]Village approach: Approach in which we will use in the different identified villages: MSP + taxini + SOP who live in the same village.

[2] Area/quarter approach: It is the same approach as Village approach but applied in the peri-urban areas

An additional innovation will be piloting the use of Tyvek coveralls by some of the MSP teams. The Tyvek suits are expected to provide a higher degree of protection and comfort for the spray operators, and provide the potential for limiting the clean-up equipment that must be carried for mobile spray teams.

TABLE 2: BAROUELI OPERATIONAL REQUIREMENTS & APPROACH, 2016

HEALTH AREA	Structures	Spray Operators	Team Leaders	Supervisors	Storekeepers	Washers	Guards	Strategy adopted
BANIDO	1968	5	2	1	1	1	1	Mobile team
BAROUELI	9248	52	13	1	1	7	1	Quarter Approach
BOIDIE	3492	13	4	1	1	2	1	Fixed
DOTEMBOUGOU	1748	5	2	1	1	1	1	Mobile team
DIOFORONGO	1635	20	1	1	1	1	1	Village Approach
DOUGOUFIE	2930	7	2	1	1	2	1	Fixed
GARNA	2474	14	4	1	1	3	1	Fixed
GOUENDO	3385	9	3	1	1	2	1	Mobile team
KALAKE	3711	9	3	1	1	2	1	Fixed
KONOBOUGOU	8285	55	15	1	1	9	1	Quarter Approach
MOABOUGOU	3513	9	3	1	1	2	1	Fixed
M'PEBOUGOU	1507	17	1	1	1	1	1	Village Approach
N'DJILLA	1802	5	1	1	1	1	1	Fixed
N'GASSOLA	2051	25	1	1	1	1	1	Village Approach
NIANZANA	2939	10	3	1	1	2	1	Fixed
SANANDO	4708	14	4	1	1	3	1	Fixed
SEGUELA	2054	8	2	1	1	2	1	Fixed
SOMO	4195	13	3	1	1	2	1	Fixed
TAMANI	3206	10	3	1	1	2	1	Fixed
TESSERELA	2311	10	3	1	1	2	1	Fixed
TIGUI	2554	6	2	1	1	1	1	Fixed
YEREBOUGOU	1552	6	2	1	1	2	1	Fixed
WONDOBOUGOU	2260	6	2	1	1	1	1	Fixed
Total	73528	328	79	23	23	52	23	

TABLE 3: KOULIKORO OPERATIONAL REQUIREMENTS & APPROACH, 2016

HEALTH AREA	Structures	Spray Operators	Team Leaders	Supervisors	Storekeepers	Washers	Guards	Strategy adopted
CHOLA	2352	6	2	1	1	1	1	Mobile team
DOUMBA	1900	25	1	1	1	1	1	Village Approach
GOUNI	4435	11	3	1	1	2	1	Fixed
KAMANI	2609	6	2	1	1	1	1	Fixed
KENENKOUN	5832	14	3	1	1	2	1	Fixed
KOLEBOUGOU	4820	27	6	1	1	4	1	Quarter Approach
KOULA	2946	8	2	1	1	2	1	Mobile team
KOULIKOROBA	3167	19	5	1	1	4	0	Quarter Approach
MONZOMBALA	3427	9	3	1	1	2	1	Fixed
NYAMINA	6706	17	4	1	1	3	1	Fixed
SIRAKOROLA	8007	16	4	1	1	3	1	Fixed
SIRAKOROBOUGOU	2304	6	2	1	1	1	1	Fixed
SIZANI	2012	38	1	1	1	1	1	Village Approach
TAMANI	4748	11	3	1	1	2	1	Fixed
TIENFALA	2669	6	2	1	1	1	1	Fixed
TOMBOUGOU	2238	6	2	1	1	1	1	Mobile team
TOUGOUNI	4420	10	3	1	1	2	1	Fixed
MASSALA	2335	35	2	1	1	1	1	Village Approach
TOTAL	66927	270	50	18	18	34	17	

TABLE 4: FANA OPERATIONAL REQUIREMENTS & APPROACH, 2016

HEALTH AREA	Structures	Spray Operators	Team Leaders	Supervisors	Storekeepers	Washers	Guards	Strategy adopted
BELECO	8 951	25	5	1	1	4	1	Quarter Approach & Classical
BOUGOUCOURALA	2 000	6	1	1	1	1	1	Village Approach, Soak pit Mobile
DANDOUGOU	5 374	15	3	1	1	2	1	Village Approach, Soak pit Mobile
DIEBE	3 888	11	2	1	1	2	1	Village Approach, Soak pit Mobile
DIELE	1 240	3	1	1	1	1	1	Village Approach, Soak pit Mobile
DJOUMAZANA	6 199	17	3	1	1	2	1	Village Approach, Soak pit Mobile
FALAKO	6 705	19	4	1	1	3	1	Quarter Approach & Classical
FANA	15 343	43	9	1	1	6	1	Quarter Approach & Classical
FARACORO	1 863	5	1	1	1	1	1	Village Approach, Soak pit Mobile
FOUGADOUGOU	2 406	7	1	1	1	1	1	Village Approach, Soak pit Mobile
KANKONI	2 000	6	1	1	1	1	1	Village Approach, Soak pit Mobile
KERELA	4 205	12	2	1	1	2	1	Village Approach, Soak pit Mobile
KONI	3 200	9	2	1	1	1	1	Village Approach, Soak pit Mobile
KONKON	1 220	3	1	1	1	1	1	Village Approach, Soak pit Mobile
KOTOULA	3 109	9	2	1	1	1	1	Village Approach, Soak pit Mobile
MARKACOUNGO	5 591	16	3	1	1	2	1	Village Approach, Soak pit Mobile
MENA	6 414	18	4	1	1	3	1	Quarter Approach & Classical
NANGOLA	5 878	16	3	1	1	2	1	Village Approach, Soak pit Mobile
SEYLA	3 322	9	2	1	1	1	1	Village Approach, Soak pit Mobile
TINGOLE	3 624	10	2	1	1	1	1	Village Approach, Soak pit Mobile
Total	92533	257	51	20	20	38	20	

3 Proposed Action and Alternatives

This section describes the alternatives for malaria control that were considered in the preparation of this report, including those that were accepted or rejected. Alternatives considered include the following:

1. **Preferred action:** Establish annual IRS campaigns that spray pesticides of the pyrethroid, carbamate, and organophosphate classes and chlorfenapyr (when recommended by WHOPES) in high-risk districts and sectors identified by the evaluation of criteria such as transmission rate, vector susceptibility, residual effect, appropriate home and wall structure, economic factors, and ecological/human health impacts.
2. **No action alternative:** This action would discontinue PMI support for IRS activities in Mali.
3. **Spraying in alternative geographic regions:** This alternative would use different criteria to select alternative districts and sectors to spray.
4. **Using alternative pesticides:** This alternative would consider pesticides other than those recommended by WHOPES.
5. **Alternative technologies:** This alternative would consider methods other than IRS to achieve the stated goals of reduction in malaria mortality and morbidity.

3.1 Description of Proposed Action

The preferred action is to implement an IRS program in selected communities, choosing among the pyrethroid, carbamate, and organophosphate classes (as well as chlorfenapyr, when recommended by WHOPES), considering current entomological, epidemiological, logistical, environmental, and economic conditions. The pesticide to be used will be determined by a process explained in Pesticide Procedures part b (Section 6.2).

3.2 No Project Alternative

Indoor residual spraying is one of the critical interventions in the control of the spread of malaria. A no project alternative will result in rising rates of infections, transmissions, mortality and morbidity due to the increased prevalence of infected vectors. Therefore, the "no action alternative" does not meet the overall goals of Mali National Malaria Control Program and the President's Malaria Initiative.

3.3 Alternative IRS Geographical Sites Considered

In IRS implementation in Mali, areas considered as highly malarious and those areas that fit within the NMCP strategic plan are considered, while lower risk areas are not considered for IRS as an intervention. Using different criteria for selecting geographical sites would reduce the effectiveness and impact of IRS, decreasing progress towards the goals of the Mali National Malaria Control Program and the PMI program.

3.4 USE OF ALTERNATIVE INSECTICIDE(S)

For IRS to be implemented, a pesticide recommended by the World Health Organization Pesticide Evaluation Scheme (WHOPES) must be selected for use. WHOPES is an international institution that analyses and recommends pesticides to be used in IRS based on their effectiveness, cost, and toxicity to human health and the environment. The USEPA regulates and registers pesticide products and uses thereof in the United States, and provides guidance for foreign health interventions.

To date WHOPES has approved the use of pesticides within the following four classes of pesticides: pyrethroids, carbamates, organochlorines and organophosphates. Other alternative insecticides are not eligible for use under PMI guidelines. Organochlorines (DDT) are not proposed for use in this SEA.

It is further proposed to allow for small studies or hut trials to evaluate new IRS insecticides such as chlorfenapyr, once the insecticide has been submitted for Phase III WHOPES evaluation, and country-level required documentation has been submitted. The guidelines for laboratory testing and small and large-scale field trials are provided in *Test procedures for insecticide resistance monitoring in malaria vector mosquitoes* (WHO, April 2013).

PMI and their implementing partner will monitor WHOPES proceedings towards recommendation of new pesticides, but will seek to amend this SEA before there is any decision to use new WHOPES recommendations.

3.5 ALTERNATIVE TECHNOLOGIES

A full range of known, available technologies is continually considered for use by the stakeholders in malaria prevention and control efforts. It has been determined that IRS plays a significant part in malaria prevention in concert with other technologies.[3] The specific focus of this PMI project is IRS, and the role that PMI plays in Mali includes IRS. If other, viable approaches were to arise that would replace or improve upon the role that IRS plays, the National Malaria Control Program, PMI and its partners would evaluate them and proceed accordingly.

[3] PRESIDENT'S MALARIA INITIATIVE Malaria Operational Plan (MOP), Mali, 2016

4 AFFECTED ENVIRONMENT

4.1 OVERVIEW OF COUNTRY

4.1.1 GEOGRAPHY

Mali, a vast landlocked country in the heart of West Africa, is situated between 10° and 25° north latitude and between 4° East and 12° West longitude. It covers an area of 1,241,238 km², or about 1/24th of the total area of Africa. It shares 7,000 km of borders with seven countries namely: Senegal, Mauritania, Algeria, Niger, Burkina Faso, Ivory Coast and Guinea Conakry.

Without direct access to the sea, distances to available ports are: 980 Km (Conakry), 1225 km (Abidjan) and 1228 km (Dakar), 1967 Km (Lome), 1973 Km (Teman) 2096 Km (Cotonou) and 1430 km (Nouakchott).

4.1.2 DEMOGRAPHICS

According to UN data[4] Mali's population is approximately 15,768,000 inhabitants, with a male to female ratio of 101.6/100. Life expectancy at birth is estimated at 55 years. The vast majority of residents are sedentary (nomads represent 0.92% of the population) and mostly live in rural areas. Urban areas account for 39.1% of the population. The density of the country is around 12 inhabitants per km². This national average hides strong regional disparities.

The Mali has experienced rapid population increase for many years. Indeed, the growth rate is estimated at 3% between 2010-15. At this rate, Mali's population will almost double every 20 years with the consequences that may result in improved well-being. The population of Mali is characterized by its extreme youth. The under 15 represent 47.5% of the population, the 15-64 age group represents 48.4% and the population aged 65 and over is under 5%.

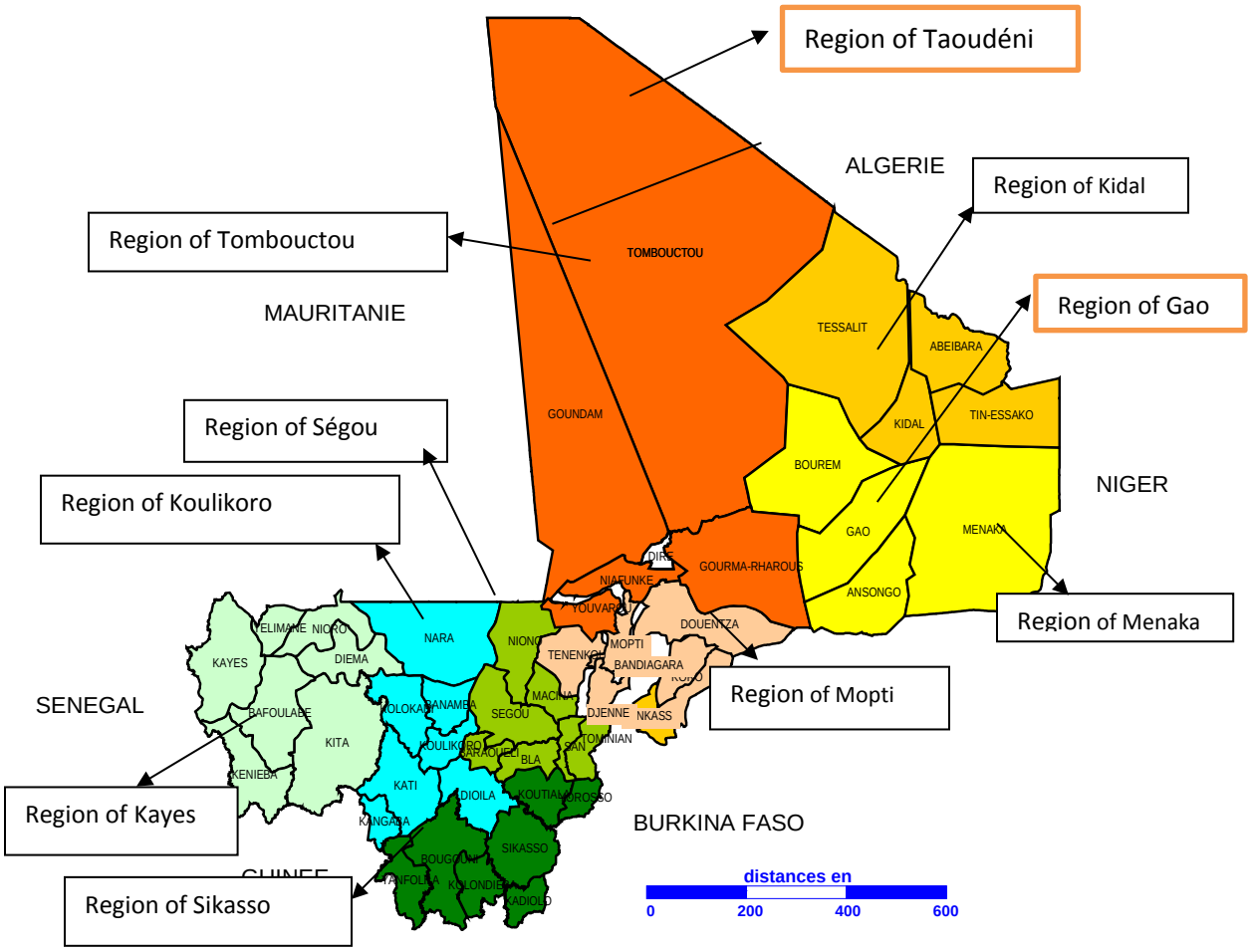
4.2 4.2 ADMINISTRATIVE AND POLITICAL UNITS – ESPECIALLY IRS STRUCTURE AND PARTICIPATION

Administratively, the country is divided into three distinct levels:

- 10 administrative regions (Kayes, Koulikoro, Sikasso, Segou, Mopti, Timbuktu, Gao, Kidal, Menaka and Taoudéni); and the District of Bamako which are also decentralized authorities;
- 49 districts (Cercles), which are both administrative subdivisions and decentralized authorities;
- 703 municipalities (including 19 urban).

Decentralization gives communities the responsibility of their land management but it remains to define the limits of national land granted by the state to each municipality

[4] http://data.un.org/CountryProfile.aspx?crName=Mali, accessed 04/28/16



Administrative map of Mali

4.3 PHYSICAL ENVIRONMENT

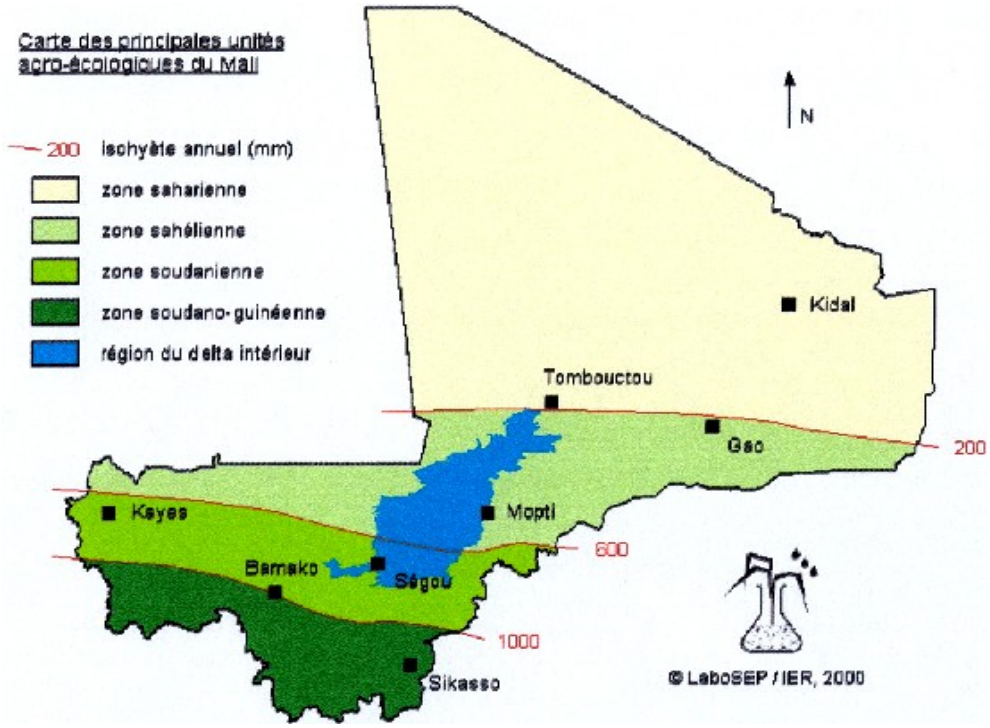
4.3.1 CLIMATE/ECO-REGIONS

In ecological terms, Mali is divided into five natural regions. In its northern part (Saharan zone), the country is 53% covered by the Sahara desert which, because of its extreme aridity, is not conducive to natural vegetation, human habitation and agriculture, except along the banks of the Niger River and around oases and ponds.

The Sahelian zone between 200 mm and 600 mm rain for three to four months a year contains significant quantities of surface water (Niger River, lakes and ponds) and fragile vegetation dominated by grasses and shrubs making it the main wildlife and nomadic pastoral activities area of the country. With rainfall of 600 mm to 800 mm per year and denser savannah vegetation, the Sudanese region is an area of both agriculture and sedentary livestock, breeding sometimes generating serious conflicts in the use lands. Better watered of all (more than 800 mm of rain over six months per year), the Guinean Sudanese area is still under-populated compared to its agro-ecological potential, mainly because of the prevalence of tsetse fly and other water-related diseases. Finally, the Inner Niger Delta and the lake area

are privileged flood areas in flora and fauna with coexisting important fisheries, breeding and flood recession agriculture.

FIGURE 5: MAP OF THE ECO-CLIMATIC ZONES OF MALI



Most of Mali can be characterized by high temperatures and low rainfall average. It may be noted that on average: the maximum under shelter temperature ranges between 34 and 37°C and the minimum between 21 and 23°C; maximum relative humidity varies between 31 and 75% and the minimum between 11 and 38%; the annual average potential evapotranspiration expressing climate evaporative demand varies between 1.534 and 2.003 mm against an average of less than 100 to more than 1000mm of rain; the average monthly sunshine ranges from 284.7 to 322.0 hours[5].

The four major climatic zones (excluding the Inner Niger Delta) also correspond to four major ecological zones with a fairly diverse agricultural potential:

- Saharan zone 632 000 km2 or 51% of the national territory. It corresponds to the northern part of Mali,
- The Sahel zone covers an area of 285 000 km2 or 23% of the territory. It includes two sub zones which are: the Sahelo Saharan zone in the north and the Sahelo Sudanese zone in the south,
- The Sudanese zone covers 215,000 km2 or 17.5% of the territory. Agricultural zone par excellence, it is increasingly an area of transhumance and refuge with tendency to settlement by farmers and herds. The rainfall distributed over five months varies from 600 mm in the north to more than 800 mm in the south.
- Sudano-Guinean in the extreme south of the country only covers 75 000km2 6% of the territory. Until recently, it was generally relatively untapped. The rainy season is spread over a period of 6 months and the heights vary from 800 to more than 1000 mm per year.

[5] Source: Direction Nationale de la Météorologie- Bulletin annuel, 2010

The Inner Niger Delta and Lake District are a specific ecological entity as a wet zone between the Sudanese and Sahelian zones. It covers more than 30,000 to 35,000 km2 and extends in a strip along the Niger River where recession agriculture is practiced.

Mali has two alternate seasons:

- A dry season ranging in duration from nine (9) months in the North (October to June) to six (6) months in the South (November to April)
- A wet season or rainy season, from May to October in the South, from July to September in the North.

There are more or less marked inter-seasons corresponding to "neither wet nor dry" months.

4.3.2 RAINFALL PATTERNS

Rains associated with squall lines are particularly important to Sahelian latitudes. Monsoon is the dominant factor of the rainy season. The climate is marked by a South to North decreasing annual rainfall (more than 1100 mm to less than 100 mm) for the period 1901-2010 (Figure 6).

FIGURE 6: DECLINING MONTHLY PRECIPITATION

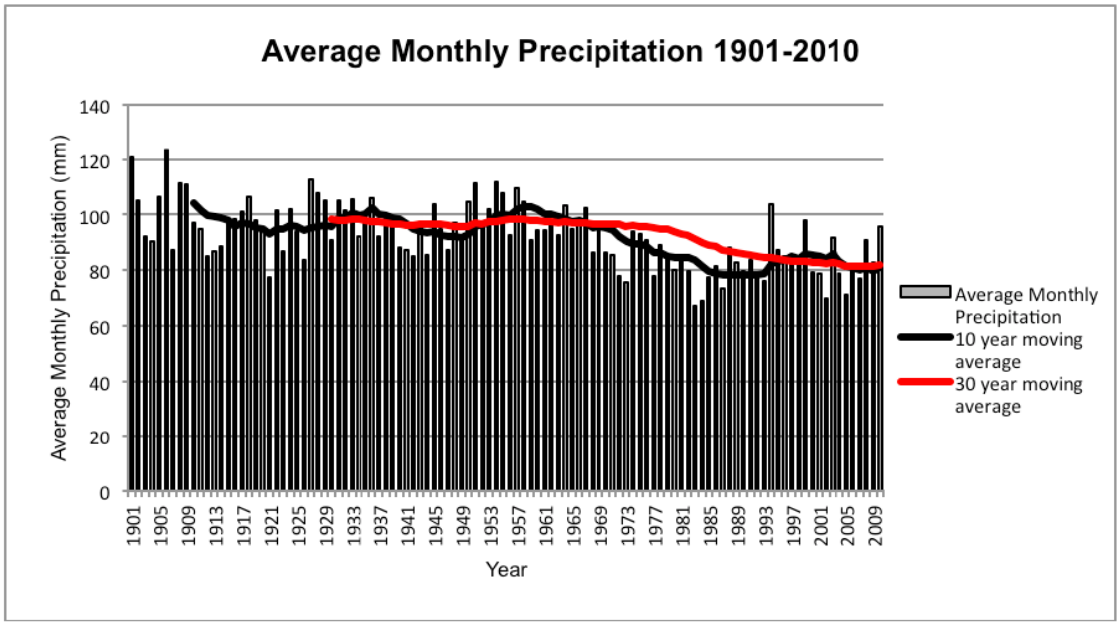


Figure 9: Average monthly precipitation across Kayes, Koulikoro, Segou, and Sikasso in Mali from 1901-2010. The 10-year moving average trend shows short-term patterns in precipitation, while the 30-year moving average suggests an overall shift in the climate regime to precipitation levels about 83% those pre-1960 (Source: mean WCRP GCOS GPCC FDP version6 0p5 prcp, accessed at http://iridl.ldeo.columbia.edu/expert/SOURCES/.WCRP/.GCOS/.GPCC/.FDP/.version6/.0p5/.prcp/T/12/0.0/runningAverage/T/12/STEP/Y/%2814%29%2810%29RANGEEDGES/X/%28-12%29%28-4%29RANGEEDGES%5BX/Y%5Daverage/figviewer.html?plottype=line&my.help=more+options on 6 June 2013).

The different climatic issues in Mali result in:

- A steady decline in the amount of rainfall, and high spatial and temporal variation,
- Lines of rain characteristics of the Sahel oriented from north to south over a distance of 500 to 750 Km often accompanied by strong winds and sometimes disastrous rains,
- A very high radiation throughout the year with average temperatures poorly differentiated,

- Increased temperatures southwest to northeast with maximum observed during the year up to or exceed 45°C while the minimum is rarely below 10°C,
- Strong values of potential evapotranspiration because of high temperatures, low relative humidity and strong winds,
- Persistence of drought causing quite significant rainfall deficits and changing isohyets south, so that migration has become increasingly a strategy to deal with these new precarious climatic and environmental conditions.

4.3.3 TOPOGRAPHY, GEOLOGY AND SOILS

The relief is characterized by the predominance of sandstone plateaus formed by the Mandingo Plateau, which stretches from north of the Niger River to the border of Senegal (its highest peak is 800 m) and Koutiala Plateau that stretches from south of the Niger River to the border with Burkina Faso. Its highest peak reaches 791 m in the Bandiagara escarpment. This relief is extended to the east by a string of residual buttes in Hombori region where the culmination of Mali is at 1,155 m.

North of the Mandingo Plateau extends a set of partially sand-covered plains, Hodh, with altitudes between 260 and 320m the lowest topographic area of Mali is the Basalt Plateau Kaarta that dominates the plains and erosion glaze of Senegal valley.

The center of the country is a vast alluvial plain known as the Inner Delta of the Niger River. In the area of Goundam, dunes and small rocky hills restrict the plains of the delta where lakes are formed. A second set of plains extends to the east of the delta between the loop of Niger in the north and the Dogon Plateau in the south. This area is known as Gourma where strings of fixed dunes and secluded dunes emerging from rocky or sand-covered plains exist.

In the northeast, Adrar des Iforas, which rises to 890 m is an extension of the crystalline massifs of central Sahara. It is bordered in the west by the fossil Tilemsi Valley. Southeast of the massif are plateaus and plains of Tamesna and in the North East of the Azaouak Valley.

There are ten major soil groups in Mali, based on geomorphology, original materials and the morphological and physicochemical properties. These soils cover 583,000 km2 south of the Sahara Desert, i.e. 47% of the total area of the country[6].

Three types of soils dominate the total arable land in Mali. First, slightly lateritic soils cover about 20,000 km2 of the Guinean zone in the extreme south of the country. The moderate fertility of these soils is partly offset by their depth. Then the ferruginous tropical soils predominate in the Sudan zone and two-thirds of the Sahelian zone, covering a total area of 173,000 Km2. These fertile soils are moderately vulnerable to erosion. Finally, vertisols and waterlogged soils occupy the Niger River Delta and the alluvial valleys of the country.

The risk of ecological and environmental problems is more severe for three soil groups: sand dunes, rocky land and soft land. Sand dunes predominate in the north of latitude 13°N and cover 27% of the surface of the protected/classified area. They are very vulnerable to wind erosion because of their sandy texture poorly protected by very sparse and degraded vegetation. Rocky and soft lands cover 29% of the protected area. Spread disparately across the country, these lands are very fragile because of their steep or moderate slopes and their less evolved soils, shallow and rocky and gravelly texture.

[6] Source : Evaluation Environnementale Stratégique –Projet d'Appui aux Sources de Croissance – Septembre 2004

Because of the fragility of these soil groups, 56% of the lands south of the Sahara Desert are unsuitable for agriculture. In fact, land classification according to their agricultural suitability shows that less than 15% of the total area of Mali is arable and therefore conducive to crops. The growing population pressure on the limited land area is the main cause of the threat of environmental degradation in Mali.

4.3.4 BIOLOGICAL ENVIRONMENT

The vegetation

The main vegetation characteristics are the low potential of woody biomass per hectare, irregular distribution in space, differences in tree size, and variable distribution of species often within the same type of natural forest. In addition, vegetation changes dramatically from isohyet 300 mm. South of this boundary woodland and savannah woodlands dominate and the most common species are: *Isoberlina doka, Danielle olivera, Vitellaria paradoxa Detarium microcarpum the Pericopsis laxiflora and Pterocarpus erinaceus*. North of isohyet 300mm savannas and tree-steppes dominate. The predominant species are the following: *Combretum glutinosum, Guiera senegalensis Acacia seyal Pterocarapus lucens, Grewia bicolor, desert date and Boscia spp.*

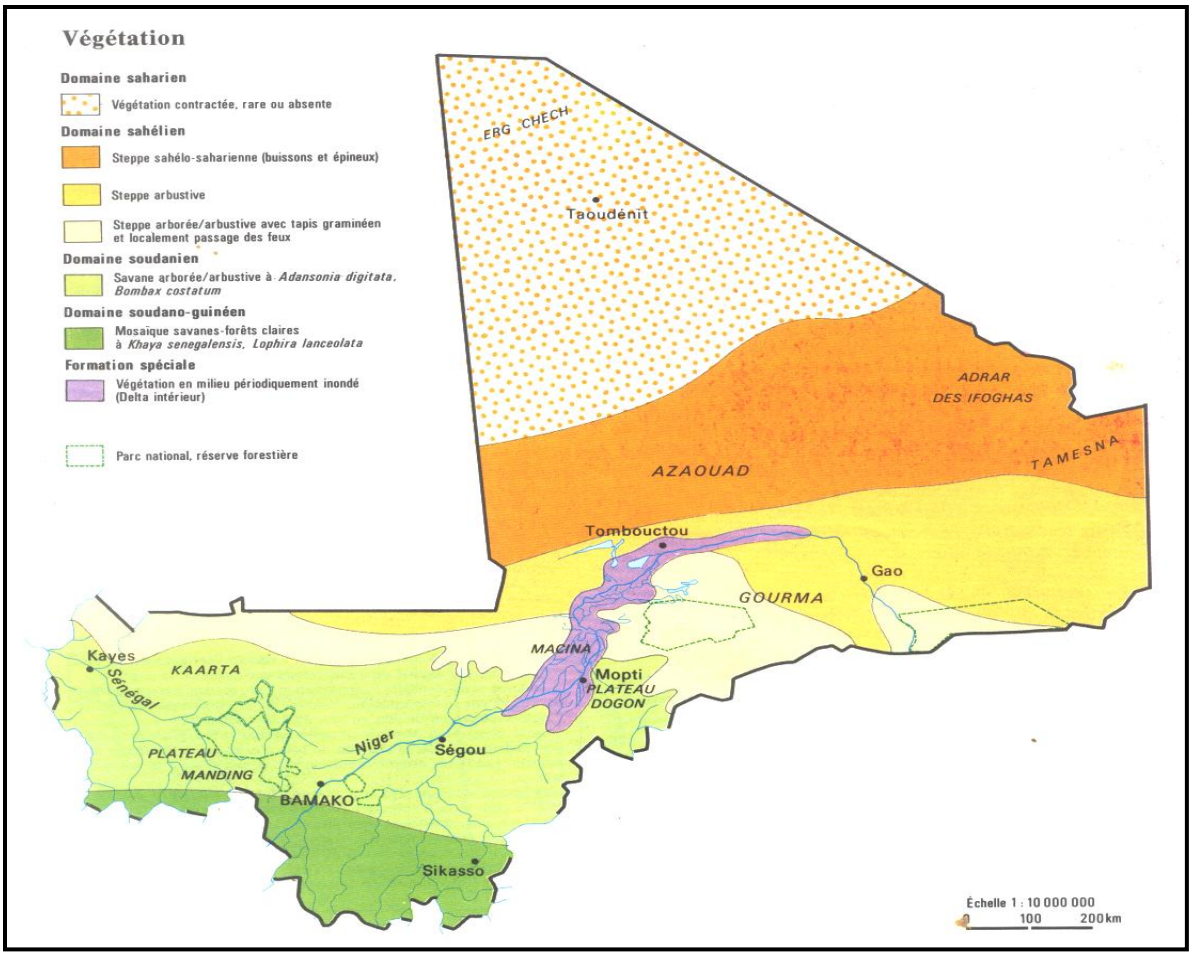
Most of the timber resources of the national forest estate, generally estimated at 100 million ha, reside in 32.4 million ha, or about 26% of the country area, of which 1.3 million ha are forest reserves and 3.9 million are protected areas (1.5 million ha in Mopti and 1.75 in Gao). In addition, areas covered by agricultural or anthropogenic vegetation (crops and fallows) are estimated at 15.7 million ha. The Land Resources Inventory Project studies (PIRT) and Woody Resources Inventory Project (PIRL) provide a detailed description of the vegetation of Mali.

The density of forest resources varies according to the region. It is 8.1 to 12.4 m^3 per hectare in the low rainfall and high population density Sahelian regions of Mopti and Segou; 13.8 to 17.0 m^3 per hectare in the western region of Kayes and central region of Koulikoro with agro climatic Sudano Sahelian and Sudanese characteristics and moderate population densities; and a maximum of 26.4 m^3 in the Sudanese and Sudano Guinean region of Sikasso, where population densities are still low especially in the wetter parts. In the latter region, over 75% of plant biomass is found in natural forests. Planted trees are 10 to 18% of the total woody biomass in cultivated areas, indicating the degree of integration of trees in the agricultural system.

Deadwood represents 3% of the total volume of woody biomass, the highest rates of tree mortality are found in the administrative districts of the Sahel such as Segou (11%), Bla (6.5%) and Youmarou (5%).

Wetlands

The main Malian wetlands are associated with rivers. The rivers of the Senegal River system, as well as the tributaries of the Niger River, have small floodplains. The largest wetland of Mali is where the Niger flows through the bottom of an ancient lake of prehistoric times. Due to land flatness, the river divides into many channels and lakes, and forms what is commonly known "the Inner Niger Delta." The "Diais" are another type of wetland: this is tracts of wetlands dotted with water holes occupying the old fossil bed rivers or isolated depressions.



Source: PNAE/PAN-CID, 1998, MALI)

Wildlife

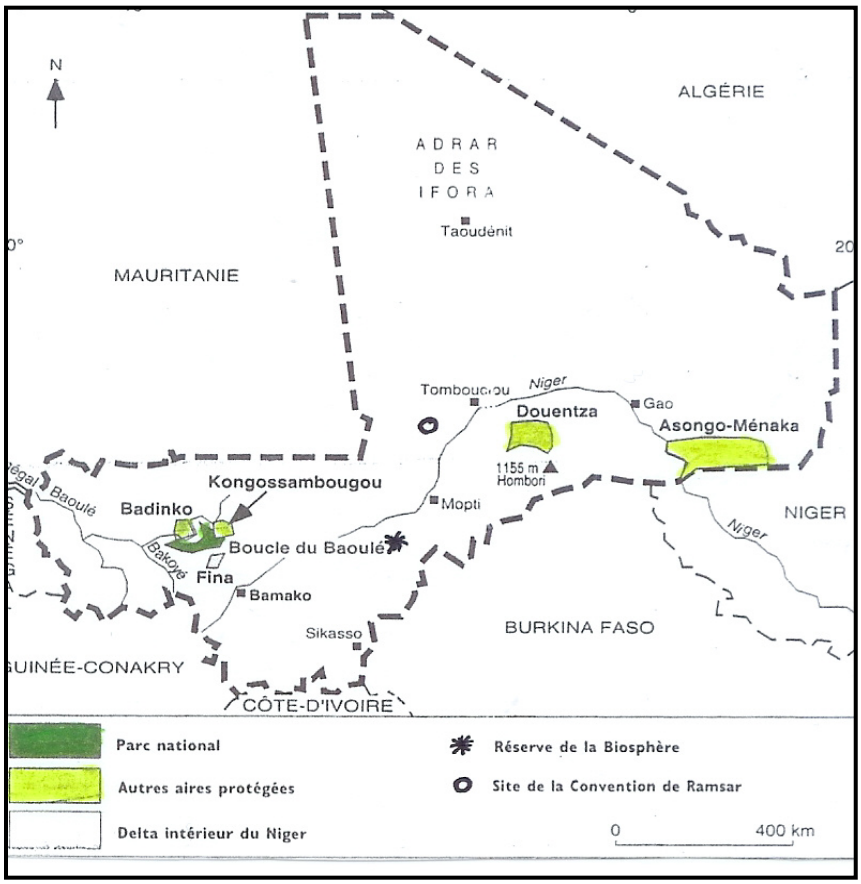
Mali has great wildlife potential due to the country's ecology diversity and abundance of vegetation in some agro-ecological zones. This fauna includes all types of large mammals and birds of the African savannah. Bird life is rich, with some 640 species recorded, including 15 rare. The Inner Niger Delta, which spreads over 40,000 square kilometers, is a very particular wetland. It consists of 3 Ramsar sites of international importance: Walado Debo, Lake Horo and Seri plain recognized World Heritage to be saved, totaling 162,000 ha. Alone it is home to nearly 350 species of which 108 are migratory.

Wild animal population evolution shows a clear downward trend resulting from the combined effects of migration and human settlement, agricultural pressure, drought and bushfires. These factors have caused a significant deterioration in wildlife habitat. Endangered main species are, among other herbivorous mammals (buffalo, elephant, and elk), carnivorous mammals (lions and leopards) and reptiles (crocodiles).

Poaching makes wildlife management more complicated in Mali. Hunting is practiced both as a subsistence activity and for socio-cultural reasons. In some of the regions richest in game, such as the southern administrative districts of Bougouni and Yanfolila, up to 87% of farmers use hunting as an activity which is second in importance to agriculture. Notwithstanding its importance as a source of

food intake, poaching is a major concern in these areas to the extent that it helps to increase the rate of wildlife depletion[7].

FIGURE 7: MAP OF PROTECTED ZONES OF MALI



(Source: Protected Zones of Africa)

4.3.6 MAJOR WATER BODIES

Two largest rivers of West Africa flow across Mali, Niger (4,200 km long, including 1,700 km in Mali) and Senegal (1700 km). These two rivers with their tributaries form an important river system in huge watersheds (Niger 300,000 km2 and Senegal 155,000 km²) that Mali shares with 12 countries. The total flow potential of these two river systems is estimated at 56 billion m³ per year, or about, a rate of 1.776 m³/s. In these basins, nearly 400 wetlands (floodplains, lakes, ponds, wadis, etc.) have been identified; some like Lake Walado-Debo, Lake Horo and Séri plain are listed Ramsar sites, including, recently, the Inner Niger Delta as a whole, making it the second largest such recognized wetland in Africa.

These river basins in which almost all of the population of Mali lives play an essential role in national economy. They are the drivers of development of economic activities (drinking water, agriculture, livestock, fisheries, industry, transport and crafts...). The other equally important activities such as tourism and mining also benefit from these rivers and their tributaries.

[7] Source: CNRST; Programme National d'Adaptation aux Changements Climatiques, Mali, 2007

Although theoretically abundant, surface water and groundwater resources are highly threatened by:

- waste and/or unsound management of irrigation systems (especially with the large irrigation systems such as Office du Niger);
- sedimentation and/or siltation of rivers, lakes and ponds;
- various types of pollution;
- annual deposition of 13 million tons of silt in major rivers.

These various phenomena produce:

- annual losses estimated at 30,000 billion cubic meters of water[8] in the Inner Niger Delta;
- pollution of surface and ground water aquifers vicinity of population concentration, due mainly to discharge of domestic waste water and household waste into rivers and streams, and industrial discharges have often a high content of toxic elements (e.g. from tanning or gold mines) that directly threaten surface water and groundwater by infiltration.
- A modification of the natural system of floods resulting in significant transformation in traditional production systems based on flood recession crops and also decreases the areas of natural pastures often leading to land conflicts between farmers and herders.

Although there is considerable potential groundwater exploitation is facing a very uneven spatial distribution, the difficulties of mobilization and constraints of access to water (depth of groundwater).

4.4 PROTECTED AREAS

A study on African Protected Areas highlighted protected areas in Mali with the features relating thereto. Despite various threats, our country still has few natural areas that can be saved. They are classified and protected forest areas in the southwest of the country and of particular importance for national and world perspective, because these areas still contain most of the mammalian diversity of Mali.

TABLE 5: MALI PROTECTED AREAS

Protected areas	Characteristics and specificities of the area
Boucle du Baoulé	- Wildlife Reserve of 1,200,000 ha - Vegetation dominated by bushland or wooded - Presence of a herd of elephants - Wildlife Presence: gazelle, hipotrague, warthogs, jackals, spotted hyena, lion, pale fox, civet etc. - Presence of diverse bird and many reptiles
Gourma (or Douentza reserve or Elephant reserve)	- Wildlife Reserve of 1,200,000 ha - Vegetation dominated by tree or shrub savannah - Presence of elephant herd - Fauna presence: gazelle, antelope, warthogs, jackals, spotted hyena, lion, pale fox, civet etc. - Presence of diverse bird and many reptiles

[8]CNRST/Projet Climat, 2003 : Vulnérabilité et adaptation des ressources en eau aux effets des changements climatiques dans les bassins de Sankarani et du Baoulé Avril 2003

Ansongo-Ménaka (or Giraffes reserve)	- Wildlife Reserve of 1,750,000 ha - Bordered by the River Niger, with lots of ponds - The eastern part presents a more shrub facies - Population of giraffes in the past, but now reduced or wiped likely

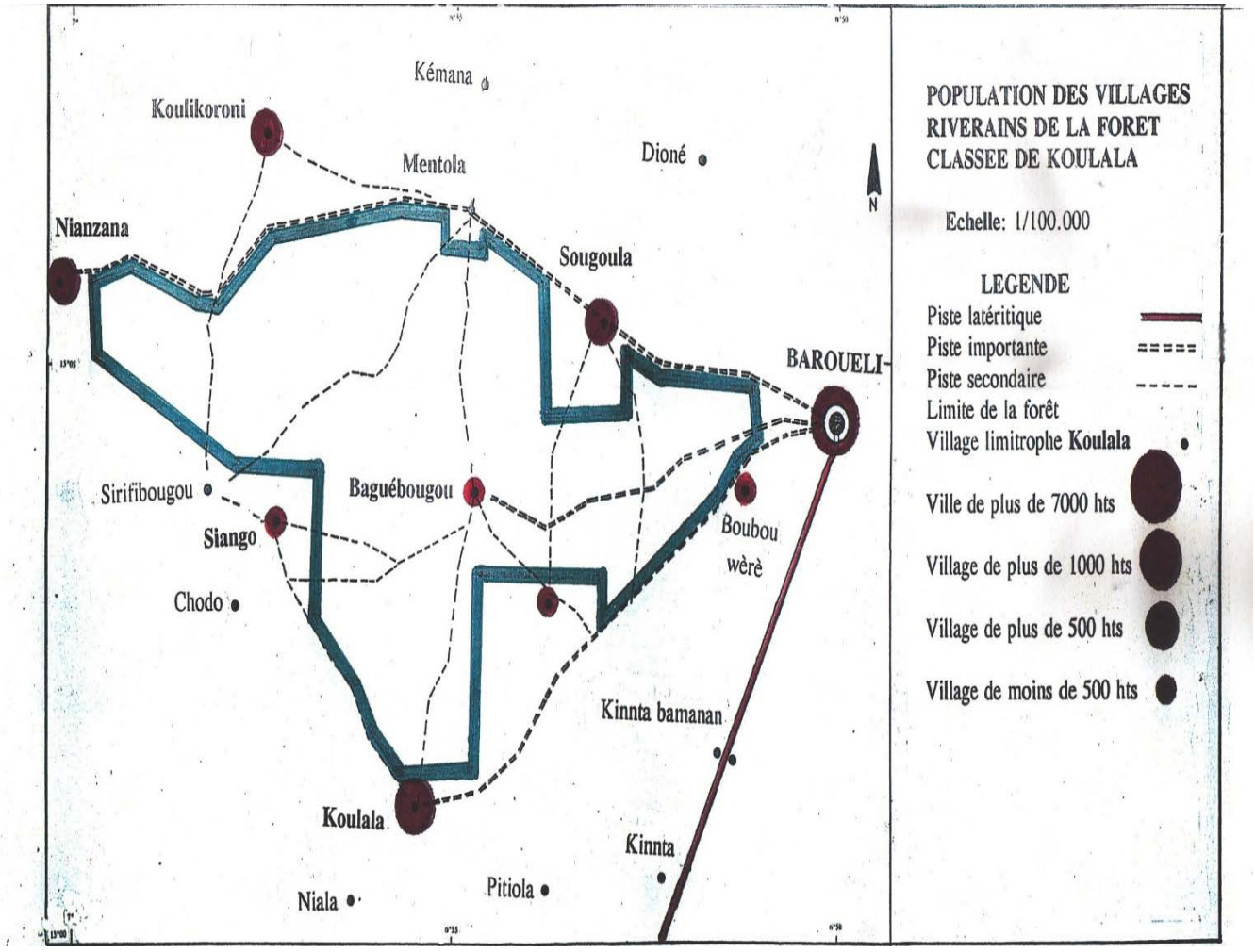
(Source: Protected Areas of Africa)

4.4.1 PROTECTED FORESTS IN IRS INTERVENTION ZONES

Baroueli

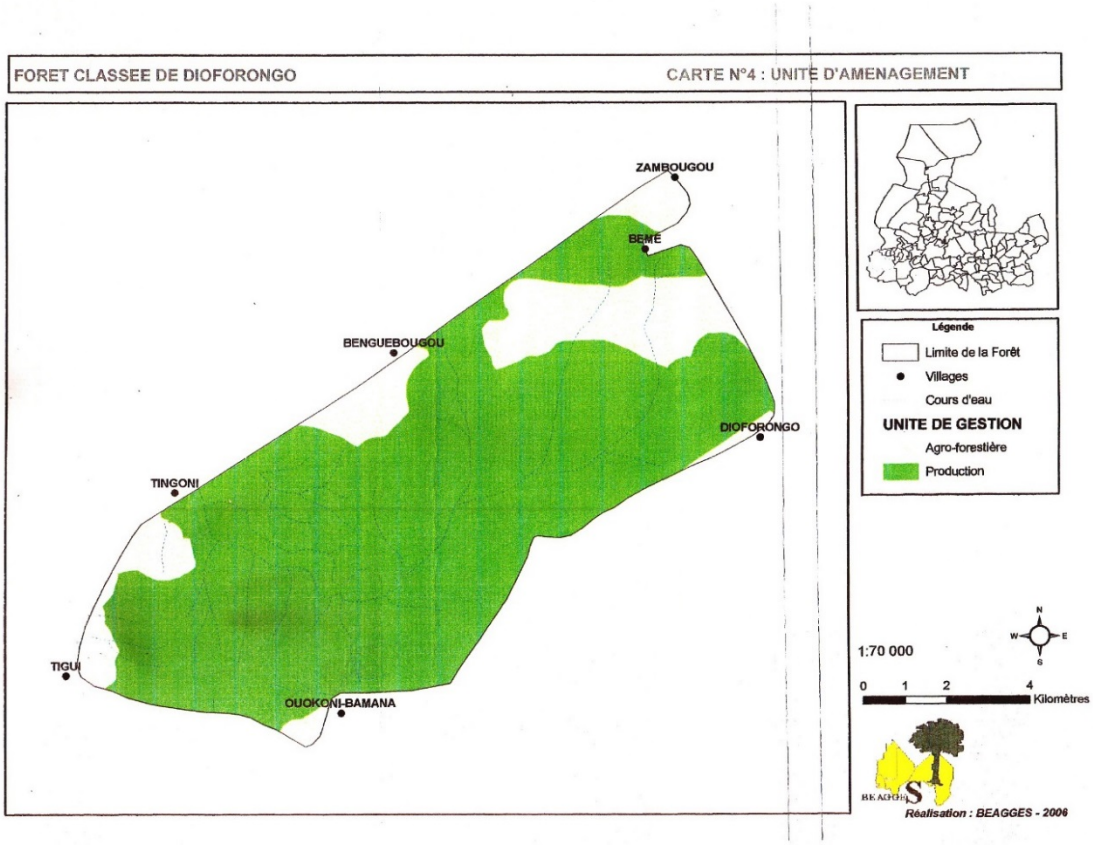
According to Baroueli head of cantonment of water and forests, there are two (2) protected forests in the district in which one is co-managed with communities. In addition, there are seventeen (17) protected massifs (forbidden) in the municipalities of Konobougou, Kalaké and Sanando.

FIGURE 8: POPULATION OF VILLAGES IN THE KOULALA



Covering an area of 6,500 hectares, the forest of Koulala was classified in accordance with Order No. 5880 SEF of August 12, 1954. The forest of Djoforongo (10,000 ha), straddling the districts of Baroueli and Segou was classified in accordance with Order No. 4371 SEF of September 22, 1948.

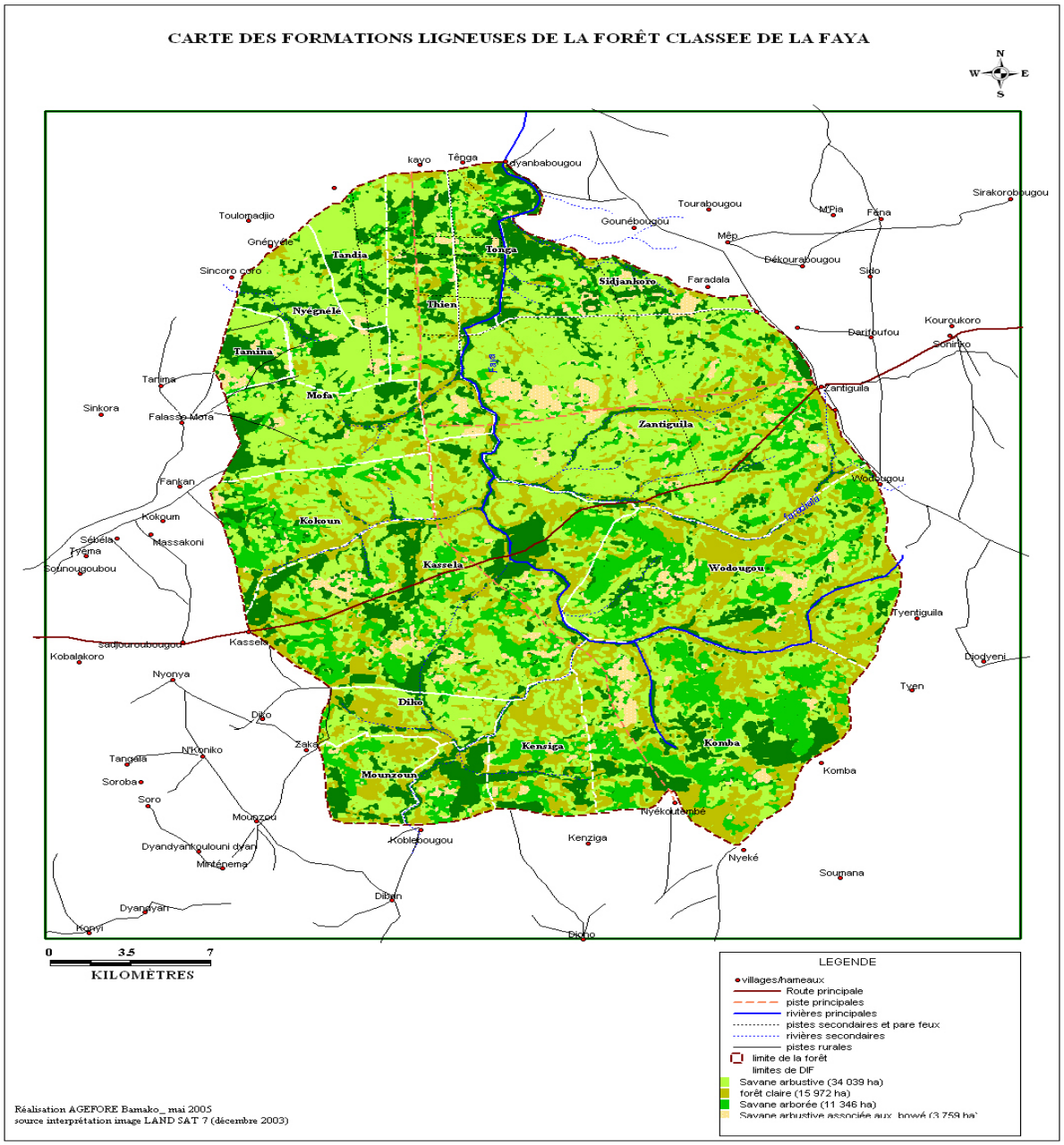
FIGURE 9: DJOFORONGO FOREST



Koulikoro

La Faya is located 40 km east of Bamako and administratively it is in the region of Koulikoro, straddling the districts of Kati, Koulikoro, Dioïla and a part of Fana. Straddling the Bamako-Segou road, the Faya Forest covers a total area estimated at 80 000 ha. The peculiarity of La Faya is that this forest is about 5 km from Gouni (Health District Koulikoro) and about 25 Km from Markakoungo (Fana Health District). The Faya Forest was classified by Order No. 40-54 of November 7, 1943 of the Governor General of French West Africa.

FIGURE 10: FAYA FOREST



4.5. AGRICULTURE AND ORGANIC FARMING

Agriculture

Rain-fed agriculture is practiced mainly in southern isohyet 300 mm. Food production is mostly based on rain-fed cereals in the country (millet/sorghum/maize, fonio, rice). Millet, whose culture was dominant in the semi-arid Sahel region, tends to be replaced by the short-cycle sorghum. In northern Sudanese zone, a relative balance was noticed between millet, sorghum, and to a lesser extent, maize. Roots and tubers are growing in importance, next to sorghum and maize in South Sudanese area.

Main cash crops are cotton in the south and to a lesser extent, peanuts. Rice production is primarily in irrigated areas of large dams (Office du Niger) and in flooded areas of Niger and Senegal rivers and lowlands of the South Sudanese area. Tree production is important in South wetter areas and near major urban centers, which also focuses on vegetable production.

Livestock and pasture resources

Country of farming tradition, Mali holds significant pastoral reserves spread unevenly across the country according to eco-climatic zones. This division is responsible for breeding practices, as nomadism or transhumance. The quality and quantity of pastures are also largely dependent on climatic conditions, particularly rainfall. Thus, periods of drought have had profound impact on traditional farming methods and even on spatial distribution of herds, which were decimated in large part. Natural pastures are steadily decreasing, mainly because of practices such as bush fires, removal of cattle corridors and the disappearance of transhumance routes and/or pasture in flooded areas.

5 ENVIRONMENTAL & HEALTH IMPACTS

5.1 POTENTIAL POSITIVE EFFECTS OF THE IRS PROGRAM

5.1.1 DIRECT POSITIVE EFFECTS

The direct positive impacts of the IRS program are the reduction in child and adult malaria morbidity and mortality that will result in a reduction in human suffering. In addition, economic losses due to absenteeism or inability to work will be reduced. Other positive impacts include reduced incidence of miscarriages, low birth-weight, adverse effects on malaria-induced fetal neurodevelopment, and reduced incidence of malaria-related childhood and maternal anemia, complications, and organ failure. There is also the benefit of elimination of other household insects, as well as vermin in some cases.

5.1.2 INDIRECT POSITIVE EFFECTS

IRS will build human and institutional capacity building by providing broad-based training to a large number of people associated with IRS operations. From this training, there will be an increase in knowledge and understanding of both IRS-specific and general health and environmental risks and impacts, as well as methods of mitigation of those risks. One of the goals of the IRS program is to build in-country capacity to the point where IRS can be conducted by national or local government, or by the self-organization of communities, without large-scale external assistance or intervention.

By reducing the malaria burden, the IRS program will improve the education level amongst children of school age, as a result of the reduction in the number of school days missed, and improve the productivity of the workforce as a result of the reduction in missed work days and days of reduced productivity.

The IRS program will indirectly contribute to the enhancement of the local economy in that IRS staff and workers will receive payment for their work. At least some of the money that they receive will be spent and injected into the local economy with a magnification effect, improving revenues for various businesses and per capita income.

In addition, the implementation of IRS requires certain local purchases of products and services, such as building and construction materials, rental of building space and vehicles, and hiring of local labor for the construction or renovation of storehouses and soak pits. Again, these revenues are injected into the economy with potentially positive and significant magnification effects.

Finally, a reduction in household pests from IRS may result in a reduction in other diseases carried by the pests.

5.2 POTENTIAL ADVERSE IMPACTS

Adverse impacts of the IRS project are those unintended effects of the project that can compromise the well-being of the environment and/or human health. Potential adverse impacts are listed below.

5.2.1 Direct Potential Adverse Effects

Contamination Of Surface Water courses And Underground Water

During IRS implementation, it is possible to accidently release insecticides into water bodies during the transportation and storage of pesticides, application of insecticides to walls, and clean-up of IRS equipment and PPE. It is also possible to have a release that will affect surface or groundwater through washing in areas other than the soak pit, or improper disposal of leftover pesticide. A spill into surface water bodies is a key concern in IRS because it could lead to contamination of water routinely used for multiple domestic purposes. Fish and other aquatic organisms that are vital to a healthy ecosystem could also be wiped out.

Contamination of underground water resources is possible through improper disposal of leftover pesticide on the ground, especially if there is a high water table. However, the impacts of this risk are likely to be insignificant, primarily because pesticide disposal is strictly controlled and supervised, and the sites for soak pits are carefully chosen according to the criteria in the PMI BMPs. Secondarily, most formulations of pyrethroids, OPs, and carbamates move slowly through soil, and degrade quickly when exposed to sunlight, hydrolysis, or microbial action in the soil. If wash areas and soak pits are properly constructed and employed, liquid pesticide traces will be captured in the charcoal layer of the soak pit or organic matter in soil, and held until degradation by natural processes.

Potential Impacts To Non-Target Organisms From Pesticides

The degree of toxicity of the four WHOPES-recommended pesticide classes and chlorfenapyr to birdlife, aquatic life and insects, as well as pesticide persistence and bio-accumulation potential is documented in Table 7 in Section 6.5.1 of this SEA.

Special Note: Impacts On Bees

Spraying in areas near beehives can lead to the death of the bees, which are vulnerable to all WHO-recommended pesticides. In addition, spraying near hives can lead to contamination of edible honey. These risks must be mitigated at all times. Bee keeping in Mali is mainly conducted away from the household and the sale of honey provides significant income to the residents. The project will identify locations where beehives are kept, and observe a 30 meter no-spray buffer zone around them. Bee-hive owners will be advised accordingly.

5.2.2 Indirect Adverse Effects

Upon termination of the IRS program, PMI will properly dispose of the IRS equipment and will no longer supervise its use. IRS equipment that may be disposed of includes spray tanks, used or clean boots, wash basins, progressive rinse barrels, etc. that are still in operable condition. Improper use of this equipment could lead to contamination of the environment or adverse health effects as noted.

In general, if PMI supports the procurement of insecticide or disposition of unused insecticide to the Government of Mali, this activity is required to be mentioned in the annual Letter Report, in addition to this SEA. This type of support requires annual environmental compliance monitoring by PMI and/or the IP, requires that PMI and/or the PMI IP provide environmental training in the PMI IRS BMPs, and language must be inserted into the government to government agreement that PMI must provide technical assistance for insecticide selection to ensure quality/appropriateness of the product. If PMI supports the procurement, loan, or disposition of spray pumps or personal protective equipment to the Government of Mali these activities must be mentioned in the annual Letter Report, in addition to this

SEA. These activities do not require environmental compliance monitoring, however, PMI and/or the PMI IP must provide environmental training in the PMI IRS BMPs. These requirements relate to the use of non-DDT insecticides by the Government of Mali. The conduct of IRS by District Medical Officers with communities, using properly working equipment left behind by PMI may temporarily, and in a minor way increase the total pesticide load on the environment. However, since the IRS equipment will be in operable conditions and capacity has been built among the District Medical Officers, it is expected that spray operations will be according to BMPs, and the total pesticide load on the environment is expected to be less than if the donation is not made.

5.3 Human Exposure Risks/Impacts

5.3.1 Worker and Resident Exposure Pathways

During the IRS spraying process, spray personnel are at risk of unintentional or deliberate exposure through accidents or poor and improper handling of the spray chemical. Worker exposure to the chemical could arise during the pre-spraying, spraying and post-spraying phase of the IRS operations. Beneficiaries can also be exposed during each of these phases, and additionally over the life of the pesticide on the wall. Exposure risks of all WHO-recommended pesticides in relation to cancer and non-cancer endpoints are presented in IVM PEA 2012. The exposure risk for cancer and non-cancer endpoints is presented at different stages of the pesticide application including mixing, spraying, post spraying, dermal risk, etc.

5.3.2 Pre Spraying Exposure Pathway

Preparing pesticide solutions during the IRS requires pouring the pesticide in the spray pump and agitating it to ensure ample mixing with the water. The process of mixing the pesticide can lead to exposures via inhalation, dermal contact, and incidental ingestion, from releases of pesticide vapors and liquids. Vapor releases can occur when liquid concentrated emulsions are diluted. Workers or residents can inhale the vapors or the particulates or be exposed through dermal contact. Spills could also pose significant risk, especially for children who ingest the resulting residues that are left on surfaces such as food, floors, soil, as well as absorbing additional doses from eating plants and animals contaminated during the preparation for spraying.

5.3.3 Exposure During Spraying

Inhalation of aerosol droplets during spraying is the main process for worker exposure during IRS, however, dermal exposure through spills or absorption onto cotton overalls is also a significant risk. Especially in the case of OPs, the dermal hazard is significant, and can cause cholinesterase depression. Residents are mainly exposed through dermal contact with sprayed surfaces and incidental ingestion of insecticide after their houses have been sprayed, especially when food or drink are left in the house during spraying. Leaky equipment can also lead to insecticide exposure through dermal contact with the floors and incidental ingestion by children who may come in contact with the spills before they are cleaned up.

5.3.4 Exposure During Disposal (Including Progressive Rinsing)

Disposal is a key issue with IRS intervention that utilizes pesticides especially during the decontamination process and disposal of the liquid effluent that will arise from washing and progressive rinse. Both burying and dumping can lead to dermal exposure to residents who come in contact with the soil or water in which the pesticide was disposed. Once the pesticide gets into the soil, it can migrate to

groundwater, which may be used as a water supply via household wells. In this manner, ingestion exposure can occur from drinking contaminated surface water. Residents may also be exposed to this contaminated water by dermal contact when it is used for cleaning or cooking purposes.

5.3.5 Occupant Long-Term Exposure From Residue

Residents of sprayed structures, especially crawling babies and children, will have a finite exposure risk due to physical contact with sprayed surfaces, as well as small amounts released from substrate walls, ceilings, and eaves, due to physical surface breakdown.

5.4 Pesticide- and Process-specific Potential Health Impacts

5.4.1 Inhalation exposure and risk during mixing

Of the proposed pesticides, only etofenprox (pyrethroid) and propoxur (carbamate) have carcinogenic properties once threshold levels are exceeded.

5.4.2 Dermal exposure and risk during mixing

On the WHOPES list of insecticides to be used in IRS only three (DDT, etofenprox (pyrethroid) and propoxur (carbamate)) have been determined to be carcinogenic at dermal exposure levels of 8E-07 mg/kg-day for etofenprox and 4E-06 mg/kg-day for propoxur

5.4.3 Inhalation exposure and risk during spraying

Of the proposed pesticides, only etofenprox (pyrethroid) and propoxur (carbamate) have carcinogenic properties once threshold levels are exceeded.

5.4.4 Dermal exposure and risk during spraying

Of the proposed pesticides, fenitrothion and pirimiphos-methyl have non-cancer risks (cholinesterase depression) due to dermal exposure

5.4.5 Resident dermal exposure and ingestion risk after spraying

The only concerns are to adults when using cyfluthrin and etofenprox (pyrethroids) and propoxur (carbamate). The risk is however very low.

5.4.6 Resident exposure and risk due to chronic ingestion after spraying

There are four insecticides with potential impact due to chronic ingestion by drinking insecticide contaminated water. These are Cyfluthrin, Permethrin and Etofenprox (pyrethroids) and propoxur (carbamate). Best management practices are recommended.

5.4.7 Resident dermal exposure and risk due to bathing using contaminated groundwater

Cyfluthrin and etofenprox (pyrethroids) have potential impact for dermal exposure using contaminated groundwater. When best management practices are applied in IRS, this risk is significantly reduced.

5.4.8 Resident exposure and risk due to reuse of pesticide containers

Only deltamethrin is considered to have potential for acute ingestion hazard from using pesticide containers. However, residents will have no access to pesticide containers used in IRS. The pesticide containers are carefully inventoried and stored in IRS storage facilities which are securely double locked.

When an appropriate recycle system is available, they will be disposed by recycling into non-consumer products. Otherwise they will be landfilled after washing and puncturing, or as a last resort, incinerated.

5.4.9 WORKER EXPOSURE AND RISK DUE TO INHALATION DURING SPILLAGE

According to information presented in the IVM PEA, etofenprox and propoxur have potential to impact workers through inhalation during spillage. The workers are trained on how to handle spillage and must be equipped with appropriate PPE.

5.5 CUMULATIVE IMPACT

Organophosphates are the pesticides with the highest potential for cumulative impacts. Pyrethroids, carbamates, and most organophosphate formulations break down readily in the environment, limiting the risk of cumulative environmental impact, especially if disposal sites are well-chosen and BMPs are followed.

However, repeated exposures to organophosphates result in cumulative cholinesterase depression, with increasingly severe effects. For this reason it is exceptionally important that PPE is worn properly and at all times when pesticide contact is possible. It is also incumbent upon team leaders to monitor the health of their spray operators on a daily basis, and to look for any signs of cholinesterase depression. Formulations of the organophosphate pirimiphos-methyl have been used for several years and in several countries without any report of observed symptoms of cholinesterase depression.

Additionally, there are indications[9] that the capsule suspension form of Actellic is more resistant to environmental degradation than either Actellic EC, or the other WHOPES-recommended pesticides. This may result in a temporary build-up of concentration within the soak pit prior to degradation.

6 PESTICIDE PROCEDURES

Title 22 of the United States Code of Federal Regulations, Part 216 (22 CFR 216) mandates the consideration of twelve factors when a project includes "assistance for the procurement or use, or both, of pesticides". As the PMI Mali IRS program includes assistance in both of these aspects, it is subject to this regulation. This section therefore addresses each of the twelve factors for the IRS Malaria Control Program in Mali.

6.1 THE UNITED STATES ENVIRONMENTAL PROTECTION AGENCY'S REGISTRATION STATUS OF THE REQUESTED PESTICIDE

Pesticides registered for IRS or a similar use in the United States and the host country government will be preferred in this IRS project. Some of the pesticides on the WHOPES list are not registered with the USEPA for economic, technical, or regulatory reasons. There is a very limited market in the US for IRS, and as a result, registrations for this use of these pesticides have been voluntarily withdrawn, or never filed. However, US 22 CFR 216.3(b)(1)(iii) allows for the use of pesticides not registered for the same or similar use by USEPA, provided that:

1. The proper assessments are performed,
2. The assessments include an evaluation of the factors in Sections 6.1-6.12 of this document, and
3. Notification is provided to, and authorization received from the host country government for the use of the pesticide in-country.

PMI works closely with host country governments, with full and clear disclosure, as well as providing any necessary assistance in the mitigation of risk from the use of these WHOPES pesticides. This SEA, supported by the PMI IVM PEA, and distributed to the National Directorate of Sanitation, Pollution Control and Nuisance (DNACPN) and MOHPS, provides the assessment, notification and mitigation requirements of US regulations. USAID/PMI is therefore empowered, upon acceptance of this document and the receipt of formal authorization from a competent Malian authority, to use in all Mali WHOPES-recommended pesticides in the pyrethroid, carbamate, and organophosphate classes, and chlorfenapyr when recommended by WHOPES.

6.2 THE BASIS FOR SELECTION OF THE REQUESTED PESTICIDES

In addition to the above criteria, insecticide selection for any PMI supported program is subject to the following considerations.

6.2.1 PRIMARY CRITERIA FOR CHOOSING PESTICIDES

Approval by the World Health Organization Pesticide Evaluation Scheme:

Only insecticides recommended by WHOPES or by USEPA can be used in IRS. Certain pesticides in the organophosphate, carbamate, pyrethroid and organochlorine classes are WHOPES recommended for use in IRS. Table 3 shows the list of WHO-recommended pesticides. Chlorfenapyr is not yet

recommended by WHOPES, but authorization is requested in this SEA to use it for hut trials, and for IRS when and if it receives a WHOPES recommendation.

TABLE 6: WHOPES RECOMMENDED PESTICIDES WITH EFFECTIVE DURATION

Updated: 2 March 2015

WHO recommended insecticides for indoor residual spraying against malaria vectors

Insecticide compounds and formulations[1]	*Class group*[2]	*Dosage (g a.i./m²)*	*Mode of action*	*Duration of effective action (months)*
DDT WP	OC	1-2	contact	>6
Malathion WP	OP	2	contact	2–3
Fenitrothion WP	OP	2	contact & airborne	3–6
Pirimiphos-methyl WP, EC	OP	1-2	contact & airborne	2–3
Pirimiphos-methyl CS	OP	1	contact & airborne	4–6
Bendiocarb WP, WP-SB	C	0.1–0.4	contact & airborne	2–6
Propoxur WP	C	1–2	contact & airborne	3–6
Alpha-cypermethrin WP, SC	PY	0.02–0.03	contact	4–6
Alpha-cypermethrin WG-SB	PY	0.02–0.03	contact	up to 4
Bifenthrin WP	PY	0.025–0.05	contact	3–6
Cyfluthrin WP	PY	0.02–0.05	contact	3–6
Deltamethrin SC-PE	PY	0.02–0.025	contact	6
Deltamethrin WP, WG, WG-SB	PY	0.02–0.025	contact	3–6
Etofenprox WP	PY	0.1–0.3	contact	3–6
Lambda-cyhalothrin WP, CS	PY	0.02–0.03	contact	3–6

Chlorfenapyr 240 SC: The current assessments of Chlorfenapyr SC (class group: pyrrole) are available in the report of the 16th WHOPES Working Group meeting, 22–30 July 2013 and the report of the 17th WHOPES Working Group meeting, 15–19 September 2014 (both reports available at: http://who.int/whopes/resources/en/).

Note: WHO recommendations on the use of pesticides in public health are valid ONLY if linked to WHO specifications for their quality control. WHO specifications for public health pesticides are available on the WHO homepage on the Internet at http://www.who.int/whopes/quality/en/.

[1] CS = capsule suspension; EC = emulsifiable concentrate; SC = suspension concentrate; SC-PE = polymer enhanced suspension concentrate; WG = water dispersible granules; WG-SB = water dispersible granules in sealed water soluble bags; WP = wettable powder; WP-SB = wettable powder in sealed water soluble bags.

[2] OC = organochlorines; OP = organophosphates; C = carbamates; PY = pyrethroids.

Registration for use in Mali: In the case where the insecticide proposed for use in IRS is not registered in Mali, PMI will work with manufacturers and distributors, as well as the NMCP, the Ministry of Health and Public Sanitation, and other regulatory bodies to obtain special authorization for the use of the pesticide.

Residual effect for a period longer than, or at least equal to, the average duration of the malaria transmission season in the area: As seen in the table above, all pyrethroids, carbamates, and organophosphates are expected to stay active and effective for 3 to 6 months after application; however, the effective duration varies under different climatic conditions and other factors. Three pyrethroids, known as longer-lasting pyrethroids, can last up to eleven months based on various field trials. For this reason, pyrethroids have traditionally made the best choice for extended seasons. However, in order to manage vector resistance, it has proven to be necessary to periodically switch the class of pesticides used in IRS.

Pesticide must be appropriate for use on the wall surfaces of the selected location:

Cone bioassays to test the longevity of Actellic 300CS on various wall surfaces in Mali, 2015

Pirimiphos-methyl 300CS (organophosphate) was sprayed in Koulikoro (IRS site 1) and Baroueli (IRS site 2) districts. At the beginning of the IRS campaign, cone bioassays were done to assess the quality of spraying at four sentinel sites (Tienfala and N'Dentila in Koulikoro district, Konobougou and Tigui in Baroueli district). The assessment helped check the efficacy and homogeneity of insecticide treatment. Mosquitoes of the *An. gambiae* KISUMU strain, which is susceptible to pirimiphos-methyl, were reared at the AIRS Mali insectary and were used to assess the quality of spraying. Bioassays were performed 24 hours after IRS, following WHO procedures. Cone bioassays were conducted in 20 sprayed structures (rooms) in the two districts within 24 hours of spraying to assess the quality of spraying and then the structures were monitored on a monthly basis to determine the insecticide decay rate. In each district, 10 structures were sampled and used for the tests.

The cone bioassay tests conducted in the two IRS targeted districts showed that the quality of spraying was acceptable and that 24 hours (time 0=T0) after spraying, the test mortality rates of susceptible mosquitoes on mud, kaolin mud, and cement surfaces ranged from 99% to 100%.

There were no differences in test mortality rates of mosquitoes exposed to the sprayed walls at three different heights at baseline, which was 99%-100%. This indicates that the spraying was relatively homogeneous.

Three months after spraying, the test mortality rates were higher than 80% for all substrates (88% on mud, 96% on kaolin mud, 100% on cement). Four months after spraying, the test mortality rates were less than the 80% WHO threshold on kaolin mud at 63% and cement at 53%. Mud was not tested in month four. Five months after spraying the test mortality were still higher than 80% on mud surface at 98%. Mortality for cement decreased further to 24%, while for kaolin mud was 77% (only slightly below WHO cut-off). According to WHO, cut-offs of 80% indicate a residual lifespan of 3 months on cement and kaolin mud and >5 months on mud. The residual life of only three months recorded on these substrates is shorter than observed in other AIRS countries, where up to 10 months was observed (Ghana). This might have been due to chemical breakdown of the insecticide or physical characteristics resulting in the insecticide not being bioavailable on the surface and warrants further investigation. The houses in Koulikoro and Baroueli typically have mud walls with some covered on the surface with kaolin.

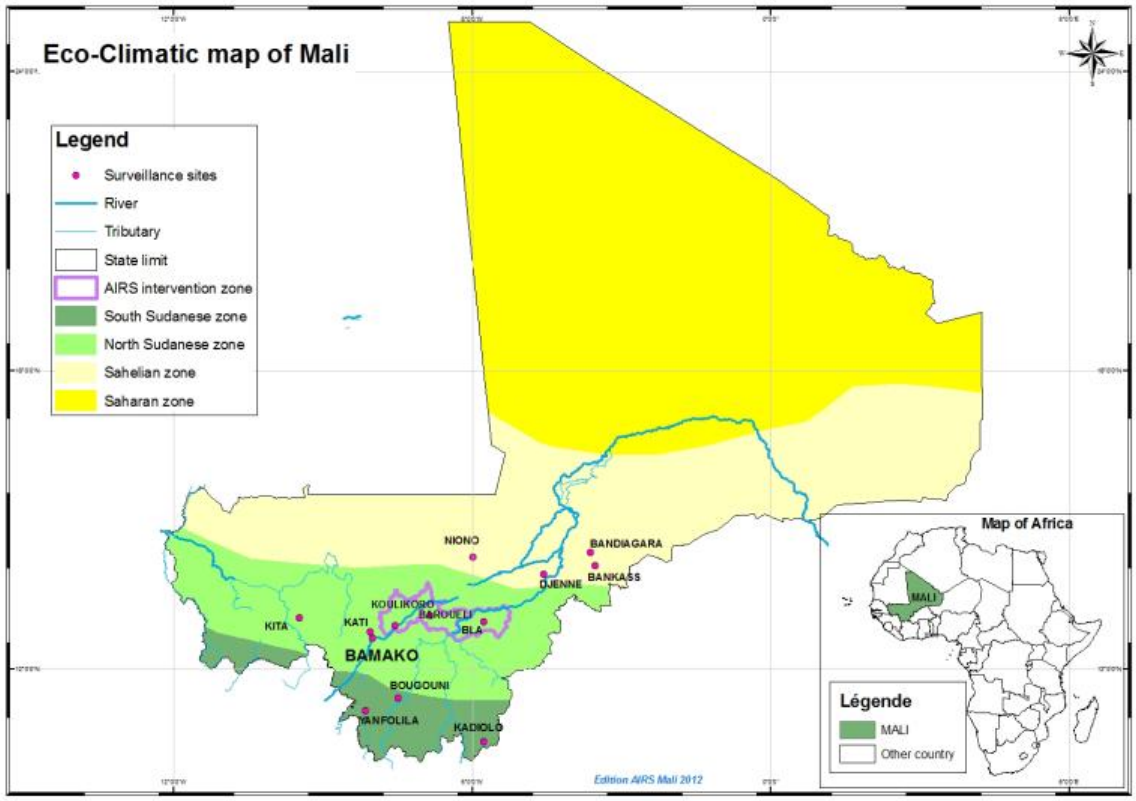
Local vector susceptibility to the insecticide: Resistance to insecticide develops when a hereditary feature is selected in an insect population that reduces the population's sensitivity to a given insecticide.

In Mali, vector susceptibility studies have confirmed the effectiveness of pirimiphos methyl in all these districts, it is now being used for IRS in the current spray districts to manage resistance and to take advantage of the long residual effect.

The national insecticide resistance monitoring in Mali 2014

PMI and NMCP Mali carried out insecticide resistance monitoring using the standard WHO tube bioassay test in 13 sentinel sites from July to December 2014. The susceptibility tests were performed by exposing the 1–5-day-old non-blood-fed female adults of *An. gambiae* s.l. to the standard WHO insecticide impregnated papers DDT 4% (organochlorine), permethrin 0.75% and deltamethrin 0.05% (pyrethroid), pirimiphos methyl 0.25% (organophosphate), and bendiocarb 0.1% (carbamate).

FIGURE 11: ECO-CLIMATE MAP OF MALI WITH ENTOMOLOGIC SURVEILLANCE SITES



An. gambiae s.l. tested from all surveillance sites was strongly resistant to DDT 4%. The vector mortality rate was in Kita (1%), Koulikoro (6%), Kati (1%), Bamako (7%), Bla (6%), Baroueli (16%), Niono (5%), Selingue (13%), Bougouni (1%), Kadiolo (6%), Djenne (19%), Badiangara (14%), and Bankasss (25%).

An. gambiae s.l. tested from surveillance sites was strongly resistant to permethrin and deltamethrin (pyrethroids). The vector mortality rate to permethrin was as follows: Kita (19%), Koulikoro (6%), Kati (25%), Bamako (1%), Bla (47%), Baroueli (25%), Niono (11%), Selingue (72%), Bougouni (60%), Kadiolo (13%), Djenne (21%), Badiangara (32%), and Bankass (54%) (Figure 4). The vector mortality rate to deltamethrin was: Kita (64%), Koulikoro (15%), Kati (18%), Bamako (6%), Bla (14%), Baroueli (31%),

Niono (42%), Selingue (42%), Bougouni (77%), Kadiolo (43%), Djenne (40%), Badiangara (30%), and Bankass (37%).

An. gambiae s.l. tested from all surveillance sites was susceptible to pirimiphos methyl (organophosphate). The mortality rate was high in all the sentinel sites, Kita (99%), Koulikoro (100%), Kati (100%), Bamako (100%), Bla (100%), Baroueli (100%), Niono (99%), Selingue (100%), Bougouni (100%), Kadiolo (100%), Djenne (100%), Badiangara (100%), and Bankass (100%).

An. gambiae s.l. tested from 7 surveillance sites was susceptible to bendiocarb (carbamate) with test mortality rates in Koulikoro (100%), Kati (100%), Niono (100%), Selingue (99%), Djenne (99%), Badiangara (100%), and Bankasss (100%). There was possible resistance with test mortality in Bamako (96%), Bla (94%), Baroueli (97%), and Kadiolo (92%). There was resistance with test mortality in Bougouni (84%).

6.3 The Extent to Which the Proposed Pesticide Use Is Part of an Integrated Pest Management (IPM) Program

IPM is defined as "an ecosystem-based strategy that focuses on long-term prevention of pests or their damage through a combination of techniques such as biological control, habitat manipulation, modification of cultural practices, and use of resistant varieties. Pesticides are used only after monitoring indicates they are needed according to established guidelines, and treatments are made with the goal of removing only the target organism. Pest control materials (pesticides) are selected and applied in a manner that minimizes risks to human health, beneficial and non-target organisms, and the environment."

IPM is often used in an agricultural context, but similar in nature is the concept of Integrated Vector Management (IVM).

The major characteristics of IVM include:

- *Methods based on knowledge of factors influencing local vector biology, disease transmission, and morbidity;*
- *Use of a range of interventions, often in combination and synergistically;*
- *Collaboration within the health sector and with other public and private sectors that impact vectors;*
- *A public health regulatory and legislative framework.*

Use of IVM for the control of the malaria vector population is practiced using two primary interventions, insecticide-treated nets, and indoor residual spray. Environmental management for malaria control is limited to some common sense safeguards, such as limiting standing water which can serve as a breeding ground for mosquitoes. USAID/PMI does not support environmental management as a vector control method. Because of the life-cycle requirements and the adaptability shown by IRS vectors, these practices have not demonstrated large-scale effectiveness.

PMI strategy has been that IRS will be implemented as a component of IVM for malaria control. PMI supports an evidence-based approach and will continue to review health management information systems and entomologic data to determine where best to deploy IRS.

6.4 The Proposed Method or Methods of Application, Including Availability of Appropriate Application and Safety Equipment

IRS involves spraying an insecticide with long lasting residual activity on indoor wall and ceiling surfaces where mosquitoes usually rest. The pesticide then dries up and leaves a crystalline deposit on the sprayed surface. A lethal dose of the insecticide is absorbed when the mosquito rests on the surface, which kills the mosquito.

Pesticide will only be applied using pressurized spray equipment approved for the pesticide in use, and by trained spray operators wearing gloves, overalls, hard hats with face shields, neck shields, and boots. All necessary PPE for this activity is supplied by PMI, and its use is supervised and enforced throughout the course of the campaign. Spray operators are trained in and use spray patterns that have proven effective for providing long-lasting toxicity toward the malaria vector mosquito.

The spray operators who implement IRS use backpack compression sprayers to apply a measured amount of insecticide on the interior walls of houses and structures. A water-soluble insecticide is added to the sprayer containing a pre-measured amount of water, the sprayer is pressurized, and the material is then applied. After the day's spraying is complete, spray operators reserve in a collection drum any pesticide left in the spray pump, clean the sprayer following PMI BMPs to maintain proper functioning of the pump and to guard against release of and/or exposure to pesticides, and reuse leftover pesticide on the following day. They also follow the pump manufacturer's recommendations to ensure their proper operation and calibration.

6.5 Acute and Long-Term Toxicological Hazards Associated with the Proposed Use and Measures Available to Minimize Such Hazards

The IVM PEA assessed the toxicity of WHO-recommended IRS insecticides to non-target organisms, including mammals, birds, fish, bees, and other aquatic organisms. The table below provides graphic information on the toxicity and some of the other characteristics of the WHOPES pesticides. In general, most of them are toxic to bees, fish, and other aquatic organisms, and less so to mammals and birds.

"Indoor" being an important operative word in IRS, the risks to biodiversity from spray operations are minimal if PMI BMPS are followed. The BMPs have been designed to prevent any significant release to the environment, and a strong, automated, smart-phone-based supervisory system ensures that BMPs are followed or non-compliance is immediately corrected. The reader is referred to Annex E of the 2012 IVM PEA, and to Chapter 5 of this SEA for greater detail about pesticide toxicity.

6.5.1 Hazards

The two broad categories of hazard are release and exposure to humans and domestic animals, and releases causing environmental damage. Release and exposure may occur at any point, from the production or importation of the pesticide through transportation, storage, distribution, pesticide make-up, spray application, clean-up, and final disposal, as well as post-spray due to improper spray deposition on household articles, or improper behavior of beneficiaries regarding sprayed surfaces.

In humans, both organophosphates and carbamates can produce cholinesterase depression if the proper protective measures are not utilized and exposure results. Cholinesterase inhibition results in overstimulation of the nervous system, with symptoms that include nausea, dizziness, confusion, and

respiratory paralysis and death at very high exposures (U.S. EPA, 2000b). The two classes of insecticides differ in their impact on human health in that with carbamates, the cholinesterase inhibition is temporary, and may dissipate in as little as 2-3 hours, providing the exposure is eliminated. With organophosphates, the inhibition is longer-lasting and cumulative, and thus more dangerous.

TABLE 7: PESTICIDE TOXICITY TO NON-TARGET SPECIES

IRS Insecticide	Mammal	Bird	Fish	Other Aquatic	Bee	Persistence	Bioaccumulate
Alpha-cypermethrin (P)							
Bendiocarb (C)							
Bifenthrin (P)							
Cyfluthrin (P)							
DDT (OC)							
Deltamethrin (P)							
Etofenprox (P)							
Fenitrothion (OP)							
Lambda-cyhalothrin (P)							
Malathion (OP)							
Pirimiphos-methyl (OP)							
Propoxur (C)							
Chlorfenapyr (PR)							

Source: IVM PEA 2012

Key

High Toxicity	
Medium to High	
Medium Toxicity	
Low to Medium	

6.6 THE EFFECTIVENESS OF THE REQUESTED PESTICIDE FOR THE PROPOSED USE

Pesticides are selected for IRS based on technical efficacy and economic efficiency in the intended use, along with other extrinsic variables. Complete selection criteria can be found in Section 1.2 of this SEA. Knowledge of vector susceptibility is critical to planning and evaluating the effectiveness of the IRS program. It enables timely forward planning to (i) manage the development of the resistance and (ii) evaluate new or alternative insecticides for possible future introduction should a change of pesticide be required. Resistance testing is done to (i) establish a baseline susceptibility of the local vectors for future reference, (ii) monitor changes that occur as time progresses, (iii) identify the mechanisms of resistance and cross-resistance to inform the resistance management strategy that will be adopted, and (iv) evaluate the susceptibility of the local vectors to potential alternative insecticides, should there be a need to change pesticide.

Prior to each campaign, it is necessary to measure vector resistance in the target areas, to ensure that acceptable kill levels will be achieved. A resistance monitoring program has been established by PMI, and the results from this ongoing program are the primary determinants of the choice of pesticide and other supplementary actions.

Pesticide efficacy is also affected by vector behavior, insecticide quality, and the residual action of the pesticide. The probability of vector-pesticide contact depends on whether the targeted vector feeds indoors (endophagic) and rests indoors (endophilic), as this increases the likelihood of the vector resting on the sprayed wall. The efficacy of the pesticide to kill may be compromised if the vector exits after feeding without resting on the wall, or if the vector feeds outdoors (exophagic) and rests outdoors (exophilic). The principal vectors of malaria in Mali are the *Anopheles gambiae* complex (*An. Gambiae s.l.*) and *Anopheles funestus* (*An. Funestus s.l..)*. The *An. Gambiae* complex consists of *An. arabiensis* and *An. gambiae sensu stricto*. The latter consists of three chromosomal forms (Bamako, Mopti and Savannah) grouped into two molecular forms (M & S forms). The *An. funestus* complex has not been studied extensively (Touré et al 1986, 1998).

Vector resistance may differ in origin, intensity, type, and significance for vector/disease control in a given population. The evaluation of the significance of resistance to vector control should therefore consider the biochemical and genetic characteristics of the resistance, as well as the eco-epidemiology of the disease and operational characteristics. Resistance also tends to be highly focal (i.e., limited to a definite area). It is therefore important to ascertain the spatial distribution of the observed resistance to better inform the resistance management strategy to be employed and the geographical extent to which it will apply (e.g., what geographical area a possible change in pesticides for IRS should cover).

The residual efficacy of the pesticide being used for IRS is crucial to evaluating the implication of vector resistance. The wall surface to which the pesticide is applied is a factor affecting residual efficacy, and must be taken into account. It is important that bioassays on various wall surfaces be carried out at specified intervals after the IRS operation in order to determine the period and level of residual activity in a given locality and the sprayed surface.

A third major factor affecting the effectiveness of the pesticides is their quality (specification). If the active ingredient, for example, is not up to the recommended specification and concentration, it may lead to under-dosage of deposited pesticide, which then contributes to intervention failure. Storage of pesticide for too long a time, or in extremely hot warehouses can lead to breakdown of the active ingredient. Poor pesticide quality may present additional risks to the pesticide handlers and spray operators who may be exposed. For this reason, samples of the pesticide will be taken prior to shipment to Mali, and analyzed for the concentration of the active ingredient. If feasible, susceptibility testing should also be performed, but seasonal dips in vector population usually limit this activity. In all PMI IRS warehouses the temperature is monitored and controlled as much as possible to avoid temperatures that could alter the chemistry or the characteristics of the pesticide.

6.7 Compatibility of the Proposed Pesticide with Target and Non-Target Ecosystems

The pesticides are compatible with the target environment (walls, ceilings, eaves) in that they dry on these surfaces, and are not released to receptors or the general environment to any great extent. The dried pesticide remains on the sprayed surfaces, and performs as designed, killing vector mosquitoes that rest on them, and the exposure to non-target organisms and ecosystems is very limited.

The WHOPES recommended pesticides are incompatible with the non-target ecosystems (humans, animals, and the environment), in that, if they are released to the environment in large quantities, they would have negative effects on land and water based flora and fauna (See Table 7). However, the IRS implementation process is designed to ensure that to the maximum extent possible, pesticides are deliberately and carefully applied to the walls and ceilings of dwellings, and do not come in contact with humans, animals, or the environment. IRS implementation is also planned to minimize and responsibly manage the liquid wastes through the reuse of leftover pesticides, the triple rinsing of equipment, and the daily washing of PPE with rinse water treatment to remove trace pesticide. Wherever possible, recycling is incorporated into the waste management plan, particularly in the case of plastic bottles used for pesticide containers. Where it is not feasible to recycle materials, they are either washed thoroughly and disposed of in a landfill, or contaminated solid wastes are incinerated in an approved incinerator that will destroy the pesticide and prevent environmental contamination (see section 7.1.11). The Environmental Mitigation and Monitoring Plan in Annex A details the measures that have been and will be enacted to prevent contamination of ecosystems. In addition, there are solid and liquid waste management plans contained in the Safer Use Action Plan of this SEA (Chapter 7).

6.8 The Conditions under Which the Pesticide is to be Used

Chapter 4 of this document provides a detailed account of the environmental conditions in Mali under which the pesticide is to be used. IRS is scheduled to be performed prior to the rainy season in each location to maximize the effectiveness of IRS, and to avoid logistical complications from the degradation of transportation infrastructure due to flooding and washout.

During IRS, particular attention will be paid to any sensitive areas identified in Chapter 4, including water bodies, schools, hospitals, any area where organic farming is practiced, where bee-keeping or natural bee habitats are established, etc. In addition, bird-nesting habitat will be protected, and all insecticides will be kept away from all water habitats and resources. Prior to spraying, geographical reconnaissance will include identification of households in sensitive areas, and the IP will train sprayers to identify houses that should not be sprayed. IRS will be prohibited within 30 meters of sensitive ecosystems. If pesticide drift is observed, spraying will be halted until the cause has been determined. Drift could be a result of spraying an inappropriate surface with gaps that allow pesticide to escape, so the wall surface must be evaluated for fitness for spraying, and the structure potentially disqualified. Alternately, if drift is caused by excessive wind (especially if spraying eaves outdoors) operators must wait until wind conditions subside. The IP will consult with competent services of the Ministry of Environment and Sanitation and Sustainable Development (MEADD) regarding the application of pesticides in or near ecologically sensitive areas, such as wetlands, lake shore, river edge and protected areas and follow their policies and guidelines, unless the conditions prescribed herein are more strict, in which case the SEA will have precedence. Strict supervisory control will also be established to prevent contamination of agricultural products.

6.9 The Availability and Effectiveness of Other Pesticides or Non-Chemical Control Methods

In Mali, as in many countries, a full range of malaria control methods are employed, and in some circumstances, one method may be favored over another. However, PMI has determined that IRS is part of the overall effort to decrease malaria morbidity and mortality in Mali and in many other countries.

This IRS program is limited to using those pesticides that are on the WHOPES list of recommended pesticides. WHO currently recommends 15 formulations from four chemical classes for IRS, each with a specific dosage regime, duration of effectiveness, and safety rating. Each of these agents has been evaluated for effectiveness within the program, and continuing monitoring for resistance and susceptibility will be employed to allow up-to-date decisions prior to each spray campaign. One goal of this SEA is to broaden the options for pesticide use to four recommended pesticide classes (including chlorfenapyr in the pyrrole class, if and when it is recommended by WHOPES), but excluding organochlorines class to combat periodic resistance development.

Non-chemical means of malaria vector control are examined and discussed briefly under section 6.3, Integrated Pesticide/Vector Management (IPM/IVM), but are generally not effective on a large scale. For example, while elimination of standing water breeding habitats is a logical and sensible concept, the malaria mosquitoes only need the smallest of aquatic habitats to successfully reproduce, and it is nearly impossible to eliminate all of these minute breeding habitats.

6.10 The Requesting Country's Capacity to Regulate and Control Pesticides Distribution, Storage and Use of the Requested Pesticides

The legal framework on pesticide management is characterized by the existence of several texts relating to import, export, manufacturing, transportation, marketing and utilization divided between several ministries. Many texts prepared by some Government departments overlap. A number of legislative texts have no or very little implementing decrees, leaving a legal gap that does not promote chemical products environmentally sound management.

As for the difficulties encountered in chemicals management, we can cite:

- lack of coherent programs for training, information, education and awareness among policymakers, the public, workers and target groups in the negative impacts of poor chemicals management;
- absence of efficient coordination structures one consequence of which is sectoral regulation and dispersal of efforts;
- sectoral regulation of chemicals management;
- insufficient resources (financial, technical and material);
- weak response capacity for chemical emergencies

It is urgent, with the proliferation and the emergence of new categories of chemicals, to strengthen legislative, institutional and operational provisions in order to minimize their risk on human health and the environment. This requires adapting national laws to the new international legal context and strengthening incentive and disincentive measures on environment and human health protection.

6.10.1 Relevant Institutions

Ministry of Environment, Sanitation and Sustainable Development (MEADD)

The MEADD houses the following technical structures: the National Directorate for Sanitation and Pollution and Pest Control (NDSPPC), the Agency for Environment and Sustainable Development (AESD), the National Directorate for Water and Forests (NDWF), the National Agency for Water

Purification Plan of Mali (NAWPPM), the Niger River Basin Agency (NRBA). Those directly involved in the project are:

NATIONAL DIRECTORATE FOR SANITATION AND POLLUTION AND PEST CONTROL (NDSPPC)

It was created by Ordinance No. 98-27/P-RM of 25 August 1998. Its mission is "*the development of the elements of the national policy on sanitation and pollution and pests control and its implementation*." NDSPPC is responsible, among others for:

- Monitoring and ensuring the inclusion of environmental issues in sector based policies, development plans and programs;
- Ensuring the implementation of measures in this regard;
- Supervising and controlling ESIA procedures;
- Developing and ensuring compliance with sanitation, pollution and nuisances standards;
- Monitoring compliance with the requirements of legislation and standards and supporting local authorities in sanitation, pollution and nuisances control.

NDSPPC contributes to improving the living environment through:

- The development of transit deposits and realization of final dump;
- The development and cleaning of collectors and drains for rainwater drainage;
- The soak pits, wash area and evaporate tank construction;

Through its various representations, at regional level it is responsible of information and dissemination of any law and regulation relating to pollution and nuisances (including chemical products among which obsolete pesticides).

NDSPPC supervises the Disposal and Prevention of Obsolete Pesticides Project. In this capacity, it oversees and monitors the project technical and financial implementation status. Regional Directors serve as relays between DPOPP and Sanitation local services that implement DPOPP activities in their respective regions. NDSPPC supervision applies through field visits, quarterly meetings to take stock of the progress of the activities program adopted by the project National Steering Committee.

THE MINISTRY OF AGRICULTURE

Institutions under the Ministry of Agriculture with a role in pesticides management are:

- The National Directorate of Agriculture (DNA)

Created by the Act No. 05-012 of 11 February 2005, the National Directorate of Agriculture's mission is to develop elements of national policy on agriculture and ensure its implementation coordination and monitoring of agricultural production.

As such, it is responsible for:

- Developing and monitoring the implementation of measures and actions intended to increase production and improve the quality of agricultural, food and non-food goods

- Ensuring the promotion and modernization of agricultural sectors;

- Developing and monitoring the implementation of training, counseling, outreach and communication actions for the benefit of farmers;

- Developing and overseeing the implementation of the regulation on plant control and packaging of agricultural products;

- Participating in the definition and implementation of agricultural research policy;

- Participating in the development and monitoring of agricultural products and inputs quality standards;
- Ensuring the collection, processing and dissemination of agricultural sector data.

Moreover, DNA accommodates the Integrated Management of Production and Pest (IMPP) program which aims to contribute to the use of alternative and sustainable methods and thus reduce the use of synthetic chemical pesticides.

THE PLANT PROTECTION OFFICE (OPV)

The Plant Protection Office was established by the Act No. 05-011 of 11 February 2005. This is a public Establishment of Administrative nature with legal personality and financial autonomy.

The OPV's mission is to ensure the implementation of the national policy on plant protection. To this end, it is responsible, among others to:

- Coordinate plant and cultures monitoring operations in view to report the existence, outbreak and spread of pests of plants and plant products;

- Take action and coordinate operations for plants and plant products pests control in view to protect crops, harvests and the flora;

- Conduct the disinfection or sanitization of consignments of plants and plant products moving subject to international trade;

- Develop, implement and popularize alternative control methods in the field of plant protection, in conjunction with relevant services and agencies in the field;

- Collect, analyze and disseminate the necessary information and technical and scientific documentation for plants protection;

- Ensure the training of rural extension staff and farmers in the field of plant protection.

OPV, as national structure user of pesticides is a key partner of DPOPP. Indeed, it is the one which holds the majority of the state's pesticide stores including obsolete stocks.

THE NATIONAL CENTRE FOR THE DESERT LOCUST CONTROL (NCDLC)

Created by the Act No. 06-065 of 29 December 2006, the National Centre for Desert Locust Control is responsible for:

- Developing, regularly updating and implementing contingency plans of exploration and controlling the Desert Locust;
- Developing and preserving intervention resources and products for the implementation of contingency action plans of exploration and controlling Desert Locust;
- Designing, implementing, coordinating, monitoring and assessing the surveillance and desert Locust controlling operations;
- Developing and implementing training plans necessary for the effective implementation of the aforesaid operations, in collaboration with partners involved in desert locust control;
- Developing and implementing with neighboring countries joint programs of exploration and controlling desert locust;
- Developing and implementing an environmental action plan in connection with the relevant departments in view to mitigate the impacts of desert locusts control on man and his environment;
- Conducting studies, research and experiments on locust in collaboration with the specialized agencies and national and international experts;
- Collecting, analyzing, processing, disseminating and exchanging information on desert locust situation at national, regional and international levels;
- Liaising with local authorities and international organizations organs involved in desert locusts control.

THE MALIAN COMPANY FOR TEXTILE DEVELOPMENT (MCTD)

Founded in 1974, the MCTD is a mixed company, in charge of managing the cotton production chain in Mali. It has several missions:

- Agricultural adviser of cotton peasant producers;
- Collection, marketing, ginning cotton seed;
- Sale of cotton fiber for export and to Malian textile industries;
- Sale of cottonseed to national oil mills.

MINISTRY OF HEALTH AND PUBLIC HYGIENE

The Ministry of Health and Public Hygiene is involved in malaria control through the National Health Directorate (NHD).

NHD was created by the Ordinance No. 01-020/P-RM of 20 March 2001. It aims to:

- Design and develop public health, sanitation and hygiene strategies;
- Develop regulations, contribute to the development of standards and see to their enforcement;

- Carry out the necessary research and studies;
- Prepare projects, programs and action plans and see to their implementation.

Given its missions, DNS will support DPOPP in training activities of health personnel in the management of pesticide poisoning cases, keeping statistics and carrying out epidemiological studies related to public health research institutions.

6.10.2 LAWS AND REGULATIONS

Presently, two main texts are governing pesticides regulation and control in Mali.

- The Act No. 02-014 of 03 June 2002 establishing pesticides registration and control in the Republic of Mali and its Decree N°09-313/P-RM of 19 June 2009 laying down the procedures for enforcement the law establishing pesticides approval and control in the Republic of Mali.
- Act No. 01-020 of 30 May 2001 relating to pollution and nuisance and its Decree No. 01-397/P-RM of 06 September 2001 laying down the terms for managing air pollutants.

In Mali, pesticide regulation is also governed by the following texts:

- Act No. 01-102/P-RM of 30 November 2001 concerning ratification of Ordinance No. 01-046/PRM of 20 September 2001 authorizing the ratification of the Common Regulation of CILSS Member States on the registration of pesticides (revised version), signed in N'Djamena 16 December 1999;
- Act No. 03-003/AN-RM of 7 May 2003 authorizing the ratification of the Stockholm Convention on Persistent Organic Pollutants (POPs) signed in Stockholm on 22 May 2001;
- Decree No. 08-346/P-RM of 26 June 2008 relating to the Studies of Environmental and Social Impact;
- The Order No. 2014-2022/MC-SG of 29 July 2014 laying down the list of prohibited goods for import and export including pesticides;
- The Order No. 02-2669/MAEP-SG of 18 November 2002 establishing the conditions for issuing the authorization for pesticides resale;
- Ordinance No. 01-046/P-RM of 20 September 2001 authorizing the ratification of the joint rules between CILSS Member States on the registration of pesticides (revised version), signed in N'djamena on 16 December 1999;
- The Order N°2011-2221/MA-SG of 9 June 2011 laying down the organization and functioning of the permanent secretariat and committees of the National Pesticides Management Committee (NPMC-Mali).
- The Order N°10-4684/MA-SG of 29 December 2010 appointing the members of the National Pesticides Management Committee (NPMC -Mali) and the Permanent Secretariat.
- Decision No. 02-0674/MAEP-SG of 18 November 2002 appointing the members of the National Pesticides Management Committee (NPMC).

6.11 THE PROVISIONS MADE FOR TRAINING OF USERS AND APPLICATORS

The effectiveness of the IRS program depends on the availability of adequately trained spraying personnel, well-maintained equipment, and competent supervision, as well as end-user acceptability and

compliance. PMI has developed guidelines for IRS operations ("Best Management Practices (BMP) for Indoor Residual Spraying in Vector Control Interventions", updated 2015), and provides a training manual "Spray Operator Pocket Guide" (A. Were, (2014)). Other resources include the *Manual on Sound Management of Pesticides and Diagnosis and Treatment of Pesticide Poisoning,* USAID PMI's IVM PEA (USAID, 2012 Updated), as well as this SEA, all of which provide precautions and recommendations on many aspects of IRS operations. The IRS BMP manual and the PMI IVM PEA requirements are the primary references and have precedence, but the other documents may be used as a reference. It is not incumbent upon the IP to comply with non-PMI documentation except where required by law. However, PMI/USAID requirements are usually stricter than others', so there should not be a conflict.

PMI will support the training of spray operators and supervisors, and provide overall guidance and logistical support to the IRS operations in Mali. The contractor will continue to provide technical support for environmental compliance, with a medium-term goal of building national capacity to progressively transfer responsibilities. Preparations will include the following:

- A training of trainers program, in which potential supervisors, storekeepers and team leaders are trained on all aspects of IRS operation. Areas of training shall include planning of IRS, household preparations, record keeping, community mobilization, rational/judicious use of insecticides including sprayer and PPE cleaning, personnel management, environmental aspects of IRS – including geographical reconnaissance, and data recording and analysis.
- The training of temporary workers recruited from local areas and trained as spray team members (operators, team leaders, and wash persons). New operators will receive five to seven days of training prior to the spray operations.

6.12 The Provisions Made for Monitoring the Use and Effectiveness of the Pesticide

Two kinds of measurements are needed to provide a complete understanding of the effectiveness of pesticide that is being used for IRS. Direct methods measure the efficacy of the pesticide, that is, the degree to which the pesticide is able to kill the targeted mosquito vectors, and involve entomological evaluations on pesticide contact bioassays and related pesticide resistance methodologies as recommended by WHO. The second broad level of measuring the effectiveness of the pesticides relates to the primary goal of reducing the local disease burden. These efforts will require specialized entomological and epidemiological skills and the assessment of the impact of vector control operations, and possibly the assignment of the contributory impact of the IRS operations. This latter measurement is usually done through a combination of methodologies such as measuring the changes in parasite inoculation rates, passive case detection at health centers, and periodic community fever and parasite surveys (active case detection).

Another key characteristic of pesticide effectiveness is the longevity of the treatment. This characteristic has important economic and health implications: the program must adjust its spray schedule to make sure that there is active pesticide on the walls of homes during critical breeding periods. Unfortunately, the guidance that is provided with regard to effective period for each pesticide is very broad (e.g. 3-6 months), and the effective period is probably subject to complex environmental factors such as heat, humidity, and substrate (wall, ceiling) composition.

However, pesticide manufacturers are well aware of the need for duration of effectiveness, and in some cases are reworking their formulations to provide greater longevity. This is the case for pirimiphos-methyl organophosphate, which has been formulated as a capsule suspension (CS) that may extend the effectiveness of the application out to six months. Because of the length of the malaria season in Mali, this characteristic may be critical to the success of IRS. Therefore pirimiphos-methyl in the CS formulation has been used for PMI spraying in the districts of Baroueli and Bla, in 2014 and in Koulikoro and Baroueli in 2015.

7 SAFER USE ACTION PLAN

This section outlines the safer use action plan proposed for the potential adverse impacts outlined in Section 5. The primary mitigation measures include delivery of a mix of IEC approaches targeting the residents and spray operators and all IRS personnel, training of spray operators and strengthening supervision and monitoring, and provision of appropriate PPE and facilities for the storage and disposal of pesticides and contaminated waste. The mitigation measures, along with monitoring and reporting information, are compiled in the EMMP found in Annex A.

7.1 IMPLEMENTATION CONDITIONS

During implementation, PMI/Mali and its PMI IRS IPs will adhere to the conditions detailed in this Safer Use Action Plan, and in the Environmental Monitoring and Mitigation Plan (EMMP), Annex A of this report.

7.1.1 QUANTIFICATION OF PESTICIDE REQUIREMENTS

PMI IRS IP will conduct an annual logistics assessment for all targeted districts for planning and procurement of the correct quantity of materials, including insecticides. Purchase of insufficient pesticide will lead to shortages, delays, and possibly the inability to spray all targeted areas. Purchase of too much pesticide may lead to expiration of the pesticide before it can be used up, which creates serious storage and disposal problems.

7.1.2 PESTICIDE QUALITY ASSURANCE

The procurement and use of pesticides that do not meet the necessary quality assurance standards can compromise the overall spray quality and desired vector action while at the same time could expose the residents and spray operators to hazards related to altered toxicological characteristics.

PMI program will procure the insecticide from a reputable supplier. Pesticide batches will be analyzed for the concentration of the active ingredient prior to shipment to Mali. Additional sampling and testing may be performed upon arrival. Delivery of all insecticide to the central warehouse will be supervised by PMI and NMCP before being dispatched to the districts where spray operations will be concentrated.

7.1.3 PESTICIDE TRANSPORT

After the receipt of insecticide at the central warehouse, insecticides are transported to the district warehouses (during the campaign) by road. During transportation, there is a risk of vehicle accidents and consequent insecticide spillage. It is essential that the vehicle type and speed of transport be matched to the conditions. Drivers must take no chances.

A lockable box truck is the expected vehicle to transport insecticides from central to district stores. If box trucks are not available, the IP will notify the COR to receive instructions for an alternative security mechanism. All vehicles must be in good condition and pass the Pre-Contract Vehicle Inspection performed by the Environmental Compliance Officer or their qualified designate, using a smart phone. If

during transport the pesticides are to be left unattended for any period of time, including lunch breaks or overnight stops, a lockable box truck is required.

Prior to long-distance transport of the insecticide from the customs warehouse or central storage facility, drivers will be trained about general issues surrounding the insecticide and how to handle emergency situations such as accidents or spillage. Training for long-distance transport will include the following information:

- Purpose of the insecticide (indoor usage for malaria protection, not for agricultural or any other outdoor use
- Toxicity of the insecticide
- Security issues, including implications of the insecticide getting into public access.
- Hazardous places along the routes to be taken, and mitigation measures.
- Steps to take in case of an accident or emergency (according to BMP standards)
- Combustibility and toxicity of the combustion byproducts of insecticide

Drivers hired for intra-district transport of insecticide and spray team members during the spray campaign will receive training in:

- Operator transportation best practices and vehicle requirements from PMI IRS BMP #2, Worker and Resident Health and Safety.
- Health and safety as provided to spray operators, with the exception of sprayer operation and spray practice.
- Handling an accident or emergency according to BMP standards.
- Handling vehicle contamination.
- Vehicle decontamination procedures.

Figure 12 below provides a list of key responses to mitigate the impact of the insecticide spills.

FIGURE 12: EMERGENCY RESPONSE TO A SPILL

IN CASE OF INSECTICIDE SPILLS

1. Control, contain and clean up the spill
2. Don protective clothing prior to attempting to clean the spills.
3. It is imperative to avoid fire as a result of the accident and a fire extinguisher should be deployed just in case. The engine must be shut off and smoking in the area strictly prohibited.
4. Onlookers and bystanders must be cautioned against approaching the accident site.
5. If the crew has come in contact with the pesticides, they must remove contaminated clothing immediately and wash the pesticide off their skin.
6. For major spills send for help immediately; drivers must have cell phones and an emergency number for use in such cases.
7. People must be kept away and the spill covered with earth, sand, etc.; no attempt should be made to wash away the spill with water or other substances.
8. Vehicles that are used for transporting large quantities of pesticides are required to be equipped with a bucket of sand, sawdust or soil, a shovel, and fire extinguisher.

Because vehicles used for insecticides transportation can be used for the transport of other goods, it is important to ensure that vehicles are decontaminated after use. The drivers will be responsible for cleaning and decontaminating the interior of the vehicle and exterior bed at the end of the spray campaign. Drivers will be provided with gloves, overalls, and rubber boots to wear for cleaning the vehicle. All cloths used in wiping down the interior and bed of the vehicle will be washed with soap and water. If pesticide is transported over water, BMP #10, Water Transport (PMI IRS BMP Manual, 2015) must be followed in every detail.

7.1.4 Qualification of Warehouses (Storage Facilities)

IRS pesticides can cause adverse impacts to human health, animals, and the natural environment if not properly stored according to PMI BMPs. Before insecticides are procured or transported to the spray areas, suitable warehouse(s) must be assessed to ensure that they can meet BMP standards. During the geographical reconnaissance and logistics assessments, the need for new or rehabilitation of previously used district warehouses to meet PMI IRS BMP standards for pesticide storage will be assessed. The standards include:

- Located at least 30 meters from flood plains, wetlands and water bodies, markets, schools, dwellings, beehives, and protected areas. Warehouses may not be located in the buffer zones of protected areas, or in schools.
- Spacious enough to store insecticides in bulk and to store other IRS commodities separately

- A separate space for the storekeeper's office.
- Well ventilated and allowing for air circulation
- Built of concrete or other solid material
- Impervious flooring, or floor must be completely covered by a leak-free tarpaulin
- Watertight roofing
- Barred and screened windows
- Preferably 2 exits from the pesticide storage area for emergency purposes
- Fire extinguisher

In addition to the above, all facilities used for storage, distribution, and transportation of insecticide products should comply with relevant requirements of Mali in pesticide regulations. During the logistical needs assessment, the PMI IRS IP will identify warehouses at the district level that can meet these requirements. PMI cannot provide funds for the construction of new buildings, but can assist in the modification or renovation of existing facilities

7.1.5 Qualification of Liquid Waste Disposal Facilities (Wash areas, Soak Pits)

Pyrethroids, OPs and carbamates degrade quickly when exposed to environmental action such as photolysis, hydrolysis, and bacterial action. If wash areas and soak pits are properly constructed in appropriate locations and used according to BMPs, liquid pesticide waste will be captured in the charcoal layer of the soak pit and held until it breaks down by these natural processes.

Site considerations for locating IRS cleaning and waste management facilities (progressive rinse, wash areas, soak pits) include soil type, topography, vertical distance to ground water, and proximity to schools, lakes, streams, and other sensitive areas. Ideally, disposal facilities should be located adjacent to the storage facilities, where they can be more easily protected and monitored. However, the setting or the function of buildings provided for storage are not always appropriate for setting a wash area, so it may need to be placed some distance away. Due to access limitations and distance to some spray sites; it may be more feasible to locate a small wash facility in an appropriate area near the spray site.

Soak pits must be located at least 30 meters from any sensitive areas such as water bodies, flood plains, habitat, schools and other public buildings, areas protected by regulations, and areas of high groundwater. They should be located on relatively high ground to increase the vertical distance to groundwater. The general area should be level, but the wash area must be constructed to slope gently toward the soak pit or toward the collection point that is piped to the soak pit .

Although the soak pit captures the majority of pesticide from wash waters, small amounts may pass through and enter the soil below. Soil characteristics affect how pesticides move through the soil, and how they break down by environmental or microbiological degradation. Clay soils have a high capacity to absorb many pesticides, but if hard-packed, may have limited percolation abilities. Sandy soils have a much lower capacity to absorb pesticides, but liquids percolate rapidly. Where possible, locate facilities on fine textured soils with organic content and good absorptive properties to capture and degrade trace amounts of pesticide. Hard packed clay or rocky soils are not appropriate.

Pesticides may move in water runoff as compounds dissolve in water or attach to soil particles. Facilities should be located on high, level ground to minimize exposure to runoff. Avoid steep slopes or natural runoff flow lines. Where necessary, curbs or berms will be constructed around wash areas to divert storm water runoff away from the soak pit, and to contain any spills or overflows. In very rainy areas or

seasons, it may be necessary to cover the soak pit and wash area when not in use with a tarpaulin, to prevent flooding of the soak pit and subsequent runoff of pesticide-contaminated water.

7.1.6 Warehouse/Storage Risk Management

In order to mitigate risks associated with pesticide storage, the following will serve as warehouse/storage best management practices:

- A trained storekeeper will manage each facility and will wear gloves, mask, overalls, and boots when in the pesticide area of storage.
- No smoking or eating will be allowed within 30 meters of the pesticide storeroom.
- Pesticide storage facilities must have thermometers installed for daily temperature recording.
- Soap and clean water will be available at all times in all the facilities.
- Recommended pesticide stacking position and height in the warehouse as provided in the FAO Storage and Stock Control Manual will be followed.
- A fire extinguisher will be available in the storage facilities and all site workers will be trained on how to use this device.
- Warning notices will be placed outside of the store with skull and crossbones pictogram, and warnings in the local language
- Insecticides must be lifted off of the floor via pallets or shelves.
- First aid kits must be fully stocked and available in all the central warehouses and secondary stores. Security and inventory management of first aid supplies is mandatory.

Accidental Warehouse Fires

Inhalation of toxic fumes in the event of a storehouse fire is a major risk of IRS. The risk can be minimized, however, by following BMPs for storage, including prohibiting lighted materials in or near the warehouse or in the vicinity of pesticides during transport to/from vehicles, providing fire extinguishers, and proper ventilation of storerooms.

7.1.7 Fetal Exposure (Pregnancy Testing)

All female candidates for spray teams will be tested for pregnancy before being recruited into the spray operations and every thirty days until operations end. Provided their work history has been acceptable, females who have been hired and later found to be pregnant will be re-assigned to positions that do not have the potential for exposure to insecticides. Women who are breastfeeding cannot have any contact with pesticides, and are thus prohibited from spraying of pesticide or washing contaminated items.

7.1.8 Spray Operator Exposure

The individuals recruited for IRS campaigns will receive intensive training on the use, operation, calibration and repair of the spray pumps, including hands-on exercises prior to the beginning of the spraying campaign. They will also be trained to understand proper hygiene, to recognize the signs and symptoms of poisoning, and to understand the referral procedure for any incidents involving poisoning. This training will be conducted in accordance with the IRS Training Guide for Spray Operations (USAID, 2009) and the 2015 IRS BMP manual. Potential spray operators must also pass written and practical tests at the end of training.

Training for monitoring spray operators for symptoms of pesticide exposure will be mandatory for team leaders and supervisors, as well as for storekeepers and other senior personnel. Any case of an

operator or beneficiary displaying symptoms of exposure will require the immediate completion of a standard Incident Report Form by the district coordinator, who will forward the report to the PMI (COR) Team and the PMI IRS Activity Manager in Mali from receipt.

For malathion and fenitrothion OPs, it may be necessary to monitor the level of acetyl cholinesterase in any worker who may have been exposed to contamination. Occupational exposures to OP insecticides are measurable using blood cholinesterase and urinary excretion of chemical biomarkers. WHOPES Working Group recommendations stated that, "provided that operational guidelines are followed, routine cholinesterase monitoring of spray men during IRS programs is not required" for Actellic CS. At the present time, biomonitoring is not required for PMI IRS, but increased supervision and monitoring are.

7.1.9 Beneficiary Exposure

Residential exposure will also be monitored. During the IEC campaign, residents are made aware of the steps to take if exposed, and, especially if acute symptoms are encountered, the advice is to report to the nearest health facility. Thus, reported cases at health facilities or by IEC mobilizers will serve as the principal monitoring strategy for beneficiary exposure incidents.

NMCP, and the PMI IRS IP and other partners will work with relevant institutions at all levels to carry out an IEC campaign/BCC to sensitize residents to IRS activities, in accordance with WHO guidelines and also Mali National Malaria Strategic Plan 2014-2020 and PMI Malaria Operational Plans. The IEC campaign carried out by IRS project leaders should focus on the following elements of residential safety during an IRS program:

- Clear homes of mats or rugs, furniture, cooking implements and foodstuffs prior to spraying; if furniture cannot be moved out of the home, then move it to the center of the room and covered with impermeable material.
- Stay at least 10 meters from the home during spraying, and for two hours after spraying.
- Move and keep all animals at least 10 meters from the home during spraying, and for two hours after spraying.
- After two hours, open all windows and doors and air the house out for ½ hour.
- Sweep up any insects killed from the spraying and drop them in latrine pits before allowing re-entry by children and animals.
- Do not re-plaster or paint over the sprayed walls after spraying.
- Keep using mosquito nets for additional protection against malaria.
- If skin itches after reentrance into home, wash with soap and water; For eye irritation, flush eyes with water; For respiratory irritation, leave the home for fresh air; For ingestion, if soap and water are unavailable, or if symptoms persist, contact program staff or go to nearest health facility which has the appropriate medical intervention.
- If spraying during the rainy season, the teams should use the following Contingency Plan which will minimize exposure of household effects.

During the rainy season:

- Each spray operator must be given adequate covering material (3m by 3m minimum), which should be used to cover household effects moved to the center of the room (only if necessitated by rain, etc.) More than one sheet may be required, depending on the size of structures and the amount of belongings.
- Materials can also be moved into structures that are not targeted to be sprayed, e.g., an isolated kitchen or domestic animal shelter.
- Move the household effects to one room which will not be sprayed on that particular day, but the next day.
- The spray teams should pay close attention to any signs of potential rains so that they prepare the communities accordingly.

When it rains in the middle of spraying:

- Stop the spraying activities.
- Cover the household effects with an impermeable material. These materials should have already been procured by the program and given to each operator.
- After the rains stop and the weather is considered good, spraying can continue.

7.1.10 Pesticide Exposure and Treatment

All spray operators, team leaders, and supervisors will receive detailed training on the emergency steps to take if accidental exposure of the chemical occurs including ingestion, inhalation, eye or dermal contact with the chemical. This training will be conducted by the District Coordinators and government technical services and will include drills to test knowledge of the operators. However, most interventions for acute exposure will have to be provided by medical professionals at the nearest health clinic, so transporting the exposed person to the health clinic will be the priority.

PMI IRS IP will confirm that all the health facilities around the spray sites have in their store the recommended treatment drugs, and that all the staff responsible for administering emergency treatment to pesticide exposure receives appropriate training. Annex F provides additional information on symptoms and treatment protocols.

7.1.11 Solid and Liquid Contaminated Waste Management

Non-contaminated wastes or those that can be cleaned thoroughly with soap and water will be recycled whenever possible, or disposed of in a municipal landfill if there is no appropriate recycling outlet.

Liquid contaminated wastes will be disposed of on a daily basis in soak pits that are carefully sited and designed according to the criteria in the PMI BMP manual. The soak pit is designed so that pesticides are absorbed by the charcoal layer, and held until environmental processes result in the degradation of the pesticide. Thus, there should be no contaminated liquid waste to deal with at the end of the spray season.

Contaminated solid wastes are incinerated in incinerators that are capable of destroying the pesticide and preventing environmental contamination. Incinerators recommended for disposal of contaminated wastes fall into two categories, those that meet:

- ❖ Basel Convention technical standards for all insecticides that do not contain greater than 1% halogens,
- ❖ WHO/FAO standards: to be used if we are using DDT or insecticides which contain > 1% halogens.

For wastes containing less than 1% halogens (e.g., chlorine, bromine):

- The recommended combustion temperature is >850 °C.
- An afterburner is required, with a residence time of at least two seconds.
- The incinerator must have emission control, including particulate matter filters.
- Ash and slag produced by high-temperature incineration of pesticides are best incorporated into concrete and buried in a secure location. In Mali, solid wastes are incinerated in a PMI-owned incinerator, ash and slag will be incorporated into cement blocks and buried.

For wastes containing greater than 1% halogens:

- The recommended combustion temperature is between 1100-1300 °C.
- An afterburner is required, with a residence time of at least two seconds.
- A quench rinse for the gas stream that causes a rapid temperature drop to below 250 °C
- The incinerator must have emission control, including particulate matter filters.
- Ash and slag produced by high-temperature incineration of pesticides are best incorporated into concrete and buried in a secure location.

Incineration is not recommended for polyvinyl chloride or other chlorinated wastes such as gloves and boots. Gloves and boots no longer usable for IRS can be easily decontaminated with soap and water and then offered to spray team members, or disposed of as normal nonhazardous waste.

Empty plastic containers should not be incinerated due to the difficulty inherent in burning them cleanly, and the nuisance and toxic emissions that may result. Once punctured to prevent reuse, plastic bottles can be triple rinsed and recycled at an appropriate facility, or land filled.

Cardboard boxes previously containing intact insecticide sachets or bottles are not considered as contaminated waste. Incineration is not recommended for cardboard boxes unless they have been contaminated by pesticide leakage, or used for the storage of other contaminated wastes. In many cases uncontaminated boxes can be recycled, or can also be disposed of as normal nonhazardous wastes. In Mali, the incineration will take place at the PMI-owned incinerator at Noumoubougou (in the district of Koulikoro). The EMMP in Annex A gives details on the steps and measures that will be taken to prevent negative impacts on the non-target ecosystems from liquid and solid IRS waste materials and disposal practices.

Annex A: Environmental Mitigation & Monitoring Plan

Please See the EMMP next page

Category of Activity	Describe specific environmental threats of your organization's activities	Description of Mitigation Measures	Who is responsible for monitoring	Monitoring Indicator	Monitoring Method	Frequency of Monitoring
Use of insecticides	1. Occupational risks for workers involved in IRS campaigns (e.g., risks from insecticide exposure and vehicular accidents), especially women of child-bearing age	a. Inspect and certify vehicles used for pesticide or spray team transport prior to contract. b. Train drivers c. Ensure that driver has cell phone, personal protective equipment (PPE) and spill kits during pesticide transportation (Phone must be provided by rental company). d. Initial and 30-day pregnancy testing for female candidates for jobs with potential pesticide contact. e. Health test all spray team members for duty fitness. f. Procure, distribute, and train all workers with potential pesticide contact on the use of	a-d. Abt Environmental Compliance Officer (ECO). e-g. Abt Operations Manager (OM). h. ECO i. Chief of Party (COP), Technical Project Managers (TPM) and headquarters environmental staff.	a. Transport vehicles have a valid inspection certificate on-board. b. Drivers have a certificate of training completion. c. Transport vehicles are equipped with cell phone, spill kit, and PPE. d. Storekeeper has records of pregnancy testing for all female team members. e. Storekeeper has medical exam results for all team members. f. Spray operators wear complete PPE	a-c. ECO inspection of vehicles in the field. d-e. ECO inspection of health records at IRS operational sites. f-h. ECO performs pre-spray inspections of inventories and training records, and mid-spray inspections of PPE use and spray operator performance. i. Monitoring of on-line database for submission of inspection reports.	a-c. 2 inspections per week. d-e. One inspection per campaign, additional inspection if new hires or more than 30 spray days. f-h. ECO pre-spray inspections 2/campaign, ECO mid-spray inspections 5 times/week. i.Weekly

Category of Activity	Describe specific environmental threats of your organization's activities	Description of Mitigation Measures	Who is responsible for monitoring	Monitoring Indicator	Monitoring Method	Frequency of Monitoring
		PPE. g. Train operators on mixing pesticides and the proper use and maintenance of spray pumps. h. Provide adequate facilities and supplies for end-of-day cleanup. i. Enforce clean-up procedures. k. Daily checks on spray operators health by team leaders.		during spraying and clean-up. g. Operators mix pesticide properly, and the pump does not leak. h. All facilities are compliant, and materials required for clean-up are present. i. Inspections are performed as scheduled, corrective action is taken as needed.		
	2. Safety risks for residents of sprayed houses (e.g., risks from inhalation and ingestion of insecticides)	a. IEC campaigns to inform homeowners of responsibilities and precautions. b. Prohibit spraying houses that are not properly prepared. c. Two-hour exclusion	a-b. IEC officers, OM, ECO c. ECO d. Spray operators (SO) and Team Leaders (TL)	a. Pre-spray IEC campaigns were executed. Homeowners know responsibilities. b. All houses being sprayed are	a. OM- IEC work records, ECO- mid-spray inspections. b-d. ECO mid-spray inspections	a. Inspect work records 1/campaign, b-d. ECO mid-spray inspections 3/wk.

Category of Activity	Describe specific environmental threats of your organization's activities	Description of Mitigation Measures	Who is responsible for monitoring	Monitoring Indicator	Monitoring Method	Frequency of Monitoring
		from house after spraying d. Instruct homeowners to wash itchy skin and go to health clinic if symptoms do not subside.		properly prepared. c. Homeowners observe 2 hour exclusion. d. Lack of incident reports, or incident reports with proper response noted.		
	3. Ecological risk to non-target species and water bodies from use of insecticides (during mixing and spraying)	a. Spray indoors only. b. Train operators on proper spray technique. c. Maintain pumps. d. Monitor spraying in sensitive sites. Maintain required spray distance from bee keeping, wetlands, surface water.	a-c. TL, Abt District Coordinator (DC), OM, ECO	a. Operators spray only inside of houses. b. Operators are trained and know and use proper spray techniques. c. Pumps are maintained and operated to eliminate leaks and erratic spraying.	a. ECO mid-spray inspections. b-c. Training records, ECO mid-spray inspections	a. ECO inspections 3/wk. b. ECO inspection of training records 1/campaign. b-c. ECO mid-spray inspections 5/wk.
	4. Environmental risk from disposal of	a. Choose sites for disposal of liquid wastes	a-c. Abt OM, ECO, DC	a. Operations sites meet PMI BMPs.	a-b. ECO Pre-spray inspections	a.2/campaign

Category of Activity	Describe specific environmental threats of your organization's activities	Description of Mitigation Measures	Who is responsible for monitoring	Monitoring Indicator	Monitoring Method	Frequency of Monitoring
	insecticide (both liquid and solid waste)	according to PMI BMPs. b. Construct soak pits with charcoal to adsorb pesticide from rinsewater. c. Maintain soak pits as necessary during season. d. Inspect and certify solid waste disposal sites before spray campaign. e. Monitor waste storage and management during campaign. f. Monitor disposal procedures post-campaign.	d-f. Abt ECO	b. Soak pits are constructed according to the AIRS BMP manual. c. Soak pits perform properly throughout the spray season. d. Disposal sites have the capacity and policies to properly dispose of wastes. e. Wastes are stored and managed according to PMI BMPs. f. Waste disposal has taken place as agreed and certificates of disposal received.	c-f. ECO mid- and post-spray inspections and monitoring.	b.1/campaign c. 5/week d. 1/campaign e. 3/week f. Continuous during disposal
	5. Risk of diversion of insecticides for	a. Maintain records of all pesticide receipts, issuance, and return of	a-d. Storekeepers, District coordinators,	a-d. All pesticide management records are	a-b, d. Inspection of pesticide management records. Storekeeper	a-b, d. Daily monitoring by storekeeper or site

Category of Activity	Describe specific environmental threats of your organization's activities	Description of Mitigation Measures	Who is responsible for monitoring	Monitoring Indicator	Monitoring Method	Frequency of Monitoring
	unintended or uncontrolled use	empty sachets/bottles. b. Reconcile number of houses sprayed vs. number of sachets/bottles used. c. Examine houses sprayed to confirm spray application. d. Perform physical inventory counts during the spray season. e. Maintain secure transport of pesticides by using a lockable box truck or equivalent security mechanism approved by the COR.	sector managers, logistics coordinator, OM, ECO	reconciled.	performance checklists. c. ECO mid-spray inspections.	supervisor. Weekly monitoring by District Coordinators c. 1/campaign by country headquarters. 2/campaign by ECO d. 2/campaign/ store-room

Annex B: EMMR Form

Mitigation Measure	Status of Mitigation Measures	Outstanding issues relating to required conditions	Remarks
1a. Pre-contract inspection and certification of vehicles used for pesticide or spray team transport.			
1b. Driver training			
1c. Cell phone, personal protective equipment (PPE) and spill kits on board during pesticide transportation.			
1d. Initial and 30-day pregnancy testing for female candidates for jobs with potential pesticide contact.			
1e. Health fitness testing for all operators			
1f. Procurement of, distribution to all, and training for all workers with potential pesticide contact.			

Mitigation Measure	Status of Mitigation Measures	Outstanding issues relating to required conditions	Remarks
1g. Training on mixing pesticides and the proper use and maintenance of spray pumps.			
1h. Provision of adequate facilities and supplies for end-of-day cleanup,			
1i. Enforce clean-up procedures.			
2a. IEC campaigns to inform homeowners of responsibilities and precautions.			
2b. Prohibition of spraying houses that are not properly prepared.			
2c. Two-hour exclusion from house after spraying			
2d. Instruct homeowners to wash itchy skin and go to health clinic if symptoms do not subside.			
3a. Indoor spraying only.			

Mitigation Measure	Status of Mitigation Measures	Outstanding issues relating to required conditions	Remarks
3b. Training operators on proper spray technique			
3c. Maintenance of pumps			
4a. Choose sites for disposal of liquid wastes according to PMI BMPs.			
4b. Construct soak pits with charcoal to adsorb pesticide from rinse water.			
4c. Maintain soak pits as necessary during season.			
4d. Inspection and certification of solid waste disposal sites before spray campaign.			
4e. Monitoring waste storage and management during campaign.			
4f. Monitoring disposal procedures post-campaign.			
5a. Maintain records of all pesticide receipts, issuance, and			

Mitigation Measure	Status of Mitigation Measures	Outstanding issues relating to required conditions	Remarks
return of empty sachets and bottles.			
5b. Reconciliation of number of houses sprayed vs. number of sachets/bottles used.			
5c. Visual examination of houses sprayed to confirm pesticide application.			
5d. Perform physical inventory counts during the spray season.			

ANNEX C: PUBLIC CONSULTATION

The Health District of Fana

The public consultation framework plan's goal is to ensure the environmental and social acceptability of the IRS at the local level, with all players in a network of information share on IRS activities. The exercise aimed to bring the various stakeholders to have a common understanding on the basis of mutual conviction, common principles and shared objectives. In this context a public meeting was held in Fana on March 15, 2016, under the chairmanship of Deputy Prefect of Diola to which Fana report. In practice, the method used in public consultation process has focused on the following areas:

- Public announcement and information of local actors: municipal, administrative officials, press, village authorities, civil society, Technical Directors of Community Health Centers (DTC), Abt Associates/AIRS Representatives, National Directorate of Sanitation and Pollution Control, Koulikoro Regional Directorate of Health to which the District of Fana report, NMCP Representative (see attendance list);

- Presentation of PMI IRS program in Mali by Koulikoro Regional Director of Health, followed by debate;

The meeting was focused entirely on Fana's IRS coverage and organizational arrangements by the beneficiary population. In her address, Koulikoro Regional Director of Health focused on the fact that: "malaria prevention and control are major objectives of foreign aid from the Government of the United States of America. The Presidential Malaria Initiative (PMI) was launched in June 2005 as a five-year initiative of US $1.2 billion to rapidly increase interventions for malaria prevention and treatment and 50% reduction in mortality from malaria in the 15 high burden countries in sub-Saharan Africa including Mali. " Residents were informed after Koulikoro and Baroueli, the health district of Fana will be covered during the 2016 campaign. The actors in the audience were invited to take over for wide dissemination in their respective village so that the campaign becomes a success. Particular emphasis was placed on the male/female parity concerning their involvement in spraying operations. Enthusiasm among residents was evident through the many questions on IRS.

The discussions helped inform stakeholders on the strategies advocated by PMI in Mali to address social and environmental issues. Of all the environmental and social issues, the following points were raised by local authorities and technical services, namely:

- effectiveness of the insecticide used (remanence)
- spraying period
- procedure
- spray operator recruitment
- environmental impact, etc

In the particular context of Fana, which will be sprayed for the first time, IRS success depends on the full involvement of all stakeholders. Therefore the PMI IP informed the audience on a series of activities it intends to undertake in the next few days (working out structures eligible to IRS, actors hiring and training, identification of secondary store, etc.). Regarding hiring of spray personnel, the PMI IP explained that it will be done according to the village and/or quarter approach. However municipal and administrative authorities involved in this recruitment must designate committed and hard-working actors. Particular attention was given to communication and information dissemination on IRS through local radios, opinion leaders and the Technical Directors of health centers.

Annex D: Names of Participants

N°	Full Name	Village	Position
1.	Boubacar Coulibaly	CHC/Kotoula	DTC
2.	Clazié I. Cissouma	CHC/Kerela	DTC
3.	Dramane Kouyaté	CHC/Djélé	DTC
4.	Adama Tessougue	Radio Siguidolo	Director
5.	Aminata Traoré	Les ECHOS	Journalist
6.	Moussa Sanogo	Radio Kolombada	Animator
7.	Moussa Diarra	Fana	AMIPI
8.	Dr. Oumar Doumbia	CHC/Falako	DTC
9.	Dr. Seydou Traoré	CHC/Nangolo	DTC
10.	Mouctar Koné	CHC/Seyla	DTC
11.	Abel Diabaté	CMDT	DTC
12.	Dr. Diakité Syrimory	CHC/Dioumazana	DTC
13.	Oumou Coulibaly	Fana/Private Radio	Director
14.	Kone Fatoumata Thiam	Independent	Journalist
15.	Dr Diabaté Moussa	CHC/Fana	DTC
16.	Dr. Diamouténé Alphonse	CHC/Mena	DTC
17.	Dr. Doucouré Bassidy	CHC/Djebe	DTC
18.	Dr. Diarra Oumar	CHC/Marakakoungo	DTC
19.	Bourama Coulibaly	Binko	Mayor
20.	Dr.Oumar Bamba	CHC /Beleko	DTC

21.	Brehima Doumbia	AMAP	Journalist
22.	Sidiki Fomba	CHC/Konkoni	DTC
23.	Alou Diabaté	Benkady Common	1er Deputy Mayor
24.	Bah Djenta	Z Coulibaly Common	Responsible for health
25.	Cissé Kalifa	Fana	Civilian Society
26.	Abdou Fomba	Radio JEKAFO Fana	Journalist
27.	Coulibaly Ousmane	Radio jamako/Diola	Journalist
28.	Tata Fané	Fana	Youth Representative
29.	Amadou Koné	Fana	Church minister
30.	Oumar Ali Maïga	CAP/Fana	Director
31.	Babintou Sissoko	Women Network /Fana	President
32.	Maxime Keïta	Diola	SACPN Chief
33.	Roumain Coulibaly	Fana	Representative Catholic Church
34.	Dr. Moulaye Farota	Bamako	Consultant
35.	Abdourahamane Dicko	Bamako	PNLP Representative
36.	Mohamed El Béchir Simpara	Bamako	DNACPN
37.	Gninto Dembele	Dolenetou Common	Mayor
38.	Kôh Keïta	CHC /Tingolé	President
39.	Banou Traoré	Fana	Chief of village
40.	Boubacar Touré	Mairie de Fana	Conseiller
41.	Moulaye Kone	Beleko	Sous-Préfet

42.	Diélimoussa Diabaté	Diola	2ème Deputy Prefect
43.	Modibo Coulibaly	Fana	Journalist
44.	Oumar H Touré	Fana	Sub-Prefect
45.	Adama Mariko	Diola	President of the Circle Council
46.	Bagnini Sow	Radio Guegneka /fana	Journalist
47.	Diakaridia Togola	Radio Dafina/Fana	Journaliste
48.	Adama Fomba	Djélé	CHCA President
49.	Abdoulaye Mallé	Mairie de Fana	Deputy Mayor
50.	Adama Dembélé	Diédougou	Mayor
51.	Drissa Fomba	Bougoucourala	CHCA President
52.	Bakary Coulibaly	Faracoro	CHCA President
53.	Seydou Coulibaly	Korokoro	CHCA President
54.	Kader Soumaoro	Koulikoro	DRS driver
55.	Doumbia Bintou	Abt -Bamako	Database Manager
56.	Tahirou Dolo	Abt –Koulikoro	Coordinator
57.	Abdoul Samadou Diop	Abt –Baroueli	Coordinator
58.	Dr. Seydou Traoré	Abt-Bamako	Director of operations
59.	Mamadou Djouldé Bah	Abt-Bamako	M.E Manager
60.	Dr.Diarra Traoré	Regional Health Directorate of Koulikoro	Director
61.	Banou Traoré	Fana	Chief of village

ANNEX E: REFERENCES

RTI International April 2011. Supplemental Environmental Assessment: Indoor Residual Spraying for Malaria Control in Mali

USAID February 2015. President's Malaria Initiative Best Management Practices (BMP) for Indoor Residual Spraying (IRS) in Vector Control Interventions.

NMCP August 2013. Strategic Plan of Malaria Control 2013-2017

Ministry of Health March 2015. National Indoor Residual Spraying (IRS) Strategy for Malaria Control in Mali (2015 - 2019)

Abt Associates September 2013. Madagascar Supplemental Environmental Assessment 2013-2018.

WHO (2012). Global plan for insecticide resistance management in malaria vectors
World Health Organization, Geneva

WHO. (2013) Test procedures for insecticide resistance monitoring in malaria vectors
World Health Organization, Geneva.

WHO (2014). Report of the seventeenth WHOPES working group meeting: WHO/HQ, Geneva, 15-19 September 2014: review of Alpha-cypermethrin 250 WG-SB, Icon maxx, Netprotect LN, Chlorfenapyr 240 SC. World Health Organization, Geneva.

WHO-UNEP Sound Management of Pesticides and Diagnosis and Treatment of Pesticide Poisoning: A Resource Tool. World Health Organization, Geneva.

Annex F: Summary of Acute Exposure Symptoms & Treatment of IRS Pesticides

Summary of Acute Exposure Symptoms and Treatment of WHO-recommended Carbamate

Carbamates	Human side effects	Treatment
Bendiocarb	Excessive sweating, headache, nausea, blurred vision, chest pain, vomiting, excessive salivation, and slurred speech. Severe intoxication causes narrowed pupils, muscle twitching, spasms, intestinal convulsions, diarrhea, and labored respiration.	The affected person should stop work immediately, remove any contaminated clothing and wash the affected skin with soap and clean water. The whole contaminated area (including the eyes, if necessary) should be flushed with large quantities of clean water. The patient should be kept at rest and immediate medical aid obtained. Administer Atropine.
Propoxur	Excessive sweating, headache, nausea, blurred vision, chest pain, vomiting, excessive salivation, and slurred speech. Severe intoxication causes narrowed pupils, muscle twitching, spasms, intestinal convulsions, diarrhea, and labored respiration.	The affected person should stop work immediately, remove any contaminated clothing and wash the affected skin with soap and clean water. The whole contaminated area (including the eyes, if necessary) should be flushed with large quantities of clean water. The patient should be kept at rest and immediate medical aid obtained. Administer Atropine.

Summary of Acute Exposure Symptoms and Treatment of WHO-recommended organophosphates

Organo-phospate	Human side effects	Treatment
Malathion	Malathion is an indirect cholinesterase inhibitor. The primary target of malathion is the nervous system; it causes neurological effects by inhibiting cholinesterase. Exposure to high levels can result in difficulty breathing, vomiting, blurred vision, increased salivation and perspiration, headaches, and dizziness. Loss of consciousness and death may follow very high exposures to malathion.	Oral exposure to malathion should be treated with rapid gastric lavage unless the patient is vomiting. Dermal exposures should be treated by washing the affected area with soap and water. If the eyes have been exposed to malathion, flush them with saline or water. People exposed to malathion who exhibit respiratory inefficiency with peripheral symptoms should be treated via slow intravenous injection with 2–4 mg atropine sulfate and 1,000–2,000 mg pralidoxime chloride or 250 mg toxogonin (adult dose). Exposure to high levels of malathion that result in respiratory distress, convulsions, and unconsciousness should be treated with atropine and a re-activator. Morphine, barbiturates, phenothiazine, tranquillizers, and central stimulants are all contraindicated.
Fenitrothion	Fenitrothion is the most toxic to man of the insecticides recommended for residual house spraying, and has a relatively low margin of safety. Absorbed through the gastrointestinal tract as well as through intact skin and by inhalation. It is also a cholinesterase inhibitor.	Dermal exposure to fenitrothion should be treated by removing contaminated clothing, rinsing the skin with water, washing the exposed areas with soap and water, then seeking medical attention. If fenitrothion gets into the eyes, they should be rinsed with water for several minutes. Contact lenses should be removed if possible and medical attention should be sought. Ingestion of fenitrothion should be treated by rinsing the mouth and inducing vomiting if the person is conscious. Inhalation exposures require removal to fresh air and rest in a half-upright position. Artificial respiration should be administered if indicated and medical attention should be sought.

Organo-phospate	Human side effects	Treatment
Pirimiphos-methyl	Pirimiphos-methyl is also a cholinesterase inhibitor. Early symptoms of poisoning may include excessive sweating, headache, weakness, giddiness, nausea, vomiting, stomach pains, blurred vision, constricted pupils, slurred speech, and muscle twitching. Later there may be convulsions, coma, loss of reflexes, and loss of sphincter control.	OP poisoning is a medical emergency and requires immediate treatment. All supervisors and individual spray men (in the case of dispersed operations) should be trained in first-aid and emergency treatment of OP intoxication. The affected person should stop work immediately, remove any contaminated clothing, wash the affected skin with soap and clean water and flush the skin with large quantities of clean water. Care must be taken not to contaminate others, including medical or paramedical workers. Automatic injectors loaded with atropine sulfate and obidoxime chloride can be made available in the field whenever relatively toxic OP insecticides are used in areas without easy access to medical care. Atropine sulfate is recommended. Administer atropine sulfate intravenously or intramuscularly if intravenous injection is not possible. Glycopyrolate has been studied as an alternative to atropine and found to have similar outcomes using continuous infusion.

Summary of Acute Exposure Symptoms and Treatment of WHO-recommended pyrethroids

Pyrethroids	Human side effects	Treatment
Bifenthrin	Acute exposure symptoms include skin and eye irritation, headache, dizziness, nausea, vomiting, diarrhea, excessive salivation, fatigue, irritability, abnormal sensations of the face and skin, and numbness. No skin inflammation or irritation observed; however can cause a reversible tingling sensation. Incoordination, irritability to sound and touch, tremors, salivation, diarrhea, and vomiting have been caused by high doses.	Depends on the symptoms of the exposed person. Casual exposures require decontamination and supportive care. Wash affected skin areas promptly with soap and warm water. Medical attention should be sought if irritation or paresthesia occurs. Eye exposures should be treated by rinsing with copious amounts of water or saline.
Deltamethrin	Acute exposure symptoms include skin and eye irritation, headache, dizziness, nausea, vomiting, diarrhea, excessive salivation, fatigue, irritability, abnormal sensations of the face and skin, and numbness.	If exposed immediately remove any contaminated clothing. Soak any liquid contaminant on the skin clean affected area with soap and warm water. Rinse copiously with water when eye exposures occur or 4 percent sodium bicarbonate. Vomiting should not be induced following ingestion exposures, but the mouth should be rinsed.
Lambda-Cyhalothrin	Skin exposure leads to transient skin sensations such as periorbital facial tingling and burning. Can irritate the eyes, skin, and upper respiratory tract. Oral exposure can cause neurological effects, including tremors and convulsions. Ingestion of liquid formulations may result in aspiration of the solvent into the lungs, resulting in chemical pneumonitis.	Dermal exposure should be treated by removing contaminated clothing and washing the exposed areas with soap and water. Eyes should be rinsed with water for several minutes. Vomiting should not be induced following ingestion. Inhalation exposures require removal to fresh air and rest.

Pyrethroids	Human side effects	Treatment
Alpha-Cypermethrin	Acute exposure symptoms include skin rashes, eye irritation, itching and burning sensation on exposed skin, and paraesthesia. Acute inhalation exposures may cause upper and lower respiratory tract irritation. Ingestion of alpha-cypermethrin is also harmful	Dermal exposure should be treated by removing contaminated clothing and washing the exposed areas with soap and water. Eyes should be rinsed with water for several minutes. Vomiting should not be induced following ingestion. Inhalation exposures require removal to fresh air and rest.
Cyfluthrin	Acute occupational or accidental exposure results in burning, itching, and tingling of the skin. Reported systemic symptoms included dizziness, headache, anorexia, and fatigue. Vomiting occurs most commonly after ingestion of pyrethroids. Less commonly reported symptoms include tightness of the chest, paresthesia, palpitations, blurred vision, and increased sweating. In serious cases, coarse muscular fasciculations (twitching), convulsions, and coma.	If exposed immediately remove any contaminated clothing. Soak any liquid contaminant on the skin clean affected area with soap and warm water. Rinse copiously with water when eye exposures occur or 4 percent sodium bicarbonate. Vomiting should not be induced following ingestion exposures, but the mouth should be rinsed.
Etofenprox	Acute occupational or accidental exposure results in burning, itching, and tingling of the skin. Reported systemic symptoms included dizziness, headache, anorexia, and fatigue. Vomiting occurs most commonly after ingestion of pyrethroids. Less commonly reported symptoms include tightness of the chest, paresthesia, palpitations, blurred vision, and increased sweating. In serious cases, coarse muscular fasciculations (twitching), convulsions, and coma.	If exposed immediately remove any contaminated clothing. Soak any liquid contaminant on the skin clean affected area with soap and warm water. Rinse copiously with water when eye exposures occur or 4 percent sodium bicarbonate. Vomiting should not be induced following ingestion exposures, but the mouth should be rinsed.

Summary of Acute Exposure Symptoms and Treatment for Chlorfenapyr

Human side effects	Treatment
As chlorfenapyr is a rather new product there are not many cases of poisonings where the symptoms were described. For the time being, one patient first exhibited general fatigue, hyper-perspiration, nausea and vomiting. He was initially diagnosed as being dehydrated. Another patient initially presented with hyper-perspiration, headache and cough. Symptomatic management was initiated, but after seven days she suffered neurological and respiratory deterioration, causing her death.	Symptoms following exposure should be observed in a controlled setting until all signs and symptoms have fully been resolved. If ingested, control any seizures first. Chlorfenapyr can produce abnormalities of the hematopoietic system, liver, and kidneys. Do not use emetics. Monitoring complete blood count, urinalysis, and liver and kidney function tests is suggested for patients with significant exposure. If respiratory tract irritation or respiratory depression is evident from inhalation, monitor arterial blood gases, chest x-ray, and pulmonary function tests. Significant esophageal or gastro-intestinal tract irritation or burns may occur following ingestion. Consider gastric lavage after ingestion of a potentially life-threatening amount of poison if it can be performed soon after ingestion (generally within 1 hour). Protect airway by placement in Trendelenburg and left lateral decubitus position or by endotracheal intubation. Activated charcoal binds most toxic agents and can decrease their systemic absorption if administered soon after ingestion. Immediate dilution with milk or water may be of benefit in caustic or irritant chemical ingestions. Rinse mouth and administer 5 ml/kg up to 200 ml of water for dilution if the patient can swallow, has a strong gag reflex, and does not drool. Observe patients with ingestion carefully for the possible development of esophageal or gastrointestinal tract irritation or burns. If signs or symptoms of esophageal irritation or burns are present, consider endoscopy to determine the extent of injury. Carefully observe patients with inhalation exposure for the development of any systemic signs or symptoms and administer symptomatic treatment as necessary. If exposure is to the eyes, immediately irrigate exposed eyes with copious amounts of room temperature water (better with 0.9% saline) for at least 15 minutes. If irritation, pain, swelling, lacrimation, or photophobia persists, the patient should be seen in a health care facility. For dermal exposure remove contaminated clothing and wash exposed area thoroughly with soap and water. A physician may need to examine the area if irritation or pain persists.